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Perspectives: A study of the Innovation Management Capability of an Irish SME, as perceived by the key players in the Innovation Process

By

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Signed: Caitríona Ansbro Date: 1st September, 2009

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Abstract

One of the biggest challenges facing organisations today is to consistently and sustainably innovate. This must be achieved in the face of global recession, intense competition and demanding dynamic markets. It cannot be achieved by just having innovators; innovation must be effectively managed, and it is this complex task which forms the basis for the ensuing research.

Organisational innovation is a game of many players, each with an important role on the innovation team. This research assesses the innovation game at Aerogen Ltd., a young Irish SME, whose innovation endeavours to-date have been recognized and rewarded in the medical device industry. The research draws from the wide-ranging perspectives of the key players in the innovation process – cross-functional, hierarchical, long-serving and newly-hired – to determine if their perceptions align, and if the innovation management practices of the company will help to pave the way to future growth and competitive success.

The research utilises a case study approach, which has been carried out in a number of phases. A deductive, multi-method approach began with a thorough review of the academic literature to identify "best practices" in innovation management. A survey approach gathered both quantitative and qualitative data from the various participant groups, and post-survey interviews were carried out to clarify, confirm and discuss the survey outcomes.

The research concludes that Aerogen has many innovators, but must now adjust some aspects of its innovation management systems and processes to ensure that long-term innovation and competitive success can be achieved.

1. Research Introduction

1.1 Introduction

Innovation: what was once a buzzword of the 1990's, has since become a global superstar; having been firmly embedded in the strategic mantras and marketing slogans being bandied daily across board rooms throughout the country. And unlike other buzzwords of the 90's (recall a time when we all thrilled at the mention of the "new economy"), it looks like innovation is here to stay.

In just a few years, innovation has become the most commonly cited champion of organisational competitive success and economic wealth. It is a subject which has neatly found its way into every business administration and marketing course worth mentioning. Its popularity is certainly not unwarranted, given that an abundance of research carried out over recent years has decidedly aligned effective innovation with high organisational performance and financial gain.

Furthermore, the need for innovation has never been more apparent. We are living in a high-tech world of global competition and dynamic marketplaces, which has no time for complacency. Consumers are constantly searching for the "next big thing", and are generally afforded the luxury of a global marketplace in which to find it. However, the "next big thing" is typically warranted no more than 15 minutes of fame before being ousted by something cheaper, better, faster, stronger, whatever the case may be. The competitive nature of today's markets requires that organisations not only quickly and continuously adapt to environmental changes and challenges, but that they do so in advance of their rivals. This requires continual organisational learning and a dynamic approach to the development of organisational capabilities (Teece et al., 1997).

SME's are in for a more challenging ride, given that the luxuries of funding, wide-ranging capabilities and abundant resources are more difficult to acquire, particularly in these turbulent economic times. Hewitt-Dundas (2006) informs us that the advantages of scale and scope make larger organisations better equipped for innovations which require

large specialist teams or sophisticated equipment, highlighting that SME's need to foster strategic external partnerships in achieving successful product innovation.

Such things are hard to come by, and it is therefore no surprise that the number of stories of companies who collapsed through a failure to innovate far outweigh those with a "happily ever after" ending. Unfortunately, many of those leading companies who sang the innovation song over the past few years have made the detrimental mistake of letting initial successes make them complacent about innovation, having since all but faded into the background as new technologies and competitors left them scratching their heads at the starting post. Further companies have fallen into competitive decline, having struggled to maintain the entrepreneurial spirit of innovation while adapting the organisation to accommodate growth. And further companies still have simply failed to overcome the many significant barriers to innovation.

The reason for such failures is, of course, poor innovation management. It is not enough to simply talk the innovation talk; the real challenge is to consistently, effectively and sustainably walk the innovation walk. Effective innovation management is what separates the winners from the losers, and it is this difficult management challenge which forms the basis of the ensuing research endeavour.

1.2 Aims and Objectives

The aim of this research is to assess the innovation management capability of a Galway-based medical devices company. Aerogen Ltd. is an Irish-owned SME which has received significant commendations and recognition for its innovations efforts to date. The company's roots lie firmly with a charismatic and entrepreneurial leader, who has effectively grown the organisation from just three initial employees to a healthy 36 members of staff over the past decade. This growth has brought with it all of the well-known management challenges of maintaining the culture and climate for innovation in an expanding organisation, while structuring for efficient professional management.

Aerogen's initial successes have been achieved through the development and commercialisation of a platform of three products, all of which are based on its core

competency in aerosol generation technology, an enabling technology which, as yet, has only scratched at the surface of its market potential. However, as the organisation continues to rapidly expand while shareholders financial expectations continue to increase, the company is now faced with the need to not only sustain and improve the existing product base and market, but to rapidly innovate new products to new markets in combination. The need for effective innovation management systems has therefore never been more critical.

Over the years, Aerogen have put in place a number of processes and procedures intended to enable the structured management of resources in a growing organisational environment, while continuously accommodating innovative activity. The aim of this research is to define, understand and critically evaluate these key processes and practices against those identified as "best in class" in the literature. The ultimate goal is to determine those areas which need to be addressed to accommodate the organisation's future innovation and growth endeavours. The research will gather the views of the various players in the innovation arena, from top management to engineers, across each key functional department, in an attempt to gain a broad and accurate understanding of both the areas of successful performance as well as those areas which need to be addressed.

It is perhaps ambitiously hoped that the research will help each participant in the study to understand and appreciate the views of his or her peers, thereby aiding in the creation of a true organisation-wide sense of what innovation means to Aerogen, and their communal role in its achievement.

1.3 Stakeholders of this Research

The key stakeholders of this research are the employees of Aerogen and those investors who have laid their stake in the company. The output of the study is intended for use by the Aerogen Innovation Management team, in determining the best methods by which the innovation capability of the company can be improved.

The research is further intended to assist future researchers in the field of innovation management, in that it provides a reusable approach to innovation assessment. The research highlights the importance of the inclusion of a broad range of cross-organisational participants in studies of this nature. This is emphasised by the wide-ranging views and perceptions provided by the various participants in the study.

1.4 Scope of the Research

This study will determine the innovation management capability of Aerogen, and its scope will extend from the initial "front end" activities through to the end of the new product development process. The following key innovation areas will be broadly encompassed:

- Concept Definition
- New Product Development
- Technology Acquisition
- Systems and Tools
- Measurement
- Linkages
- Strategy
- Leadership
- Learning
- Organising for Innovation

The study will utilise the "best practices", as determined throughout the literature review, in assessing the company's innovation management capability. Areas which can be improved upon will be identified through this benchmarking exercise, and the various views and perceptions of the wide range of participants will be correlated and discussed.

The hypothesis under test is the following:

> **Aerogen's approach to innovation management can serve to effectively lead the company in its future product innovation and growth endeavours.**

It is intended to test this hypothesis through the use of an innovation audit methodology, involving a multi-method approach to data gathering to ensure that an accurate conclusion can be drawn. The key research questions to be addressed are:

Q1: How well do the innovation management practices at Aerogen (both at the front end and in new product development) compare with best practices identified in the literature?

Q2: What areas of innovation management can Aerogen improve upon?

Q3: Do the innovation management views of the various players in the innovation process align with each other?

The third research question is of particular interest to this author, who, coming from an engineering background and having taken part in many innovation surveys in recent years, has often wondered how differently one of her peers would have responded to such surveys in her place.

1.5 Research Methodology

The research method chosen is that of the case study. This method has been chosen to enable an in-depth analysis of a complex subject, which requires deductive reasoning and the gathering of both quantitative and qualitative data.

The deductive approach will progress through a number of steps:

1) Identify through a thorough literature review, the "best practices" of effective innovation management.
2) Utilise a multi-method approach to capture the data required to test Aerogen's innovation management practices against those identified as "best practice".

3) Conduct a series of unstructured, informal interviews to expand upon, clarify and verify the data gathered.
4) Compare the Aerogen data gathered with the "best practices" as prescribed, to determine key areas of success as well as areas which require improvement.
5) Review the data obtained for any significant differences or similarities in responses received from the various participants across hierarchical levels and functional boundaries.

The study will be completed in a number of phases. Phase 1 will utilise an innovation scorecard, adapted from that provided by Ciesa et al. (1996), to quickly capture a high-level view of the perceived innovation capability of the organisation in a number of key areas of activity. Phase 2 utilises a more detailed innovation questionnaire, intended to further clarify and verify the findings of Phase 1, while providing a more detailed understanding of Aerogen's employees' views on a number of key management areas deemed integral to successful innovation. The final phase of the study utilises informal unstructured interviews, to further clarify and discuss key audit findings.

1.6 Chapter Overview

This section provides a brief overview of the subsequent research chapters.

Chapter 2 presents a review of the relevant academic literature on innovation in competitive business. Innovation is defined in business terms and its importance is clarified. The existing theories on innovation are reviewed, and the innovation process and its known management challenges are discussed. Various determinants and organisational factors which have been found to influence innovation are further identified. The overall intention is to provide an understanding of the various organisational aspects which should be considered by companies in creating an environment for successful innovation.

Chapter 3 introduces the New Product Development (NPD) process, which spans from concept definition to product development and commercialisation. The literature on NPD is reviewed to uncover best practices in the NPD process. The theory on the front end of

innovation is then broached, in an attempt to identify specific front end best practices against which the Aerogen data gathered can be compared. Finally, the literature on innovation auditing is reviewed, providing an appropriate method by which the innovation management practices of Aerogen can be identified and assessed.

Chapter 4 provides some background to the organisation under assessment. The history of the company is narrated, and its key products and their associated markets are introduced. The future plans of the company are described and the relevance of this research to these plans is highlighted.

Chapter 5 presents the research methodology. The hypothesis under test is clarified and the three key research questions defined. The chosen research method is provided and reasons for this choice are discussed. The various available data gathering methods are considered and the methods chosen expanded upon. The chapter considers the sample population required for the research and the issues of data validity and reliability.

Chapter 6 outlines the research findings. The results of the study are provided and analysed.

Chapter 7 includes a discussion on the research results as presented in Chapter 6.

Finally, Chapter 8 provides the research conclusions drawn, and presents some recommendations for further study.

2. Literature Review Part 1

2.1 Part 1 Contents

- Introduction
- Definition of Innovation
- The Drivers and Value of Innovation
- Innovation Theories
- Innovation Typology
- Innovating Organisations
- The Innovation Process
- Innovation Management
- Concluding Summary

2.2 Introduction

Innovation is everywhere. It is in the products we use, from the simple toothbrush to the plasma TV. It's in the houses we live in, the jobs we carry out, the means by which we communicate, every aspect of our lives. It knows no boundaries. We all know innovation when we see it, yet when asked to articulate its meaning, we often run into difficulty. When asked to describe how to manage innovation, this difficulty is amplified. A Google search of the word 'Innovation' yields an overwhelming 16 million results. Compare this to 192,000 results yielded for the term 'Innovation Management', and the basis for this chapter and subsequent research is borne.

The chapter reviews existing academic literature on innovation in competitive business, aiming to pull together the literature findings into a cohesive line of thought. It seeks to define innovation, to grasp its importance in business terms, and to review the existing theories on innovation, the innovation process, and the means by which innovation is managed. The overall aim is to gain an understanding of the various broad-ranging aspects of innovation which should be considered by companies in developing an innovation management process.

It is intended that the academic literature discussed will provide the backdrop for the next aspect of this literature review, which specifically homes in on two key innovation areas. This first of these is the area of new product development, while the second is what is frequently termed the "fuzzy" aspect of the innovation process, the front end of innovation. It is hoped that by reviewing each of these key areas in separation, the similarities and differences in the means by which both can be best concurrently managed will become clear.

2.3 Definition of Innovation in Business Terms

In today's cut-throat world of competitive business, where new products and services are being churned out at an alarming rate, innovation is increasingly cited as being one of the driving forces behind those companies who compete most successfully. In this fast-paced, high-tech age of global markets, where organisations must 'innovate or die', the questions surrounding what stimulates and promotes innovation, and most importantly, how innovation can be successfully managed, loom large. Before delving into these oft elusive aspects of innovation, the term itself must first be defined.

Austrian economist Joseph Schumpeter (1934) provided one of the earliest definitions, considering five different elements of innovation (Goffin and Mitchell, 2005):

- The introduction of a good (product), which is new to consumers, or one of higher quality than was available in the past;
- Methods of production, which are new to a particular branch of industry. These are not necessarily based on new scientific discoveries and may have, for example, already been used in other industrial sectors;
- The opening of new markets;
- The use of new sources of supply;
- New forms of competition, that leads to the restructuring of an industry.

Schumpeter's definition is quite similar to that proposed by Porter (1990), who further includes the importance of organisational learning in his definition of innovation:

"…to include both improvements in technology and better methods or ways of doing things. It can be manifested in product changes, process changes, new approaches to marketing, new forms of distribution, and new concepts of scope…[innovation] *results as much from organisational learning as from formal R&D."*

A more recent definition, which further incorporates the importance of knowledge, is provided by Luecke and Katz (2003):

"Innovation…is generally understood as the introduction of a new thing or method…Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services."

West and Farr (1990) see innovation as an applied process, viewing innovation as:

"...the intentional introduction and application within a job, work team or organisation of ideas, processes, products or procedures which are new to that job, work team or organisation and which are designed to benefit the job, the work team or the organisation."

Zain (1993) defines the concept of innovation as *"the process of matching organisational and environmental means and needs"*, whereas Drucker aligns innovation with organisational change and performance, defining innovation as *"change that creates a new dimension of performance"* (Hesselbein, 2002).

Much of the earlier literature defines innovation in terms which are analogous with invention. Zaltmen et al. (1973) state that innovation is *"an idea, practice, or material artefact perceived to be new by the relevant adoption unit"*. Story (2004) observes that this definition is one of the most frequently used in the literature, including research by Damanpour et al. (1984), Damanpour (1991) and Freeman (1982).

More recent literature, however, seeks to make the clear distinction between invention and innovation. McKeown (2008) defines invention as an "*idea made manifes*t", whereas innovation is defined as *"ideas applied successfully"*. Rickards (1985) further

distinguishes between invention and innovation, defining innovation as a process whereby *"new ideas are put into practice"*.

Further academic literature seeks to define the explicit relationship between organisational creativity and innovation. Amabile et al. (1996) suggest that innovation begins with creative ideas, and that *"...creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second."*

The reviewed definitions of innovation are broad in scope, but centre on a common theme, that innovation requires newness i.e. a new way of doing things. However, to this end, Rogers (1995) points out that the perception of newness is more important than the originality, stating that innovation *"….is an idea, practice, or object that is perceived as new by the individual or other unit of adoption".*

Buxton (2005) succinctly highlights the difference between invention and innovation, and the notion of innovation as a "black art", stating that:

"[innovation is]*...far more about prospecting, mining, refining and adding value to 'gold' than it is about alchemy. Rather than focusing on the invention of the 'brand new', one might better strive for creative insights on how to combine, develop and leverage what is already out there, but hidden, or not understood."*

In summary, innovation can be defined as simply the act of adding value to an idea or creation, or the process of turning an idea into a new, marketable product. Its scope extends beyond that of creating thinking or initial invention, to encompass all stages of a process which extends from the initial formation of an idea to the final delivery of a valuable product or service to the consumer.

Whereas creativity can be typically thought of as the ability to come up with new ideas, or to apply or combine existing ideas in a new way, and invention could be described as the 'eureka' moment arrived at as a result of creative thinking, the term 'innovation' refers to the process of adding commercial value to an idea or creation. As such, creativity, invention, and innovation go hand-in-hand.

From an organisational perspective, it is also recognized that innovation can encompass the sourcing of creative ideas or inventions external to the organisation, and the process of turning these ideas to the organisation's competitive advantage.

2.4 The Drivers and Value of Innovation

2.4.1 The Need for Innovation

Innovation literature is fraught with theory on what drives a company to innovate, along with examples of the consequences of not doing so. Cooper uses the theme of warfare to highlight the importance of innovating new products to market (2001). He quotes U.S. General Omar Bradley, who stated that "*In war, there is no prize for the runner-up",* to convince organisations that if they don't effectively bring new products to market quickly, they will watch from the sidelines as competitors steal market share (Cooper, 2001).

Cooper's 2001 research indicated that some 33% of companies' revenue came from products which had been introduced in the last five years, and that this figure was increasing such that it was expected that new products would soon account for 50% of a company's profits.

From his research, Cooper (2001) cites the following four key innovation drivers:

- Technology Advances
- Changing Customer Needs
- Shortening Product Life Cycles
- Increased World Competition

Goffin and Mitchell (2005) cite market change as being the key driver of innovation. They categorize four main drivers of market change, most of which align with those identified by Cooper (2001). These, in combination, create the need for innovation and are outlined in Fig 2.1. They include: technological advances, changing customers and needs, intensified competition and the changing business environment.

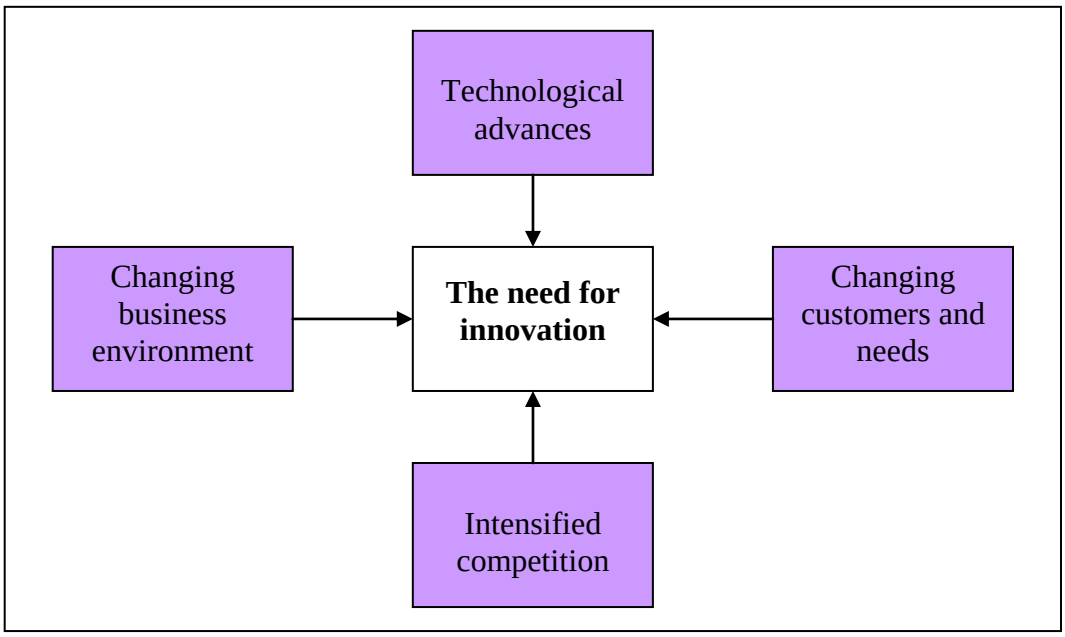

Figure 2.1 Drivers of innovation (Goffin and Mitchell, 2005)

2.4.2 The Value of Innovation

The literature suggests that not only are there numerous environmental drivers necessitating organisational innovation, but further that innovation in itself can be one of the key drivers to achieving long-term success and competitive advantage (Baker and Sinkula, 2002; Lyon and Ferrier, 2002; Utterback, 2001; Wolfe, 1994).

Drucker (1985) aligns innovation with organisational wealth, stating that *"innovation is the specific instrument of entrepreneurship, the act that endows resources with a new capacity to create wealth"*, whereas the research of Tidd et al. (2005) indicates that innovative organisations are up to twice as profitable as other organisations.

Miles and Snow (1978) suggest that organisations with a high capacity for innovation will be in a position to better respond to changes in the external environment, while the studies of Damanpour and Evan (1984) and Schulz and Jobe (2001) indicate the innovation has a positive effect on organisational performance.

On an economic level, Porter views innovation as "*the central issue in economic prosperity*" (1990). Coad and Rao (2006) state that:

"In modern economic thinking, innovation is ascribed a central role in the evolution of industries. In a turbulent environment characterized by powerful forces of 'creative destruction', firms can nonetheless increase their chances of success by being more innovative than their competitors."

Ulku's research on innovation output per capita in OECD countries furthers this view, identifying a positive link between innovation and economic growth (2007).

Innovation can therefore be seen not only as a necessity for organisational survival, but as a driver for long-term organisational success and a key input to economic growth and prosperity.

2.5 Theories of Innovation

One of the pioneers of innovation theory was economist Schumpeter, who introduced the economic concept of 'creative destruction' (1934). His theory describes the transformational process that accompanies spurts of radical innovation, whereby well-established, powerful enterprises and industries are destroyed, and new ones created. Schumpeter proposed that this process of 'creative destruction' was the force that sustained long-term economic growth, and argued that the innovative ability of entrepreneurs was the driving force of economies, generating growth and, through successes and failures, setting the wheels and cycles of economies in motion.

Schumpeter's theories formed the basis of the concept of 'technology push', whereby a new innovation originates in R&D and is pushed through production and sales functions

onto the market, often without due consideration of whether or not it satisfies a market need or customer desire. Schmookler's research subsequently introduced the concept of 'market pull', whereby innovation is pulled from an organisation's R&D, having originated as a result of customer or market demand (1966). Schmookler's research indicated that both 'technology push' and 'market pull' were important sources of innovation, and the author likened each to one half of a pair of scissors, which must effectively work together to serve the innovation purpose.

The dichotomy of 'technology push' and 'market pull' is frequently found in the academic literature, with more recent research advocating user driven innovation, finding that consumers and lead users are an important source of innovate ideas (Von Hippel, 2005). Cooper (2001) stresses the importance of the 'voice of the customer' throughout the innovation process, from the generation of ideas to the evaluation of product prototypes, while the work of Teece (2006) prescribes that both the external and internal environments are important inputs to the innovation process.

Some more recent theories on innovation include those of Chesbrough, who also suggests that innovation can come from both outside and inside of the organisation (2003). Chesbrough proposes an *Open Innovation* paradigm, which assumes that organisations can use both internal and external ideas, as well as internal and external paths to market, in seeking to advance their technologies (2003).

Thomke's research focuses on the means to increase the innovative capacity within the R&D environment through 'enlightened experimentation', and advocates the use of new technologies in every aspect of the development process (2001). He introduces four rules which he believes can increase a companies R&D innovative capacity: organise for rapid experimentation; fail early and often, but avoid mistakes; anticipate and exploit early information; and combine new and old technologies.

Cooper (2001) views product innovation as a staged process, proposing his Stage-Gate approach, with funnels and Go/No-Go criteria enabling a systematic process which he aligns with innovation success, whereas Amabile's (1999) research highlights the importance of creating the right organisational environment for innovation to flourish.

In summary, the academic literature highlights that innovation and innovative ideas can come from both the external and internal environment and that for innovation to thrive, an organisation must be effectively managed and organised, while creating the appropriate organisational environment and implementing effective processes to encourage successful innovation.

2.6 Determinants of Innovation and Innovation Typology

While the innovation theories of 'technology push' and 'market pull' continued to be researched, adapted and debated, academic researchers endeavoured to understand if some 'one size fits all' key influencing factors on successful organisational innovation could be identified (Amabile, 1998; Damanpour, 1991; Kimberly and Evanisko, 1981; Tidd et al., 1997; Tornatzky and Fleisher, 1990; Leonard-Barton, 1992; Wolfe, 1994; Tidd, 2000). This body of research has led to the general recognition that innovation is a process which is contingent on a number of factors, including organisation type, characteristics and competencies, innovation type, and stage of adoption. Other influencing factors include the external environment context and the technological context (Tornatzky and Fleischer, 1990).

Damanpour's (1991) study of the adoption (i.e. *"the generation, development and implementation of new ideas or behaviours")* of multiple innovations, and the organisational properties that serve to enhance or diminish innovation, indicates that distinguishing between the various types of innovation is a necessity and should be considered in the development of future innovation theories. He categorises innovation types into pairs including: Administrative and Technical, Process and Product, and Incremental and Radical.

Duchesneau et al. further discuss the importance of distinguishing between incremental and radical innovations, highlighting that each innovation type leverages different organisational capabilities (1979).

Downs and Mohr discuss innovation types in the organisational context, stating that *"the classification of the innovation depends on the organisation that is contemplating its adoption"* (1976:702). They remind us of the importance of the organisational context, stating that innovation *"might be seen as minor or routine by some organisations but as major or radical by others"* (1976:704).

Mohr et al. (2005) provide a continuum of innovations which places innovative developments on a continuum ranging from incremental, modest developments to radical, breakthrough developments, as depicted in Fig. 2.2. The continuum of innovation clearly distinguishes between incremental and radical innovation, and enables a better understanding of the theory that each type of innovation leverages different organisational capabilities.

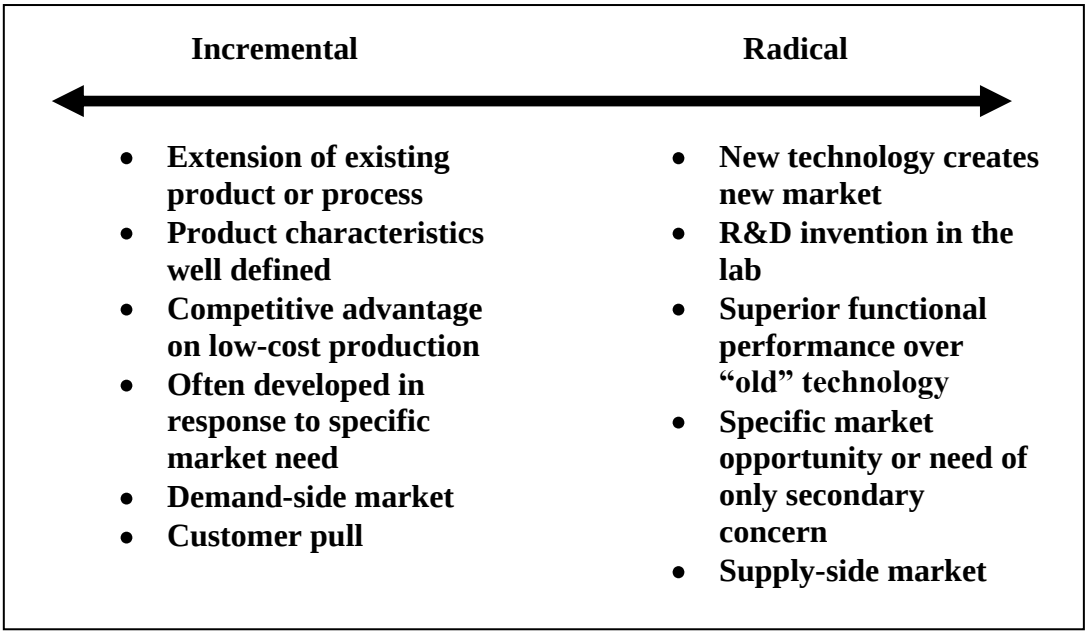

Fig. 2.2 Continuum of Innovations (Mohr et al., 2005)

In summary, the academic research indicates that there is no universal set of innovation determinants. Rather, that the determinants of innovation are dependent on a number of organisational, technological and external environmental factors, as well as on innovation types themselves.

2.7 Innovating Organisations

The literature recognizes three sets of organisational environmental variables which have been found to influence innovation, namely structural, cultural and human resource variables.

In terms of *structural variables*, Damanpour's research yielded positive associations between innovation and functional differentiation, external and internal communications, administrative intensity and slack resources, while yielding negative associations between innovation and centralization (1991). Kanter et al. (1987) advocate structures that develop people in the entrepreneurial spirit and that maintain their commitment to the organisation, while Burns and Stalker (1961) promote organic structures, which typically are decentralized and informal. The authors state that these should have an emphasis on lateral interaction and an equal distribution of knowledge throughout the organisational network. From a management and human resources perspective, Paulillo and Brown (1978) found positive correlations for innovation with autonomy, information flow, creativity, rewards and training. The number of formal supervisory levels and the number of R&D employees were negatively correlated with innovation, whereas the size of the research project teams was positively correlated with innovation. The research of Katz and Allen (1985) found that appropriate separation of roles between project and functional managers in R&D matrix structures promoted overall R&D productivity.

In terms of *cultural variables*, Lumpkin and Dess (1996) propose that "*it is the freedom granted to individuals and teams who can exercise their creativity and champion promising ideas*" that is needed for innovation to occur. This must occur free of stifling organisational constraints. Kanter (1983) suggests that innovating organisations need to adopt a *"culture of pride and climate of success*". She prescribes that the structures within such organisations must be compatible with the culture, furthering the research argument that bureaucratic structures can stifle innovation. Tushman and O'Reilly (1997) emphasise the need for flexibility, speed and responsiveness in adapting to changing circumstances on the one hand, while on the other hand they suggest that some degree of consistency, reliability and stability should be maintained.

Theory on culture generally advocates low external controls, acceptance of ambiguity, tolerance of the impractical, tolerance of conflict, and the rewarding of creativity and ideas – both good and bad. Employees must feel that it is expected of them to innovate, and focus must remain on the ends rather than the means. Risk-taking and participation must be encouraged, and a sense of responsibility must be cultivated from the top down. Resources and time must also be made available for people to undertake creative and innovative work in line with communicated strategic goals and objectives and punishment for failure must be avoided.

The final group of organisational variables which have been found to influence innovation performance are *human resource variables*. Goffin and Mitchell (2005) stress that human resources must be managed strategically i.e. people management must be aligned with innovation strategy. They list the following key human resource components which influence innovation performance:

- Recruitment and assigning jobs
- Managing performance
- Motivation, rewards and recognition
- Employee training and development

2.8 The Innovation Process

Academics agree that the 'art' of innovation is a process which begins with an idea and ends with a valuable product or service. An early description of the process of innovation was put forth by Coombs et al. who described it as "*a sequence of stages, starting from either R&D or some perception of demand and ending with a product sold on the market*" (1987). The Coombs et al. model prescribes that the outputs from the previous stage become the inputs to the next i.e. that the innovation process is linear in fashion (1987). However, more recent models challenge the linear approach with an 'interactive model', a model which characterises the innovation process by continuous interaction and feedback, emphasising the role of R&D (OECD, 1992).

Rothwell informs us that there are in fact five generations of innovation models which have evolved over time, having originated with the linear model (1992). According to Rothwell (1992), the 'fifth generation' of innovation models describe innovation as a process of extremely high levels of interaction, both internal and external to the organisational environment, which is greatly assisted by the use of Information Technology.

Goffin and Mitchell (2005) state that any innovation must progress through a number of phases irrespective of the type of innovation, be it administrative, product, process or service. They present the typical phases of innovation using the idea of a 'development funnel' (Majaro, 1988), whereby the outputs of the initial phases (i.e. ideas, concepts) are whittled down as the process progresses. The Goffin and Mitchell (2005) model is outlined in Figure 2.3. The model appears linear in nature, however the authors stress that while the simple flow from idea, to concept, to implementation is certainly desirable, this is not necessarily easy to achieve, and that many phases in fact often overlap and include many iterations.

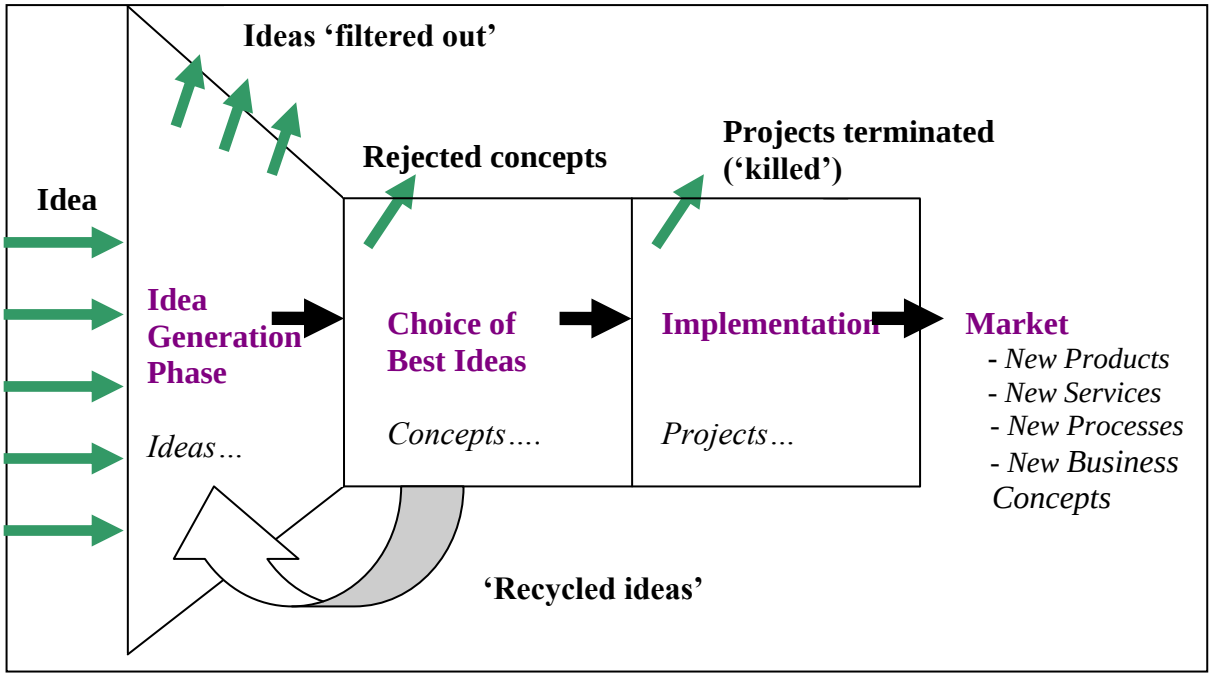

Figure 2.3 Typical phases of an innovation process (Goffin & Mitchell, 2005)

It can be seen from the literature that the innovation process is a multi-staged, complex endeavour, contingent on many organisational and environmental factors, and it is

therefore no surprise that much further research continues to be dedicated to unravelling the challenges and complexities of managing the innovation process.

2.9 Innovation Management

Innovation management is a multi-faceted and challenging endeavour, which requires a vast array of both 'technical' and 'soft' skills on the part of the innovation manager (Goffin and Mitchell, 2005). Van de Ven (1986), author of one of the most recognized articles on the management of innovation, proposes that to manage innovation is to *"understand the process of innovation and to understand the actors that facilitate and inhibit the development of innovations. These factors include ideas, people transactions, and context over time"*. He further stresses the complexity of innovation management, and his (1986) research seeks to tackle a number of key problem areas which innovation managers face, namely:

- How to develop an organisational culture of innovation
- How to prepare for innovation while organising for efficiency
- How to direct attention away from protection of existing practices
- How to institutionalise leadership and create an infrastructure conducive to innovation

Goffin and Mitchell (2005) emphasise that there are no 'quick fixes' in innovation management, highlighting that its complexity is compounded by the fact that many ideas that are effective in one organisation cannot be easily transferred; managers must adapt them to each situation their company faces. The authors liken innovation management with competing in the Olympic pentathlon, stating that excellent performance in one area alone will not guarantee a gold medal, and introduce their Innovation Pentathlon Framework, which categorizes what they deem to be the main issues facing innovation managers into five different areas, per Fig 2.4 (2005).

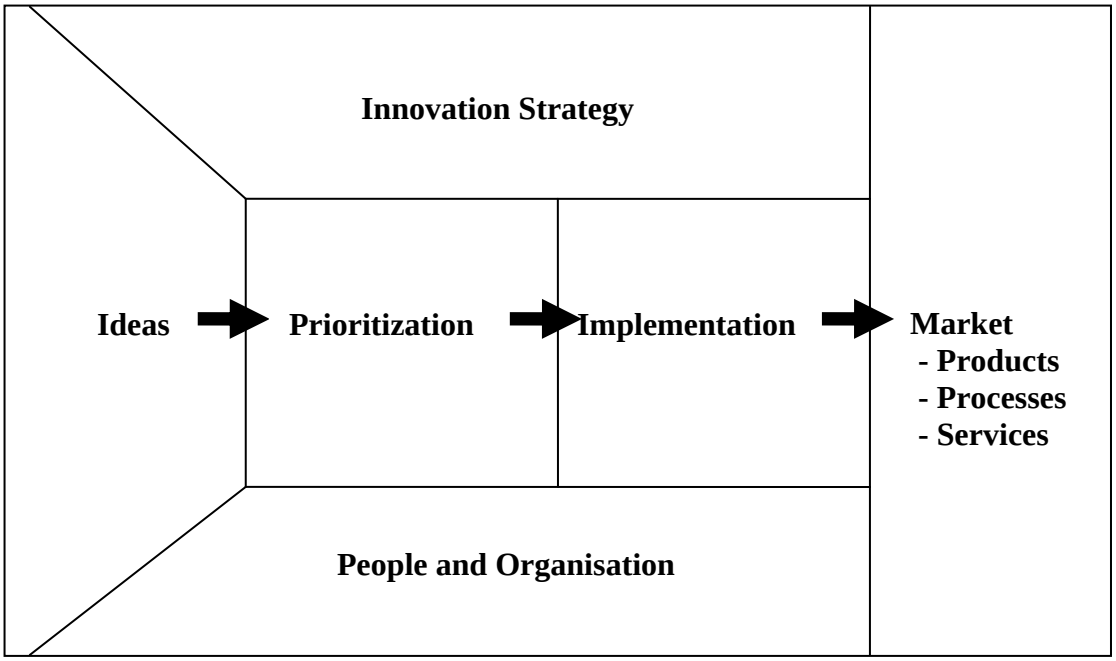

Fig 2.4 Innovation Pentathlon Framework (Goffin and Mitchell, 2005)

To summarise, the innovation process extends the length and breadth of an organisation and beyond to its external environment, therefore one of the key themes of the research is that innovation managers must grapple with innovation from a broad front, applying different methods and approaches across the various stages and aspects of the innovation process. Effective innovation management requires orchestrated attention to many organisational factors, including organisational culture, structure, leadership and learning.

2.10 Concluding Summary

This introductory chapter of the literature review has taken a 'wide lens' view of innovation. It posed and attempted to answer a number of general questions, beginning with the definition of innovation, and progressing to identify its importance, its determinants, its influencing organisational factors, the nature of the innovation process and the management challenges it poses.

We have seen that the innovation process involves a wide variety of actors, whose combined activities lead to the introduction of new and successful products and services to a welcoming market. We understand the need for effective management of the innovation process, and the complexities and challenges this brings.

The following chapter will narrow in scope, focusing on the practices involved and challenges posed at both the earlier stages and the new product development phase of the innovation process.

3. Literature Review Part 2

3.1 Part 2 Contents

- Introduction
- The New Product Development (NPD) process
- Best Practices in NPD
- The Fuzzy Front End (FFE) of Innovation
- Structuring the Front End
- Best practices in the Front End of Innovation
- Innovation Auditing
- Concluding Summary

3.2 Introduction

The aim of this dissertation is to assess the innovation management practices of Aerogen against those identified as best practice within the academic literature.

The first chapter of the literature review took a broad look at the innovation process and its determining factors and influences, attempting to loosely identify the various areas which should be considered in evaluating the innovation practices of the organisation. This second chapter now delves further into the academic literature on the new product development process, and its pre-cursor, that of the "Fuzzy Front End" of innovation. The intent is to gain a better understanding of the various aspects of each of these areas, how they fit into the overall innovation process, and the processes and best practices by which the entire process might be tamed and evaluated.

The chapter begins with an introduction to the New Product Development (NPD) process, which spans from concept definition to new product development, to commercialisation. Best practices in the NPD process are identified and discussed in

detail. The theory on the front end of innovation is then broached, in an attempt to identify specific front end best practices against which an audit result can be compared.

Finally, the relevant literature on innovation auditing is considered, to determine the appropriate approach by which the innovation management practices of Aerogen Ltd. can be appropriately identified and assessed.

The chapter concludes with a brief overall summary of the literature reviewed.

3.3 The New Product Development process

According to Koen et al. (2002), the entire innovation process can be divided into three sub-processes: the fuzzy front end, new product development, and commercialization. Of these three processes, one of the most heavily researched is that of the new product development process, which could be described as a well-defined set of concurrent and/or sequential steps, requiring integration across an organisation to successfully design, develop and launch a given product for its chosen market.

The research into the NPD process heavily advocates the use of a structured staged or phased approach to its implementation, indicating that organisations that adopt and effectively execute a staged process are more successful than organisations that take a less systematic approach (Cooper and Kleinschmidt, 1994; Cooper, 1996; Cooper et al., 2004). Griffin's (1997) research furthers these findings, and the research of Nicholas et al. (2008) indicates that having a structured NPD process in place is highly ranked by both SMEs and large organisations throughout Ireland and the UK, in terms of its importance to NPD success.

There are a vast amount of models available which divide the NPD process into a number of phases. One of the most successful of these is the Stage-Gate™ model, provided by Cooper (2001), which builds on 'best practice' NPD studies of in excess of 2,000 projects. The model is based on the principle that the development of a new product begins with an idea and concludes with a product launch. It divides the new product development process into a number of stages, ranging from the 'discovery' and

preliminary assessment of an idea to its commercialisation as a final product. Each stage of the model includes its own 'gate', which is a decision-making checkpoint where a project can be terminated, put on hold, or progressed to the next project stage.

Cooper's (1985) original Stage-Gate model incorporated five stages, omitting those 'fuzzy' aspects at the beginning of the innovation process, and spanning from Idea Screening at Stage 1, to Product Commercialization at Stage 5. However, the model has since been considerably revised, addressing a number of identified issues such as excess bureaucracy and lack of flexibility. In response to research findings on the criticality of front-end or pre-development activities to organisational competitive success, Cooper (2001) further introduced some aspects of the pre-development process to the model, as a precursor to Stage 1. He names this newly introduced stage the 'Discovery' stage, or Stage 0, and his most recent research prescribes that this stage should include the following vital predevelopment activities (Cooper and Edgett, 2008):

- Preliminary market assessment
- Technical assessment
- Source-of-supply-assessment: suppliers and partners or alliances
- Market research: market size and segmentation analysis, voice of the customer research
- Product concept testing
- Value-to-the customer assessment
- Product definition
- Business and financial analysis.

The third generation of the Stage-Gate model features six fundamental 'F's, and a graphical representation of the model is depicted in Figure 3.1 (Cooper, 2001:145):

1. Flexibility
2. Fuzzy (conditional gates)
3. Fluidity
4. Focus (project prioritisation and portfolio management)
5. Facilitation

6. Forever green – always regenerating and improving

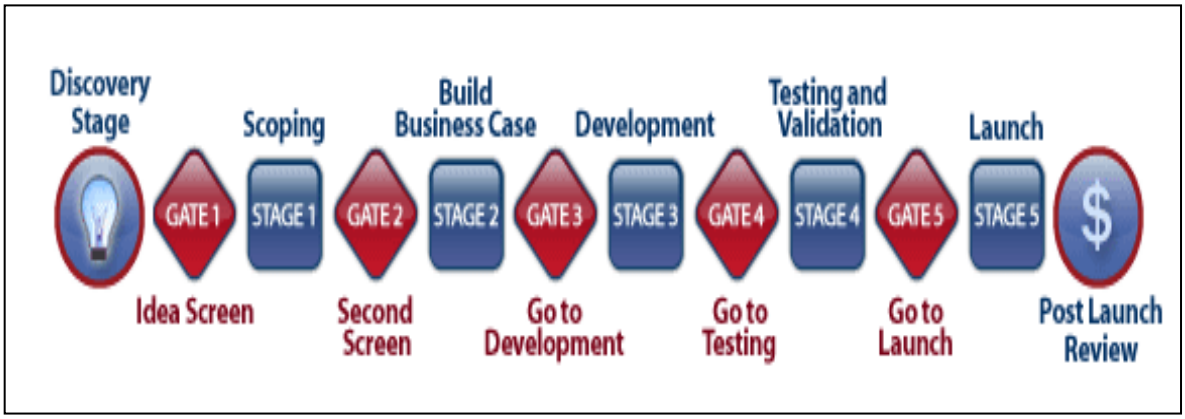

Figure 3.1 Cooper's Stage-Gate Process (image from http://www.prod-dev.com)

The research on NPD identifies a number of goals for a new product development process. Cooper (2001) identifies seven goals, as follows:

1. Quality of execution
2. Sharper focus, better prioritisation
3. Fast-paced parallel processing
4. A true cross-functional team approach
5. A strong market orientation with 'Voice of the Customer' built in
6. Better homework up front
7. Products with competitive advantage

Smith and Reinersten (1998) view NPD processes in the context of the overall goals of the organisation, listing four strategic goals which need consideration when designing a process:

1. Time-to-market
2. Product cost
3. Customer benefits delivery
4. Development costs

In terms of influencing factors on the NPD process, Ledwith (2000) identifies four sets of factors which must be present in a firm, in order for it to be able to implement an efficient and successful new product development process. These are displayed in Table 3.1.

Organisational Factors - Internal/external relations - Inter-functional communication	**Development Process Factors** - Top management support/skill - Speed to market - Financial
Skills and Capabilities - Technological synergy - Marketing synergy - Company resources - Strategy	**Marketing and New Product Characteristics** - Product advantage - Market potential - Market competitiveness - Environment

Table 3.1 New Product Development Success Factors Matrix (Ledwith, 2000)

3.4 NPD Best Practice Framework

The research on NPD proposes a number of frameworks to enable benchmarking of a company's NPD practices against the best in class. One such framework is that proposed by Kahn et al. (2006). Their model is based on the results of the benchmarking studies carried out on hundreds of companies by industry experts Griffin (1997) and Cooper et al. (2004a, 2004b). It comprises six NPD dimensions across four levels of maturity or sophistication, to describe poor, better, good and best practice in new product development. The six NPD dimensions or key process areas (KPAs) identified by the framework developers are: Strategy, Portfolio Management, Process, Market Research, People, and Metrics and Performance Evaluation.

Strategy

The importance of having a clearly defined and effectively communicated business strategy in place, and of aligning all pursued NPD activity with company strategic goals, has long been advocated as key to the achievement of competitive advantage by leading experts in both NPD and organisational strategy. Hamel and Prahalad (1992) advocate that the application of concepts such as 'strategic fit' (between resources and NPD opportunities), 'generic strategies' (low cost vs. differentiation vs. focus), and the 'strategy hierarchy' (goals, strategies and tactics), have often abetted the process of

competitive decline. Cooper et al. (2004) maintain that strategy is key to competitive advantage and stipulate that a product innovation and technology strategy for a business should include clearly defined NPD goals, strategic arenas or areas of focus, and a product or technology roadmap (which maps the major initiatives over the next 5-10 years). In industry, more recent research carried out by Nicholas et al. (2008) identify strategy as the most highly ranked of the identified NPD dimensions.

Portfolio Management

The second NPD dimension identified by Kahn et al. (2006) is that of portfolio management, which is intended to aid in the screening out of the least preferable product concepts to identify the best product concepts with which to proceed. The importance of effective portfolio management in NPD success is highlighted by Cooper et al. (2004), who identify key issues including the selection and prioritization of high-value projects (and killing off of poor ones) and ensuring that there is a good balance and mix of projects in the portfolio. They also highlight the need to appropriately balance the limited resources available against the demand to take on even more projects. Adams-Bigelow (2006) stresses that portfolio balancing should be more strategically than financially based, considering long-term rather than short-term potential for success.

Process

The area of process, whose importance is outlined above, represents the various NPD stages, tasks and activities, and gate criteria for moving products from concept to launch.

Market Research

The area of market research is most important. It not only determines the potential for a new product's commercial success at an early stage in the NPD process, but also aids in ensuring that a new product is developed inline with customer requirements, thereby multiplying its potential for acceptance and success within the market. Effective market research includes the customer in the overall design process, helping to ensure that the needs of the customer are kept to the fore throughout any NPD process (Cooper, 2004). Finally, market research aids in determining an understanding of the market space, including the competitive situation, expected sales revenue, market size and potential,

and customer perceived reaction to the proposed product and price sensitivity (Cooper et al., 2002).

People

While it is relatively simple to implement the processes and procedures required for successful NPD, no new product can be effectively introduced if sufficient, adequate resources are not made available. The people area, outlined by Kahn et al. (2006), includes human resources and team-related initiatives, and is based on expert opinion that NPD teams should include a cross-functional mix of appropriate people, and that the most successful companies are those with a centralized NPD function where NPD experts work fulltime on such activities (Cooper et al., 2002). Adams-Bigelow (2006) suggests that the maturity model needs to go beyond criteria about individual teams to include criteria related to inter-team learning and senior and functional management support to and interactions with teams. Kuczmarski (2006) suggest that people must be motivated and rewarded for their NPD efforts, specifically in relation to calculated risks, and must be encouraged and recognized to create new business models and new ways of delivering value to customers. Kuczmarski (2006) also highlights that it is not enough to simply have cross-functional teams in place, but that companies must focus on creating an innovation mindset and in enabling a risk-taking culture in the organisation, in order to reap the financial rewards associated with the successful innovation of more risky products.

Metrics & Performance Evaluation

The final area identified in the Kahn et al. (2006) model is that of metrics and performance evaluation, an area in which many companies have difficulty, in that in some cases the appropriate metrics for evaluation can be difficult to determine. In many companies, this area is ranked low in terms of its perceived impact on NPD performance and success (Nicholas et al., 2008). However, leading NPD experts have highlighted this as being of significant importance in achieving maturity and excellence in NPD, as that *"what cannot be measured, cannot be improved"* (Cooper et al., 2002).

Metrics and performance evaluation pertain to how NPD performance is measured, analysed and rewarded (Kahn et al., 2006). As highlighted above, Cooper et al. (2002) advocate the use of the Stage-Gate process, whereby Go/No-Go gates are utilized to review each stage of the process and to sanction the proceeding to the next stage of the process. The authors advise that the best performing companies are those who actively measure specific NPD goals such as market share, customer satisfaction, time to market, sales volume, and customers' attitude toward the brand (Cooper et al., 2002). However, some experts highlight that traditional metrics such as revenue and market impact may not be traceable. This is especially true in radical innovation projects, as stressed by (Peters, 2006).

In summary, the research suggests that an effective New Product Development process is typically systematic yet flexible in structure, comprising a number of interdependent stages or phases, with Go/No-Go criteria determining either project termination or progression to the next stage in the process. The stages typically range from concept to product commercialisation, with more recent models having incorporated some aspects of the Front end of innovation, and stressing the 'Voice of the Customer'.

The research highlights that the NPD process should be approached from a strategic perspective, and that a range of factors, both organisational and external, can determine its successful implementation. Frameworks of best practice have been developed to enable a company to benchmark NPD performance against the best in class.

3.5 The "Fuzzy Front End" of Innovation

The "Fuzzy Front End" (FFE) of innovation could be said to encompass all activities which lead to the decision to proceed with the development of a new product or service. It is one of many terms, including 'Stage 0', the 'pre-development phase', the 'front end of innovation', used to describe those activities that lead up to the beginning of the formal product development stage of a project.

According to Murphy and Kumar (1997), the FFE encompasses the generation of an idea to either the approval of a concept for development or its termination. Kim and Wilemon (2002) and Koen et al. (2002) describe it as the stage between the first considerations of an opportunity and when it is deemed ready to enter the structured product development process. Khurana and Rosenthal (1998), define the front end of innovation as "*to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews"*.

The front end is often termed "fuzzy" as it is quite difficult to define, and needs focused attention that it often does not receive. As a consequence, it is often poorly executed and takes too long (Goffin and Mitchell, 2005). Smith and Reinertsen (1998) note, that while the front end of innovation might not be an expensive part of product development, it can consume 50% of development time. The authors also note that it is the stage where major financial and resource commitments are typically made, thereby setting the course for the entire NPD project (1998). It can be seen, therefore, as one of the most crucial areas of the innovation process.

3.6 Structuring the "Fuzzy Front End"

While the research indicates that some typical NPD models have been recently expanded to include many aspects of the FFE (Cooper, 2001), many explicit front end models have also been proposed. One such model is that proposed by Husig et al. (2005). The structure of this model incorporates three phases, each with an associated gate. Phase 1 includes environmental screening and opportunity identification, where external changes are analysed and translated into potential business opportunities. Phase 2 involves preliminary definition of an idea or concept. Phase 3 defines the product, project or concept in detail and plans its development. The final gate leads to a new product development project.

Reinertson (1999), who coined the term 'fuzzy front end', presents a model which focuses on the implementation of fast effective screening methodologies to improve cycle

time and create a ‘fast failure’ process, ensuring that only high-impacting opportunities are developed.

One of the most widely-recognized models is proposed by Khurana and Rosenthal and provided in Figure 3.2 (1998).

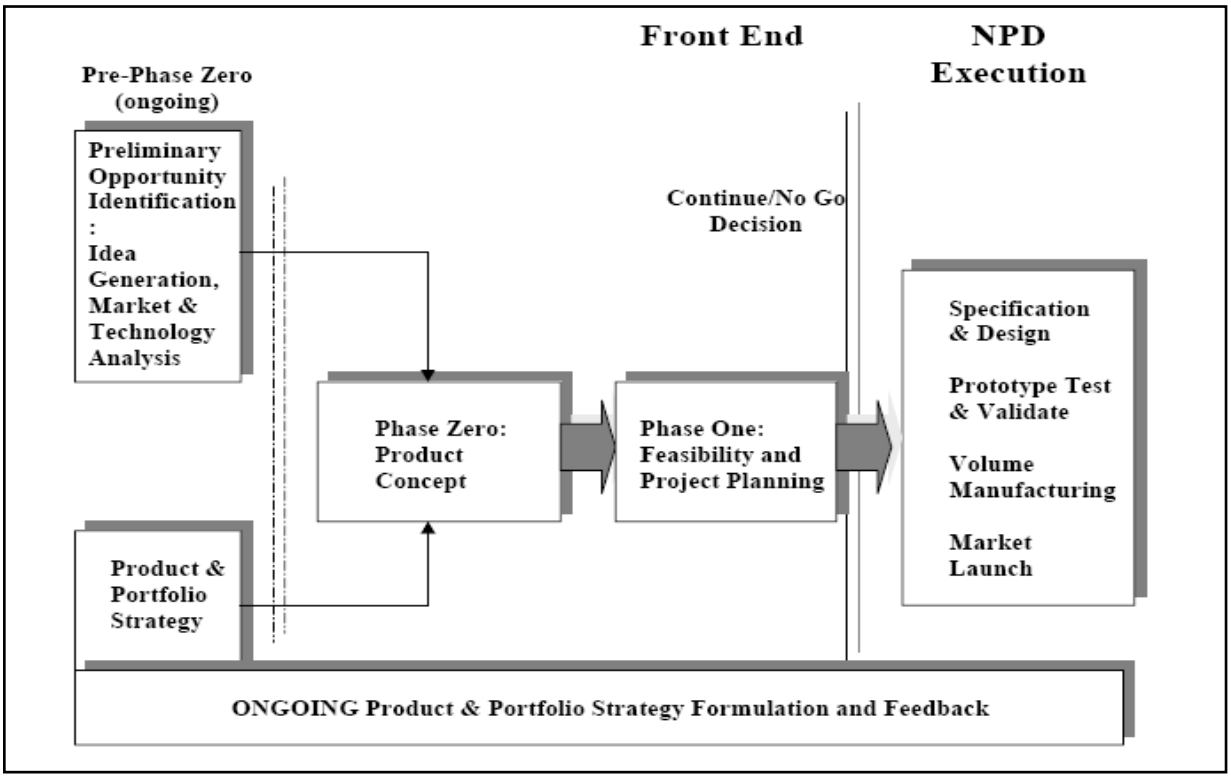

Figure 3.2 Model of the front end of NPD (Khurana and Rosenthal, 1998)

Khurana and Rosenthal’s (1998) approach is a somewhat systematic process which takes product concept inputs from two organisational areas. The first area, that of “Preliminary Opportunity Identification”, is similar to Cooper’s (2001) “Discovery” stage in his new product development Stage-Gate model, and the second input stream comes from strategic management activities such as product and portfolio strategy formulation. Product concept definition leads to feasibility and project planning, which is the final phase of their FFE process. Khurana and Rosenthal (1998) stress the importance of a well-formulated and communicated strategic vision, as well as cross-functional sharing of responsibilities, a strategically planned portfolio of new products, and an effective information system. Their model, however, does not provide a detailed description of the required preliminary opportunity identification and idea generation activities.

Verworn and Herstatt (2001) note that while the Khurana and Rosenthal model might be useful in visualising and structuring the front end activities as well as reducing the fuzziness and easing communication, it lacks some flexibility. They further argue that while the systematic process models provided by Cooper (2001) and Khurana and Rosenthal (1998) might lead to success for incremental innovations with low market and technological uncertainty, radical innovations with high uncertainties require a more flexible organisational learning approach with many iterations and various parallel activities.

The research of Verworn and Herstatt (2001) explores the implications of innovation type on implementing a front end innovation process, suggesting that for radical innovations thorough strategic planning is critical, a suggestion which is backed by Song and Montoya-Weiss (1998). Empirical research confirms that a learning-based approach more adequately serves radical innovations, as opposed to a systematic process-based approach (Tidd et al., 2005; Lynn and Akgun, 1998; Lynn and Green, 1998; Rice et al., 1998). Several studies have also confirmed that conventional marketing approaches and sophisticated analytical methods for the evaluation of new product opportunities can be inaccurate for radical innovations (Lynn et al., 1996; Lynn and Green, 1998; Balachandra and Friar, 1997). Rather, a 'probe and learn' approach, emphasising gaining maximum information through the use of early prototypes rather than 'getting it right first time', is deemed more appropriate for breakthrough innovations (Lynn et al., 1996). Baker and Sincula (2002) advocate the importance of organisational learning in "new-to-the-world" innovations, as they require a change in the way businesses were seen beforehand.

Koen (2004) similarly argues that different strategies and processes should be adopted in the FFE depending on innovation type, namely incremental, platform and radical projects. He states that the traditional Stage Gate process is more suited to incremental innovation of a single product, whereas the front end for developing new product platforms must begin with a strategic vision of where the company wants to develop a family of products. Finally, breakthrough product projects should begin with a similar strategic vision and are associated with technologies which require new discoveries (Koen, 2004).

Given these criticisms of some of the earlier proposed systematic models, Koen, along with a team of experts from eight different companies, undertook a joint endeavour to identify a universal model and associated best practices in the front end of innovation (FEI). One of the intentions of the research was to provide a common language or definition of the key elements of the FEI, which the authors found lacking. The result was the development of what is termed the New Concept Development (NCD) model (Koen et al., 2002*)*, depicted in Figure 3.3.

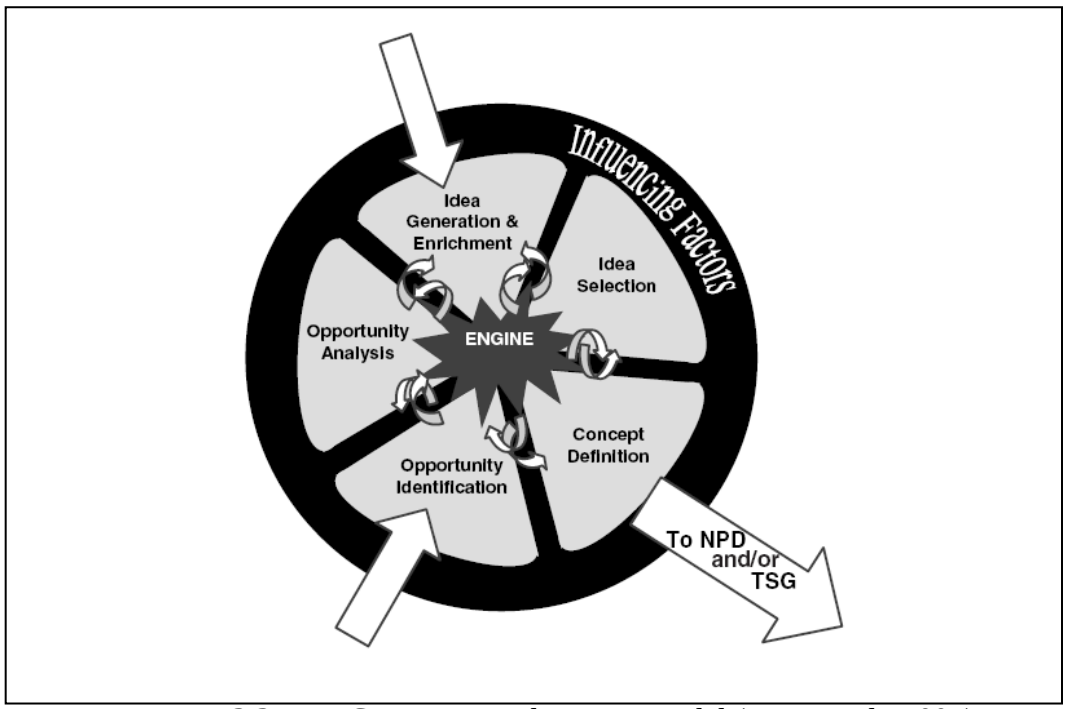

Figure 3.3 New Concept Development Model (Koen et al., 2002)

The New Concept Model comprises three key parts:

1. Influencing Factors (The Environment)
2. The Engine (Leadership & Culture)
3. Five Front End Elements:
    - Opportunity Identification
    - Opportunity Analysis
    - Idea Generation & Enrichment
    - Idea Selection
    - Concept Definition

The first of the three key parts of the model is that of “Influencing Factors”, which according to Koen et al. includes such factors as an organisations capabilities, customer and competitor influences, external influences such as regulations, laws and socioeconomic trends, and the extent and strength of enabling sciences and technology (2002). Other factors include complementary competitors and government law and policy and, in combination, these are all potential sources of new ideas (Koen et al., 2002*)*.

The second part of the model, the “Engine”, includes such aspects as leadership, culture and business strategy, which according to Koen et al. (2002), sets the environment for effective innovation.

The final part of the model includes the five front end elements of opportunity identification, opportunity selection, idea generation, idea selection and enrichment, and concept definition.

The developers of the model prescribe that the “Engine”, which signifies top-level management support, powers the five front end elements of the model, and that the circular shape of the model is intended to suggest that ideas and concepts are expected to continuously iterate across each of the five elements (Koen et al., 2002*)*. The arrows indicate that projects can begin with either idea generation or opportunity identification, and both the engine and the five elements sit on top of a range of influencing factors. The iterative and looping nature of the interactions between each activity contrasts with the sequential NPD or Stage-Gate process, and the authors highlight that it is this looping nature which distinguishes the model, making it suitable for breakthrough innovation types.

In summary, the FFE research findings suggest that a ‘one size fits all’ systematic process-based approach to front end activities should be avoided, rather that the approach taken iterative and looping in nature, and tailored to the innovation type.

3.7 Best Practices in the "Fuzzy Front End"

While it is now widely recognized that the front-end activities are of immense importance in any innovation endeavour, many organisations continue to focus on the more 'manageable' aspects of the innovation process, such as the product development stage (Koen et al., 2002). Many doubt that the pre-development phase is manageable at all, given the 'fuzzy' nature of its various aspects.

Further, while best practices are known at the start and within the NPD aspects of the innovation process (Kahn et al., 2006; Khurana and Rosenthal, 1998; Cooper and Kleinschmidt, 1994), Koen et al. (2002) point out that many of these practices don't apply to the front end, stating that "*the nature of the work, commercialisation date, funding level, revenue expectations and other factors are fundamentally different*". The authors suggest significant research on best practice in the Front End of Innovation (FEI) has generally been somewhat lacking, and their 2002 research and academic review attempted to address this shortcoming (Koen et al., 2002). The results of this research highlight a number of proposed methods, tools and techniques which can be applied to each area of the New Concept Development model. These best practices incorporate many of the identified best practices as proposed throughout this literature review, and are summarised in Table 3.2.

FEI Area	**Best practice methods, tools and techniques**
Influencing Factors (Organisational capabilities, customer and competitor influences, external influences, etc)	- Early awareness and organisation-wide communication of changes in the external environment - The ability to execute the strategy or plan of action when changes occur - Forging mutually beneficial alliances and partnerships with external forces to provide the capability needed to address influencing factors

The 'Engine' (Leadership and culture)	- Creating and nurturing a culture that encourages innovation and creativity - A collaborative culture that encourages knowledge creation - Leaders maintaining constancy of purpose - Setting aggressive goals
Five Front End Elements:	
Opportunity Identification	- Creating more opportunities by envisioning the future through: o Roadmapping o Technology trend analysis o Customer trend analysis o Competitive intelligence analysis o Market research o Scenario planning
Opportunity Analysis	- Same methods, tools, and techniques used to determine future opportunities, but the effort is expanded in considerably more detail - Assignment of a full-time specific multifunctional team of three to five people for large projects
Idea Generation & Enrichment	- Use of formal methods for identifying customer needs - Early involvement of the customer - Market and business needs and issues continuously interspersing with technology advances - Identifying new technology solutions through increasing technology flow through internal and external linkages and partnering - An organisational culture that encourages employees to spend free time testing and validating their own and others' ideas - A variety of incentives to stimulate ideas

	- A formal role for someone to coordinate ideas from generation through assessment - A limited number of simple, measurable goals to track idea generation and enrichment - Frequent job rotation to encourage knowledge sharing and extensive networking - Mechanisms for communicating core competencies, core capabilities, and shared technologies broadly throughout the organisation
Idea Selection	- Portfolio methodologies based on multiple factors (not just financial justification) using anchored scales - Formal idea selection process with prompt feedback to the idea submitters
Concept Definition	- Goal deliberation approaches o Time spent on carefully defining the project goals and outcomes - Setting criteria for the company that describe what an attractive (in terms of financials, market size, etc.) project looks like - Rapid evaluation of high-potential innovations - Early involvement of the customer in real product tests - Partner outside of areas of core competence - Focus resources (in contrast to spreading too thin) - Pursue alternative scientific approaches

Table 3.2 Best Practices at the Front End of Innovation (adapted from Koen et al., 2002)

The above set of wide-ranging methods, tools and practices have been identified through an extensive review of the existing academic research of the front end practices of high-performing firms (Koen et al., 2002), and can be used as a best practice benchmark in assessing a company's front end management practices.

3.8 Innovation Auditing

Having reviewed the innovation literature, we now clearly understand the link between effective and sustained innovation and the achievement of competitive success. We also have a new appreciation of the complexity of the innovation process, the 'fuzziness' of its earlier aspects, and the broad range of factors and actors involved. We understand the need to continuously work to improve our innovation processes, and the final aspect of this literature review now seeks to review the means by which the entire process and its capabilities can be effectively measured and assessed. The age old sayings *"what cannot be measured, cannot be improved",* and further, *"what cannot be measured, cannot be managed",* are as true in innovation management as in any other aspect of organisational performance.

Tidd et al. (2005) state that developing innovation management "*involves a learning process concerned with building and integrating key behaviours into effective routines".* The authors inform us that the use of benchmarking can help this learning process in many ways, particularly in that it offers a powerful motivator for organisational change by identifying poor performing areas. They highlight that by benchmarking against other firms or identified best practice an organisation can glean valuable clues about how to manage key processes more effectively.

Chiesa et al. (1996) state that *"if we are to understand innovation performance more profoundly, we must look at innovation capability and the processes involved in developing and exploiting innovations".* The authors recommend the use of an innovation audit in assessing innovation performance, and highlight that auditing goes *"beyond measuring; it builds on this to identify gaps between current and desired performance"* (Chiesa et al., 1996). They state that an audit of innovation capability can not only help an organisation to address the process of forming innovation strategies, but can also address the organisation's capabilities to implement such strategies and to adapt innovation practices in response to changes in the environment.

Chiesa et al. (1996) propose a model for auditing an organisation's technical innovation capability, which comprises four core processes – the identification of new product

concepts, product development, process innovation, and the development and management of technology. It also includes enabling processes such as resources, systems and tools, and leadership, and provides two means of assessing an organisation; a process audit, which focuses on the outcomes of each individual core and enabling process and it's impact on competitiveness, and a performance audit, which generates quantitative results to facilitate benchmarking comparisons.

Tidd et al. advocate the use of innovation auditing in enabling the operation of an effective learning cycle through adding the dimension of structured reflection (2005). They advocate that audits should be used to drive continuous improvement in the innovation process and the means by which it is managed, and provide an audit framework intended to enable assessment of an organisation's innovation management capability against best practice. The authors further provide a number of specific measures which can be used to assess the internal workings of the process of innovation, including a number of measures of the outputs of the innovation process and its various elements.

Amidon Rogers (1996) provides a similar model to that of Chiesa et al. (1996), which enables organisations to assess their activities across five innovation management domains – performance, structure, people, process and technology, and according to five levels of innovation development – technology transfer, technology exchange, knowledge exchange, knowledge management and knowledge innovation.

While many organisations continue to assess their innovation performance through the use of metrics only, asking only the 'what', as opposed to the 'why' and 'how' questions, tools such as those discussed here are now becoming more widely recognised and used in those organisations seeking to effectively evaluate their entire innovation processes and capabilities.

3.9 Concluding Summary

This chapter of the literature review sought to develop the theme of the research through an assessment of the available literature on NPD and the front end of innovation. Both processes and their associated elements were discussed and best practices in each area were identified. The chapter concluded with a review of the literature on innovation auditing, which is fast-becoming a common tool for those organisations that are serious about sustaining and continuously improving their innovation capability. The subsequent study of Aerogen's innovation practices will draw on the auditing models and best practices identified, to enable an effective and accurate assessment of the innovation management capabilities of the company.

4. Company Background

4.1 Introduction

Aerogen Ltd. is an Irish-owned specialty medical device company, located in Galway, Ireland, currently operating at the upper end of the critical care respiratory market. The company employs 36 people in the design, manufacture, marketing and sales of a number of drug-aerosolisation systems, offering high quality, high efficiency, and easy to use products, at an above-average cost. Aerogen's strategic intent is to "Create Value through Innovation", and the company currently manufacture and sell three key products, all of which utilize its patented core technology, the OnQ™ micropump aerosol generator.

Aerogen sells its products worldwide through a network of world-class respiratory distribution partners that includes Covidien (formerly Tyco Healthcare), Respironics, Maquet, Cardinal Health, GE Healthcare and Dräger Medical. Its products are distributed throughout Europe, USA, Asia and Australia, with more recent market development in Africa, India and Mexico.

4.2 Company History

In 1997, entrepreneur John Power, current Managing Director and CEO of Aerogen Ltd., set up his first medical device company, Cerus Medical, in a small office above a local butcher shop in the village of Moycullen, Galway. The company employed three people in the development of innovative drug delivery technology.

In 1999, Cerus licensed a unique aerosol generation technology from Silicon Valley bio-pharmaceutics company, Aerogen Inc. The two companies merged in 2000, bringing the company public on NASDAQ in November of that year.

Aerogen launched its first product out of its Galway Research and Development Centre in 2002, and has since released a number of market leading products, all incorporating the company's core technology, the OnQ™ micropump aerosol generator.

In 2005, Aerogen was acquired by US bio-pharmaceutics firm Nektar Therapeutics. However, in late 2007, following a management buyout (MBO) which was completed with the aid of a number of external investors, Aerogen became an Irish-owned SME, with Nektar retaining a marginal share in the company.

In January 2009, Nektar's pulmonary division was acquired by Novartis, one of the largest healthcare companies in the world and a leading giant in the pharmaceutical industry. As a result, Novartis took over Nektar's stake in the company.

Since completion of the 2007 MBO, Aerogen has shifted its strategic focus in an attempt to meet the financial expectations of its stakeholders and to effectively grow the business, through the expansion of its product range both within and more particularly outside of the respiratory care market. This shift or expansion of strategic direction has resulted in many significant changes within the company, most specifically in terms of the organisation's structure and innovation management systems. Other significant changes include an increase in resource and core competency development, and increased alliances and strategic partnerships intended to aid in the company's expansion and diversification efforts. Achieving excellence and sustainability in product innovation is now of particular importance to the organisation, as it strives for commercial success in new market areas without the backing, financial or otherwise, of its former parent company.

4.3 Aerogen's Core Technology

Each of Aerogen's commercial products utilises the company's core technology, an aerosol generator known as the OnQ™ (Figure 4.1).

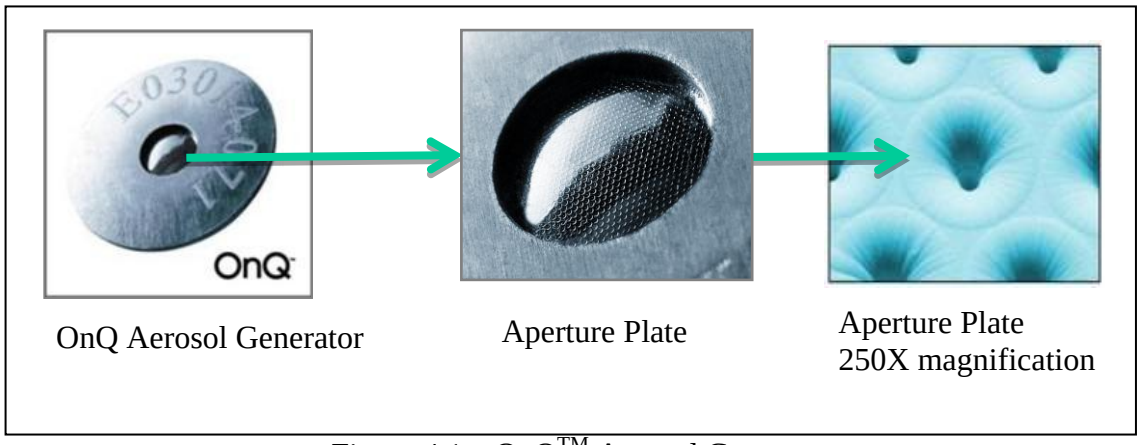

Figure 4.1 – OnQ™ Aerosol Generator

OnQ™ is an electronic micropump – a heavily patented technology that produces liquid aerosol in a manner unlike any other technology currently available. As small as 15mm in diameter and wafer-thin, OnQ™ is comprised of a unique dome-shaped aperture plate containing over 1,000 precision-formed tapered holes, surrounded by a vibrational element. When energy is applied, the aperture plate vibrates over 100,000 times per second causing the aperture to act as a micropump, drawing liquid through the holes to form consistently sized droplets, as depicted in Figure 4.2. The result is a low velocity aerosol, optimised for deep lung drug deposition.

Figure 4.2 - OnQ™ Aerosol Generator in operation

4.4 Product Portfolio

In 2002, Aerogen introduced its first commercial product to the market, the Aeroneb® Pro nebulisation system. This system comprises a nebuliser incorporating the OnQ™ technology and is a high efficiency, reusable and sterilizable nebulisation system, for application in the critical care setting.

This project was followed up with the introduction of a home-care product, the Aeroneb® Go nebuliser system, in 2004. Aerogen's third commercial product, the Aeroneb® Solo nebuliser system, was designed in response to Aeroneb® Pro customer feedback. Customers requested a similar nebuliser incorporating the OnQ™ technology but in a single patient use format. Customers also requested an added functionality of continuous mode for nebulisation. The Aeroneb Solo® was commercially launched in 2007, and is the highest volume product that Aerogen have manufactured. The organisation is currently in a period of considerable transition as it prepares its supply chain for an increase in manufacturing volumes from 80k units per annum to 200k+, to accommodate market demand.

4.5 Market Advantages

The introduction of the Aeroneb® range of nebulisers marked the most significant innovation in nebulisation therapy in the past 20 years. These nebulisers are the world's first to enable high performance aerosol drug delivery for the most critically ill patients. They effectively deliver a wide range of drugs to treat respiratory illness such as chronic obstructive pulmonary disease (COPD), asthma, cystic fibrosis and pulmonary hypertension. The fine aerosol particles are capable of navigating tortuous breathing passages of the human respiratory system to enable deep drug deposition. This is especially effective in neonate and paediatric patients.

The Aeroneb® Solo and Pro devices occupy a unique market position in that they are the only micropump nebulisers that have a critical care application. The two most widely used technologies for ventilator nebulisation are Metered Does Inhalers (MDI's) and Jet

or Small Volume Nebulisers (SVN's). However, both of these technologies have very poor performance in terms of delivered dose when compared to Aeroneb® products (achieving typically 10-20% of delivered dose), as well as having technical restrictions in terms of the range and types of drug that can be delivered. SVN's are critically restricted from use with neonatal ventilation applications as typically the gas flow required to create an aerosol is greater than the rate required to ventilate the infant's lung.

Ultrasonic Nebuliser's (USN's) can deliver a dose comparable to Aeroneb® Solo or Pro, but again have restrictions in terms of the type of drug delivered, and typically have a lower respirable dose due to producing less particles within the required range. USN's also have recognised heat generation issues which further restrict their application. The Aeroneb® Solo and Pro nebulisers do not heat, degrade or shear medications and can deliver suspensions.

Whereas existing technologies have been on the market for over twenty years, the Aeroneb® Solo and Pro nebulisers are the only new generation technologies addressing customer needs in this market. Further, all of these unique characteristics make them not only attractive to patients and caregivers, but indeed to many biotechnology and drug companies, who are investigating the use of the Aeroneb® nebuliser technology as part of their drug/device development programs.

Aerogen's unique market position is based on its strongly patented technology. Irrespective of patent protection (Aerogen have over 30 patents granted/filed), the manufacturing process and technical know-how required to make a vibrating mesh nebuliser is vastly more complicated and integral. As such, there is no easy transition from traditional aerosolisation technology to vibrating mesh technology. This assures a certain amount of market protection against competitors copying, or otherwise.

Aerogen's products offer a further advantage over competitive products, in that they effectively minimise contamination risks. Given the recent increased need for infection control due to the spread of hospital-related viruses such as MRSA and the outbreak of the H1N1 Influenza-A 'swine flu' virus, the Aeroneb® products are uniquely set to treat

under-lying respiratory disorders that may become exacerbated in an infected patient, without causing the undue risk of contamination.

4.6 Market Position

Aerogen's nebulisers have come from zero share of the market in 2002 to becoming the gold standard in acute care. The launch of the Aeroneb® Solo in 2007 has been a key driver in volume and revenue sales, as a result of the increase in demand for a convenient disposable product. Aerogen have leveraged Aeroneb Solo® sales off sales of its flagship reusable Aeroneb® Pro nebuliser, given its significant installed base of over 30,000 systems. This installed base provides the opportunity for a high revenue stream for the disposable Aeroneb® Solo. The Aeroneb® Solo can be back integrated onto the Aeroneb® Pro controller, thereby eliminating the switching costs. It is anticipated that due to the low cost, disposable nature of the Aeroneb Solo® system, hospital departments will use more than 30 Aeroneb® Solos over the lifetime of one Aeroneb® Pro, and that this will drive sales volumes and serve as a basis for predicting conversion volume requirements.

Impressed by its performance and utility, many of the Original Equipment Manufacturer (OEM) ventilation companies have integrated the Aeroneb® technology into their ventilators, thereby effectively 'locking out' competitors and increasing potential revenue streams for the Aeroneb® Solo. The overall result has been a significant 52% growth in revenue over the past 12 months, enabling an increase in the number of Aerogen staff from 20 to 36 people.

4.7 Aerogen's Future Ambitions

Approximately one third of all acute care patients have a respiratory condition. Aerogen has an ambition to raise the performance of its nebuliser technology to such levels of performance that would see it on par with intravenous delivery as an accepted means of targeted drug delivery treatment for these patients. The current modes of drug delivery, both intravenous and oral, are sub-optimal. Using the OnQ™ technology, which produces a fine particle, low velocity aerosol optimised for deep lung deposition, enables

nebulisation of a very broad range of solutions including suspension medications, peptides, proteins and new formulations. New medications that are not appropriate for oral or intravenous drug delivery can be developed for use with OnQ™.

For the next 3 to 5 years, Aerogen's strategy is to continue to lead the way in promoting a broadening use of its unique technology, enabling aerosol respiratory treatment which allows a wide range of drugs to be administered with a much greater efficiency of delivery. Aerogen has established a number of partnerships in drug delivery combination products with bio-technology and pharmaceutical companies, and these projects include the application of the OnQ™ technology into humidification provision in its core market of ventilation, as well as drug/device combination products and a number of vaccination programs.

The company also seeks to develop radically new applications for the proprietary technology outside of the field of pulmonary drug delivery. A number of opportunities have been identified, including nasal drug delivery, bio-security programs and perfume applications. One key area of opportunity is that of laparoscopic or "key hole" surgery. Although this growing area of surgery has revolutionized the treatment of patients with its minimally invasive approach, complications such as post-operative pain and adhesion formation persist. Aerogen is working with lead users in laparoscopic centres of excellence in Europe to addresses these issues through the introduction of aerosolised drug directly into the patient's body cavity. Early results are very promising and the company has set the ambitious goal to become an important player in the multi billion dollar laparoscopy market in the very near future.

4.8 Aerogen Awards and Recognition

Over the past two years, Aerogen have been pro-active in creating awareness of the company's successes in innovation and in promoting the Aerogen brand.

While the company continues to grow, the entrepreneurial spirit persists, with Managing Director and CEO John Power having very recently been chosen as a finalist in the Ernst & Young Irish Entrepreneur of the Year Awards, 2009. In July of 2009, John travelled to

Brazil along with the three other finalists, to help create new opportunities and to unleash existing potential in an emerging market.

Aerogen has also achieved the highly commended Small Firms Association award for Innovator of the Year 2009, due to its innovation endeavours in commercialising the Aeroneb® Solo product.

In 2008, Aerogen was successful in achieving the IMDA Gold Award for Innovation, Research, Development and Commercialisation, again for its innovation in developing the Aeroneb® Solo product. Further recognition was received in reaching the finals of the Irish Exporter of the Year 2008, and the Connaught finals of the Ulster Bank Business Achievers award.

The company has received much national publicity as a result of these awards, with recent coverage including a full page company review in the Irish Independent, interviews in the Sunday Tribune and Irish Times, as well as abundant coverage in local newspapers and radio.

4.9 Importance of this Research

Given the many awards received by Aerogen in recognition of its past innovation efforts, this research into Aerogen's current innovation management capability is all-the-more relevant. As the company now ambitiously strives to exponentially grow through innovation, given this turbulent economic climate, it is most important to determine if the most effective innovation management systems are in place to encourage achievement of this far-reaching goal.

Razaghi states that *"moments of economic turbulence provide the unique opportunity to start new businesses, launch disruptive new products, and strengthen customer loyalty – often at a discount"* (2008). These are the best of times to provide customers with innovative products of real value. When the going gets tough, the tough innovate, and it is this philosophy which must drive Aerogen in achieving long-term competitive success.

5. Research Methodology

5.1 Introduction

It has been stated by many academic researchers that innovation must be effectively managed if competitive advantage is to be maintained. This statement is compounded by the fact that many of those companies who achieved magnificent competitive success in days gone by are no longer in the game, due to being ousted by more innovative competitors.

Aerogen is a company which to-date has been highly regarded in terms of its recent innovations in new product development. It is a company which has grown in size from just 3 employees in 1999 to 36 employees in 2009, and this growth has brought with it a more structured approach to entrepreneurship and innovation management. This research now seeks to investigate the innovation management capability of Aerogen, to determine if the processes and practices currently in place will aid the company in achieving its ambitious goals for growth and innovation into the future.

The study assesses Aerogen's capabilities across the many innovation management areas which have been discussed in the preceding literature review, using the case study approach to determine if the current innovation management capabilities and practices of the organisation match the standard of the "best in class". The research further seeks to identify those innovation areas in which the company can improve, to enable an easier achievement of its goals. Finally, the research undertakes to determine if innovation is seen as an organisation-wide endeavour, comparing the views of the various players in the innovation process across departmental and hierarchical boundaries.

The following sections outline the research questions, the research approach, strategy and data gathering method, and finally, the limitations of the research undertaken.

5.2 Research Question

The hypothesis under test is as follows:

> **Aerogen's approach to innovation management can serve to effectively lead the company in its future product innovation and growth endeavours.**

The literature review brought forth a vast array of "best practices" in innovation management, which, when combined, can effectively serve to further the innovation potential and competitive success of a company. The literature highlighted the many different players in the innovation process and the importance of their interaction and involvement throughout the process. Finally, the review helped us to understand the differences and similarities in approaches to management of both the front end of innovation and the new product development process.

Drawing from the findings of the literature review in each key innovation area, along with the Aerogen data gathered, this research seeks to answer the following questions:

> Q1: How well do the innovation management practices at Aerogen (both at the front end and in new product development) compare with best practices identified in the literature?
>
> Q2: What areas of innovation management can Aerogen improve upon?
>
> Q3: Do the innovation management views of the various players in the innovation process align with each other?

The research approach is set to answer these key questions, utilising both quantitative and qualitative methods to capture a high-level cross functional and hierarchical perspective of the innovation management capability of the company, along with an in depth assessment of how this capability is achieved.

The research questions will cover the key aspects of best practice in innovation as identified in the literature review, examining Aerogen's innovation management practices in the following areas:

1. Areas of Innovation Process:
    - Concept Generation/Front End of Innovation
    - New Product Development
    - Process Innovation
    - Technology Acquisition

2. Innovation Management Areas:
    - Organisation
    - Strategy
    - Process
    - Linkages
    - Learning

5.3 Research Approach

Given the vast body of theory and research available on the topic of best practices in innovation management, the deductive 'top down' approach was chosen for this study. Further, given the availability of a sample of sufficient size and scope to generalise conclusions, the familiarity of most managers with the deductive approach, and their *"faith in the conclusions emanating from this approach",* (Saunders et al., 2007), the deductive approach was deemed most suitable.

Deductive reasoning allows us to move from the more general to the more specific, and its approach involves the development of a theoretical or conceptual framework against which subsequently accumulated data can be tested (Saunders et al., 2007). The approach to this research began with general theory and ideas as picked out throughout the literature review, before moving to data collection, discussion and observation, intended to test Aerogen's innovation management capabilities and practices against those best practices which have been identified.

5.4 Potential Data Gathering Methods

Various data collection methods were investigated in order to determine the appropriate method by which the identified research questions could be answered. The methods considered are as follows:

1. Questionnaires: This approach is deemed suitable for the deductive approach, and allows for statistical and analytical interpretation of data gathered. It is an approach which is well-known and trusted by organisational managers and employees, and is a relatively straightforward means to collect quantitative data. The approach can allow for anonymity on the part of respondents and can therefore be useful in research where the subject matter may be particularly sensitive. It is also useful in research which requires data to be collected from a large sample size.

   Although questionnaires can be useful as a single data collection method, Saunders et al. (2007) indicate that it is usually better to link them with other methods in a *"multiple-methods research design".*

2. Participant Observation: Delbridge and Kirkpatrick (1994) categorise the types of data generated through participant observation as 'primary, 'secondary' and 'experiential'. While such methods of data collection can be very time-consuming, difficult and demanding, they offer a number of qualitative advantages. Participant observation answers the "how", and "why" questions, which questionnaires and other quantitative data collection methods typically struggle with. This method is particularly useful for researchers working within their own organisation, and typically all data collected are useful (Saunders et al., 2007).

3. Semi/Unstructured Interviews: This form of data gathering can be useful in validating primary data gathered through surveys or otherwise. It can add meat to the bones of quantitative research, and, similar to the participant observation method, can be useful in answering the "how" and "why" questions that other research methods often fail to do. This approach, however, also has

disadvantages, in that the researcher is generally only able to interview few individuals or groups of people, and answers to questions can be complex to analyse. Saunders et al. (2007) indicate that this form of research can also be subject to interviewer and interviewee bias, both due to the interpretation of responses by interviewers and to perceptions about the interviewer by the interviewee.

5.5 Research Strategy & Data Gathering Method

This research sought to provide an all-encompassing understanding of Aerogen's innovation management capability and practices, and it was deemed that the best method by which this could be achieved was through the use of the case study approach, which enables a rich understanding of the context of the research and the processes being enacted (Morris and Wood, 1991). The case study research method has the added advantage of being able to answer both the "what" questions, as well as the "why" and "how" questions. This method typically uses triangulated multiple sources of data, thereby helping to validate the data collected.

The first aspect of the study required the collection of quantitative data from a group of Aerogen employees, spanning hierarchical and cross-functional boundaries. The intent was to get a quick, broad understanding of how Aerogen employees would rate the company in each general innovation area. Therefore the survey approach was chosen here.

The multi-method approach was utilised for the second aspect of the study, which was intended to determine why each survey participant responded to the initial survey as they did. This in-depth phase asked "why" and "how" Aerogen achieved the scores attributed in the initial survey, and the data was collected through the use of a descriptive survey, as well as through a number of informal employee interviews.

This mixed-method case study approach to the research enabled the collection of both qualitative and quantitative data, which effectively combined to enable more accurate research conclusions to be drawn.

5.6 Description of Research Method chosen

This research was carried out in two key phases, using a combination of the innovation audit approaches prescribed by Tidd et al. (2005) and Chiesa et al. (1996), which have been described in Part 2 of the literature review.

Phase 1 utilised an adaptation of the innovation scorecard, devised by Ciesa et al. (1996), to quickly capture a high-level view of Aerogen's innovation practices across the following key process areas: Concept Definition (front end of innovation), New Product Development, Process Innovation, Technology Acquisition, Leadership, Resource Provision, Systems and Tools Provision, and Competitiveness Measurement. The scorecards were distributed via e-mail with the assurance that individual results would be kept confidential, while the overall result would be analysed during the second phase of the study.

Phase 2 utilised a more detailed approach. Participants were issued via e-mail with a second innovation management survey, which was adapted from that provided by Tidd et al. (2005). This survey contained 45 innovation statements which respondents ranked on a scale of 1-7, with 1 being "Not True at All" and 7 being "Very True". The Tidd et al. (2005) survey was adapted to include an "Examples/Comments" section, which enabled respondents to provide reasons for the scores given. In order to improve the reliability of the results, participants were asked to rate only those statements which they felt that they could rate accurately. Phase 2 enabled validation of the initial Phase 1 results, and the gathering of more detailed qualitative data. The innovation management areas covered were: Strategy, Organisation, Process, Learning and Linkages.

The final aspect of the study utilised the informal unstructured interview approach, whereby results were clarified, assessed and discussed, and areas for potential improvement agreed upon.

Both the Chiesa et al. (1996) innovation scorecard and Tidd et al. (2005) innovation management audit questionnaire were chosen for this research, as it was felt that these, in

combination, would address the key best practice areas as identified throughout the literature review, thereby providing an all-encompassing result.

5.7 Sampling Considerations

The target population for this research was 18 of the 36 employees at Aerogen Ltd. The sample was chosen to ensure statistically relevant, reliable and valid results, and care was taken to ensure that an appropriate mix of employees across the various organisational boundaries, both hierarchical and functional, would participate.

It was considered to only include those employees who have been working within the company for a period of two years or longer, in order to achieve the most accurate of results. However, on further consideration, it was decided to include a number of recently hired managers, to enable an "external" perspective to be determined. These participants have joined the company within the last six months, having previously worked in large multi-national medical device companies within the locality. Their "large-corporation" and external perspectives were therefore considered most important to include.

The sample population included all employees who are at a senior engineering level within the company, as well as all who hold a management or top management position. The remainder of the population was comprised of a group of engineers and executives, representing 50% of the employees who operate at a similar level within the company.

The sample population breakdown is as follows:

No. of R&D Participants: 7

No. of Quality & Operations Participants: 6

No. of Sales, Marketing & Business Development Participants: 5

The sample population can alternatively be described in terms of their position in the organisational hierarchy, as follows:

No. of Top Management Participants (CEO, Director of Engineering): 2

No. of Departmental Management Participants: 6

No. of Senior Engineering Participants: 3

No. of Engineer/Executive Participants: 7

5.8 Limitations of the Research

Saunders et al. (2007) indicate the quality of the results any research endeavour can be limited if appropriate measures are not taken to ensure the validity and reliability of the data gathered. They provide three approaches to assess the reliability of survey results generated:

- Test-retest
- Internal consistency
- Alternative form

Test-retest estimates of reliability can be obtained by correlating data collected with those from the same questionnaire collected under as near equivalent conditions as possible (Saunders et al., 2007). This approach requires that the same questionnaire be administered twice to respondents, and as such, is often deemed an impractical and time-consuming means of verifying data reliability.

Internal consistency measures whether several items that propose to measure the same general construct produce similar scores, whereas alternative form offers some sense of the reliability of a questionnaire through comparing responses with different forms of the same question or group of questions (Saunders et al., 2007).

This means of assessing reliability was enabled throughout the research by the use of both the Phase 1 innovation scorecard and the Phase 2 innovation management survey, which both covered similar topics, albeit in a different manner. Furthermore, the unstructured interviews which were conducted at the end of the study helped to verify the consistency and reliability of the survey results.

5.9 Data Gathering Surveys

A ‘pilot’ of both surveys was reviewed with a group comprising two members of the Aerogen management team and two members of the R&D and Sales and Marketing teams, prior to the finalisation and distribution of each.

The Innovation Audit Scorecard, adapted from that provided by Ciesa et al. (1996) and utilised in Phase 1 is provided in Appendix A in its final format. Appendix B contains the Phase 2 questionnaire, which has been adapted from that provided by Tidd et al. (2005).

5.10 Conclusion

This chapter provided the methodology by which the research was approached. The hypothesis under test was defined and the three key research questions were identified. The best means by which the questions could be addressed were determined.

The various data gathering possibilities were assessed, and the mixed-method case study approach emerged as being the most appropriate, due to its proficiency in enabling the collection of both the quantitative and in-depth qualitative data required to ensure that accurate research conclusions would be drawn.

The chosen research approach was then further clarified, and the various phases of study and chosen data gathering techniques were discussed. Sample population considerations were described, and the various checks for data reliability were identified. The two surveys chosen for use in this research are provided in the attached Appendices.

6. Results

6.1 Chapter Introduction

The following sections provide the results gathered in each phase of the Aerogen innovation management capability study. As described in Chapter 5, results for Phase 1 were gathered through the use of an innovation scorecard, whereas Phase 2 results were gathered using a multi-method approach, including both a quantitative and descriptive survey and a series of post-survey informal interviews intended to assimilate the data gathered. Detailed statistical and graphical analysis of the data obtained is provided in the accompanying appendices.

6.2 Participant Contribution & Feedback

All 18 members of the target population responded to both the Phase 1 and Phase 2 surveys. This population represents 50% of the total Aerogen employee-base, and includes all members of the Aerogen management team. All aspects of each innovation survey were rated by each participating employee.

Initial feedback from draft surveys indicated a lack of understanding of the term 'lead user' by participants outside of the Marketing and Management teams. A number of respondents also displayed a lack of knowledge of the 'probe and learn' approach to entering new markets and developing new technologies. Clarification on the meanings of both terms was provided to enable more accurate data to be gathered, and participants were reminded to abstain from rating any statement that was not clearly understood.

On completion of both surveys, six members of the population agreed to take part in follow-up interviews. This population included Aerogen founder, CEO John Power, two long-serving members of Aerogen's management team, one newly-hired manager in the area of Quality and Regulatory Affairs, and members from both the R&D and the Sales and Marketing teams. The purpose of these interviews was to verify that respondents understood the statements as presented in both surveys, and further, to gain a better understanding of the results gathered.

6.3 Results from Phase 1

The following data are those obtained during Phase 1. As previously described, these were gathered using an adaptation of the Innovation Scorecard, provided by Chiesa et al. (1996). The scorecard was used as a rapid, initial data gathering means, quickly providing a broad understanding of how Aerogen employees rate the company's innovation practices across the following *core innovation processes*:

- Concept Development
- New Product Development
- Process Innovation
- Technology Acquisition Process

The scorecard also enabled the initial gathering of high-level data across a number of key *enabling processes*, including:

- Leadership Process
- Resource Provision Process
- Usage of Innovation Systems and Tools

Ciesa et al. further prescribe that the outcome of both the *core* and *enabling* processes should also be initially assessed, stating that the process of innovation should result in improved performance, which in turn should result in increased competitiveness (1996). Therefore, the final area of data collection was in the measurement of competitiveness.

Results from this initial information gathering endeavour were crunched in a number of ways, to enable cross-functional, hierarchical, and long-term/newly hired management scores to be assessed against "best practice", which is assigned a score of 4 in the Ciesa et al. model (1996). The intention was to highlight those key areas which should be focused upon during Phase 2, as well as to point out any anomalies between the following key sets of perspectives:

- Management and Non-Management
- Long-serving Management and Newly-hired Management

- R&D, Sales, Marketing & Business Development, and Operations & Quality Functions

The overall result, averaging all data collected in each key area, is provided in Figure 6.1.

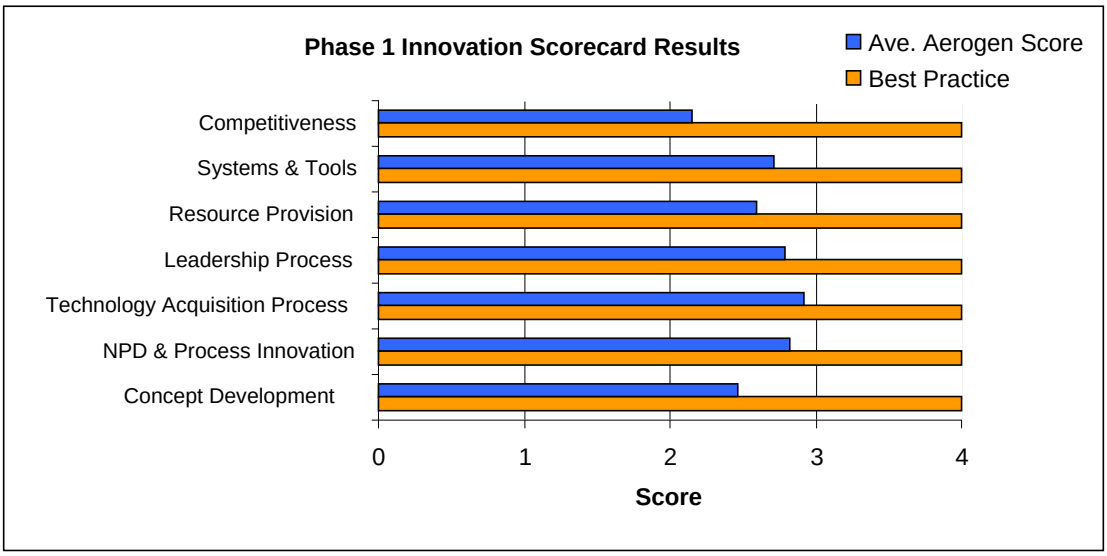

Figure 6.1 Aerogen Innovation Scorecard Results

Figure 6.2 provides a breakdown of the overall results obtained, highlighting the differences in perspectives across each group.

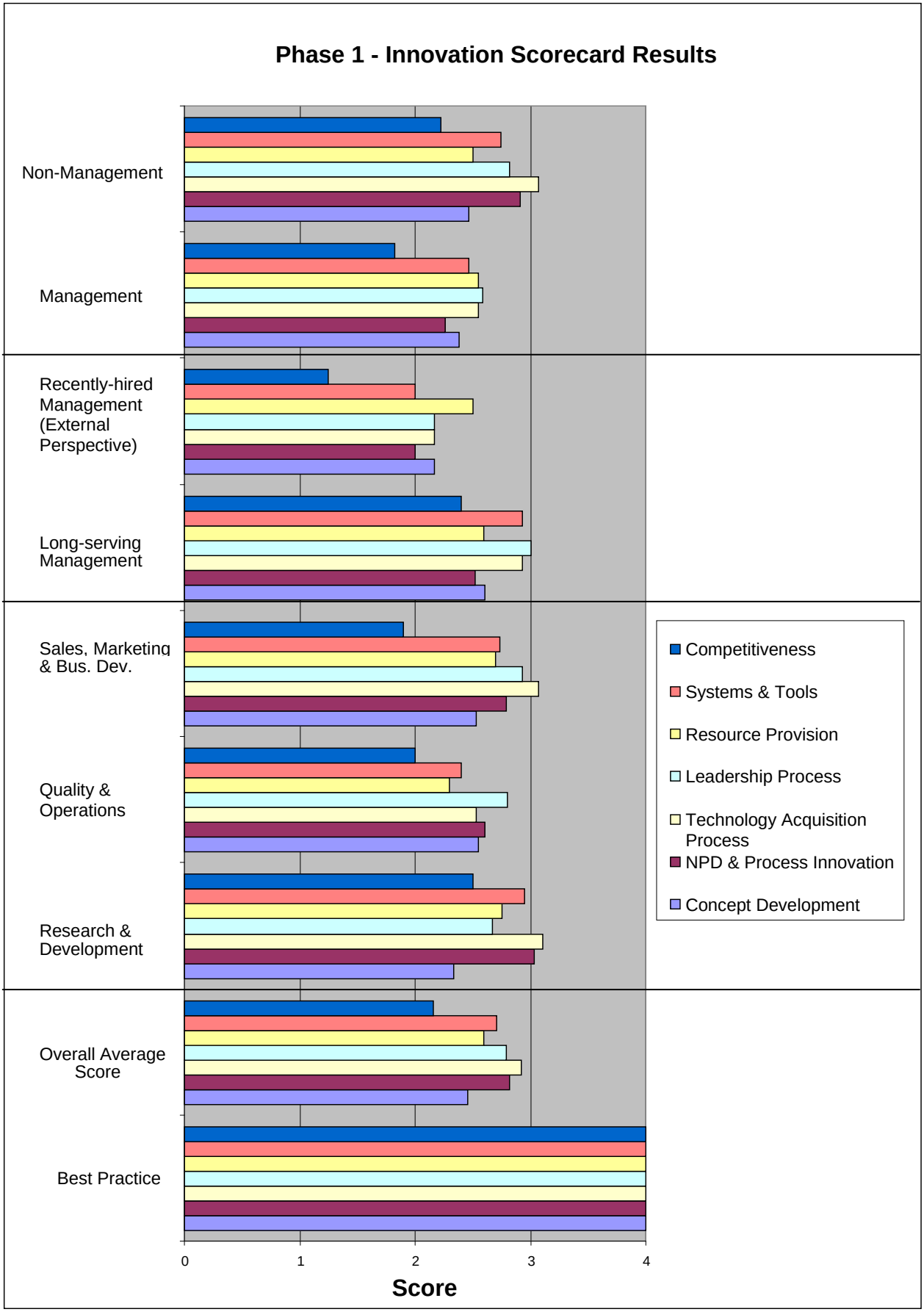

Figure 6.2 Aerogen Innovation Scorecard Results Analysis

6.4 Results from Phase 1 – Key Points of Note

It was expected that the innovation scorecard would highlight those key areas which should form the basis of the in-depth phase of the case study. However, initial findings indicate that all areas assessed did not quite reach the standard of best practice. Some key comments on the results obtained are now provided.

6.4.1 Overall Result

The overall results indicate that Aerogen have achieved an average score of 2 or more in each area assessed.

The least favourable ratings were in the areas of Concept Development, Resource Provision and Competitiveness Measurement, with slightly higher scores being achieved in all other areas assessed. Key findings in these three areas include:

Concept Development

Results indicate a general weakness in longer-term product innovation planning, a lack of organisation-wide involvement in front-end activities and a lack of effective rewards and recognition for entrepreneurial behaviour. There was a wide-ranging recognition of research efforts into determining customers' needs, and the involvement of both technical and marketing personnel in concept evaluation; however, results indicate that there is room for improvement here.

Resource Provision

In the area of Human Resource provision, findings suggest that the human resources needed for innovation are generally known and available, but usually slow to be applied.

Competitiveness

The least performing area, this highlighted a weakness in the measurement of innovation and competitiveness.

On average, the most highly rated innovation process area was that of Technology Acquisition, with positive scores in aspects such as technology strategy and learning.

6.4.2 Anomalies in Respondent Perspectives

One of the key findings of the detailed statistical analysis was a general anomaly between the ratings of recently-hired managers, who may have a more large-company and "external" perspective, and those managers who have been long-serving within the company. These differences were highlighted for further exploration.

In general, non-management participants rated the company's innovation performance more highly than management, and there was a general consistency in ratings from one functional group to the next.

6.5 Overall Phase 2 Survey Results

Phase 2 of the case study utilised an adaptation of the Innovation Management Capability audit tool, as provided by Tidd et al. (2005). This comprised of a survey containing 45 statements, which respondents were asked to rank on a scale of 1 to 7, with 1 meaning "Not True At All" and 7 meaning "Very True". The statements were intended to enable assessment of the company across the following key innovation areas:

- Strategy
- Innovation Processes
- Organisation
- Linkages
- Learning

The intention of this aspect of the study was to capture a cross-functional and hierarchical perspective of Aerogen's capabilities in the above-mentioned areas. A 'description/comments' section was added to the survey to enable an understanding of the reasons behind the ratings given. Post-survey interviews were subsequently held to confirm and discuss the results provided.

6.5.1 Overall Result

The overall result of this Phase 2 data gathering endeavour is provided in Figure 6.3. Results were calculated by averaging the scores provided by all respondents.

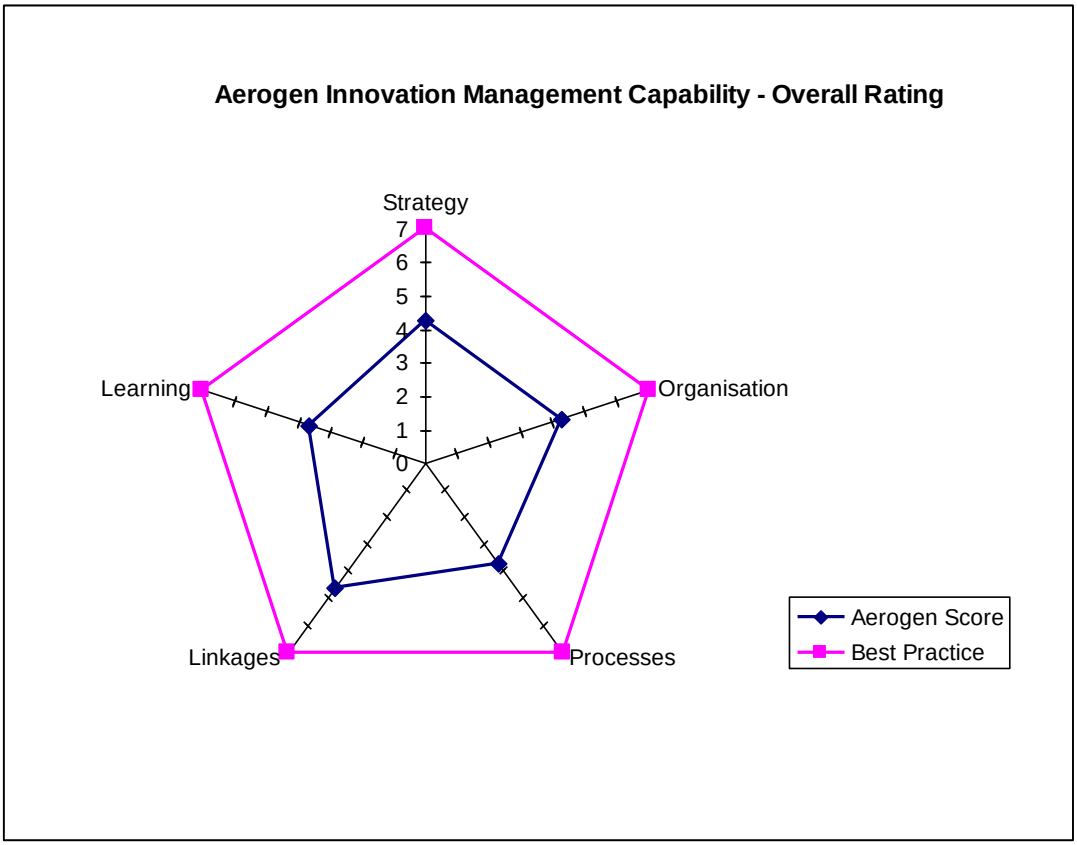

Figure 6.3 Overall Innovation Management Capability Rating

The following sections provide an analysis of the results gathered in each innovation area.

6.5.2 Results from Innovation Area 1: Strategy

Figure 6.4 shows the average rating obtained for each of the 9 survey questions pertaining to the area of Innovation Strategy. These questions correspond to questions 1, 6, 11, 16, 21, 26, 31, 36 and 41 from the Phase 2 survey, as provided in Appendix B.

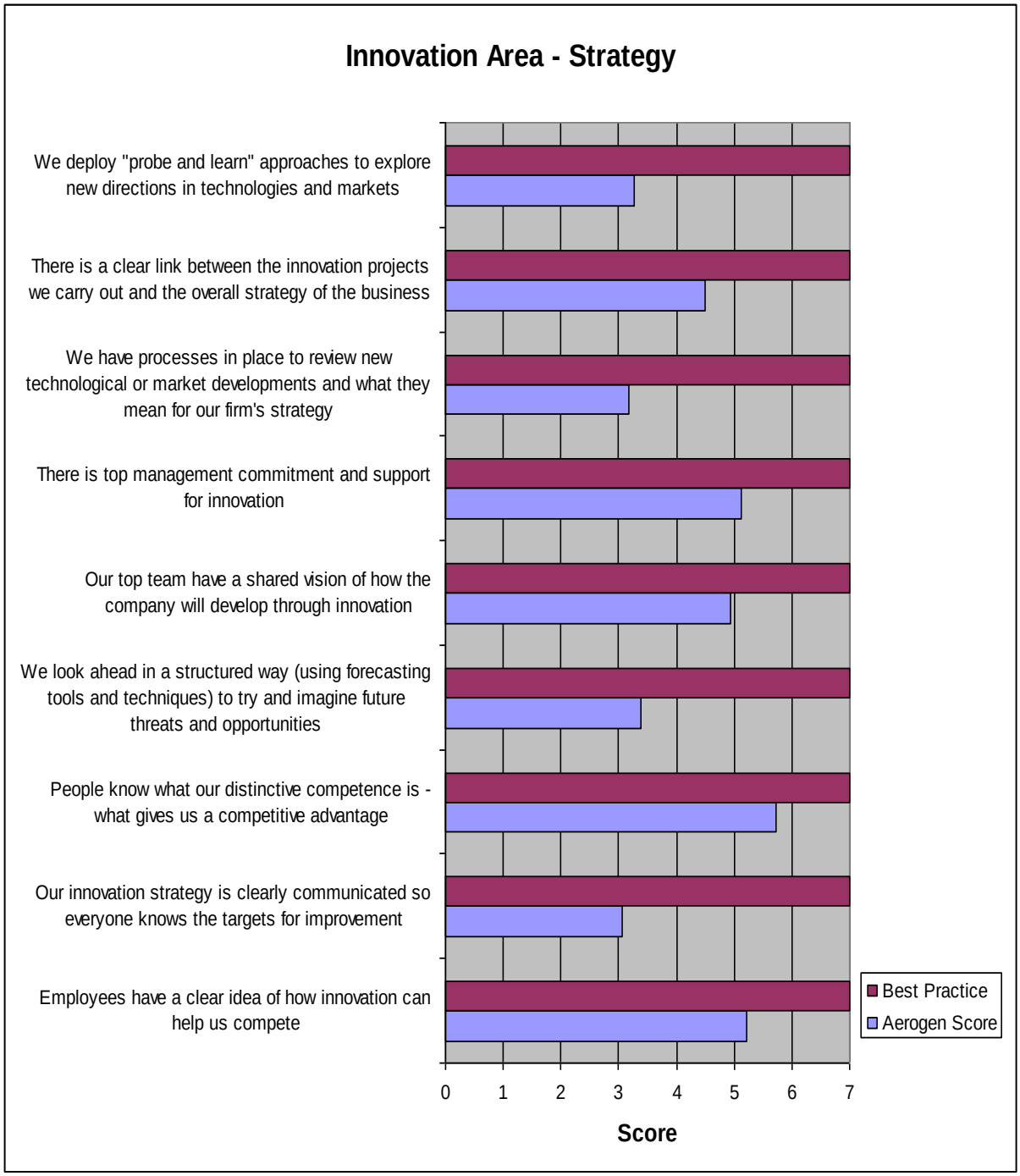

Figure 6.4 Innovation Area 1: Strategy – Company Mean Ratings

6.5.3 Results from Innovation Area 2: Processes

Figure 6.5 displays the average rating obtained for each of the 9 survey questions pertaining to the area of Innovation Processes. These questions pertain to both the front end processes and the NPD process and correspond to questions 2, 7, 12, 17, 22, 27, 32, 37 and 42 from the Phase 2 survey.

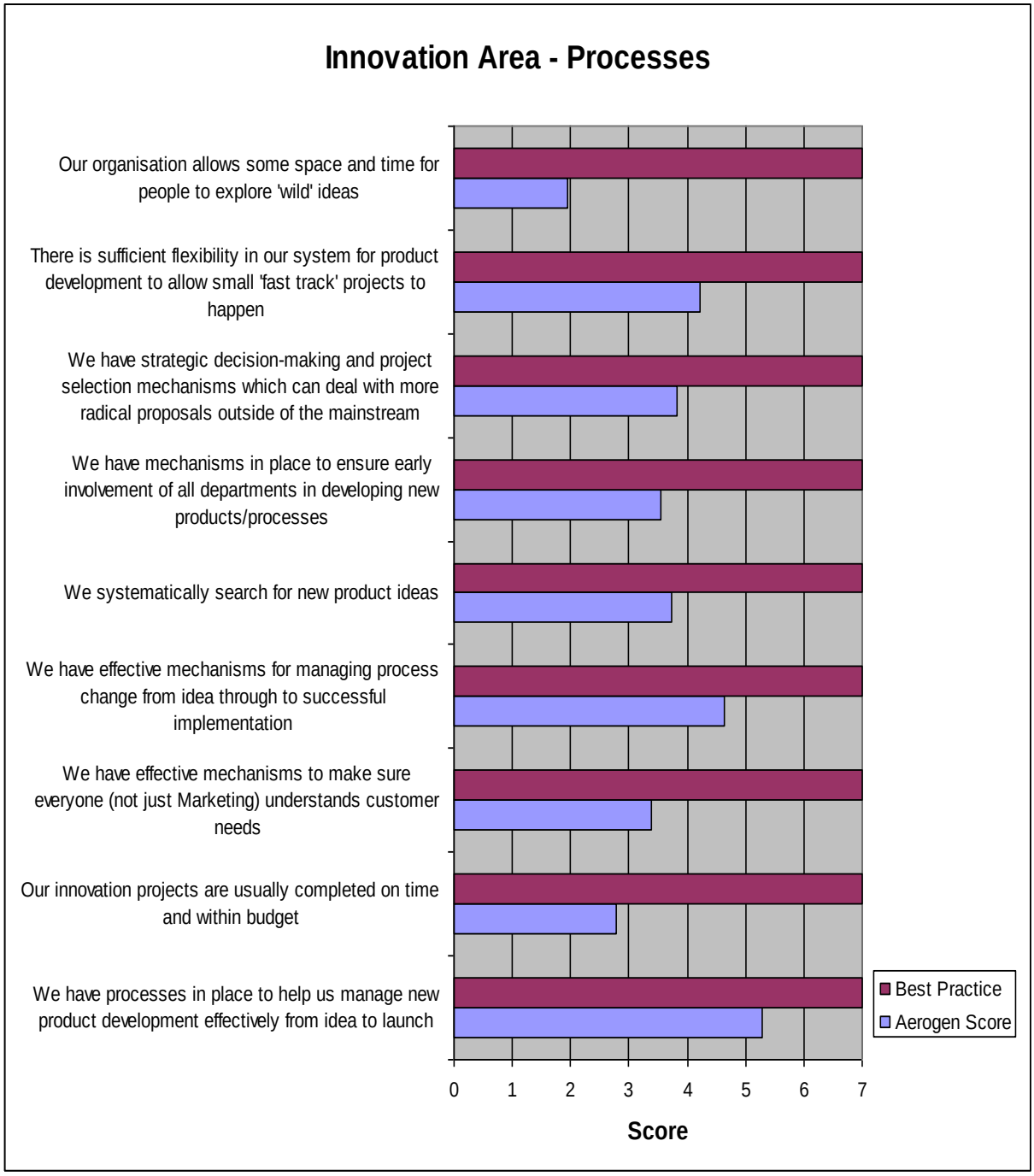

Figure 6.5 Innovation Area 2: Innovation Process – Company Mean Ratings

6.5.4 Results from Innovation Area 3: Organisation

Figure 6.6 provides the average rating for each of the 9 survey questions pertaining to the area of Innovation Organisation. These questions were intended to assess the organisation's culture, structure and climate for innovation against best practice, and correspond to questions 3, 8, 13, 18, 23, 28, 33, 38 and 43 from the Phase 2 survey.

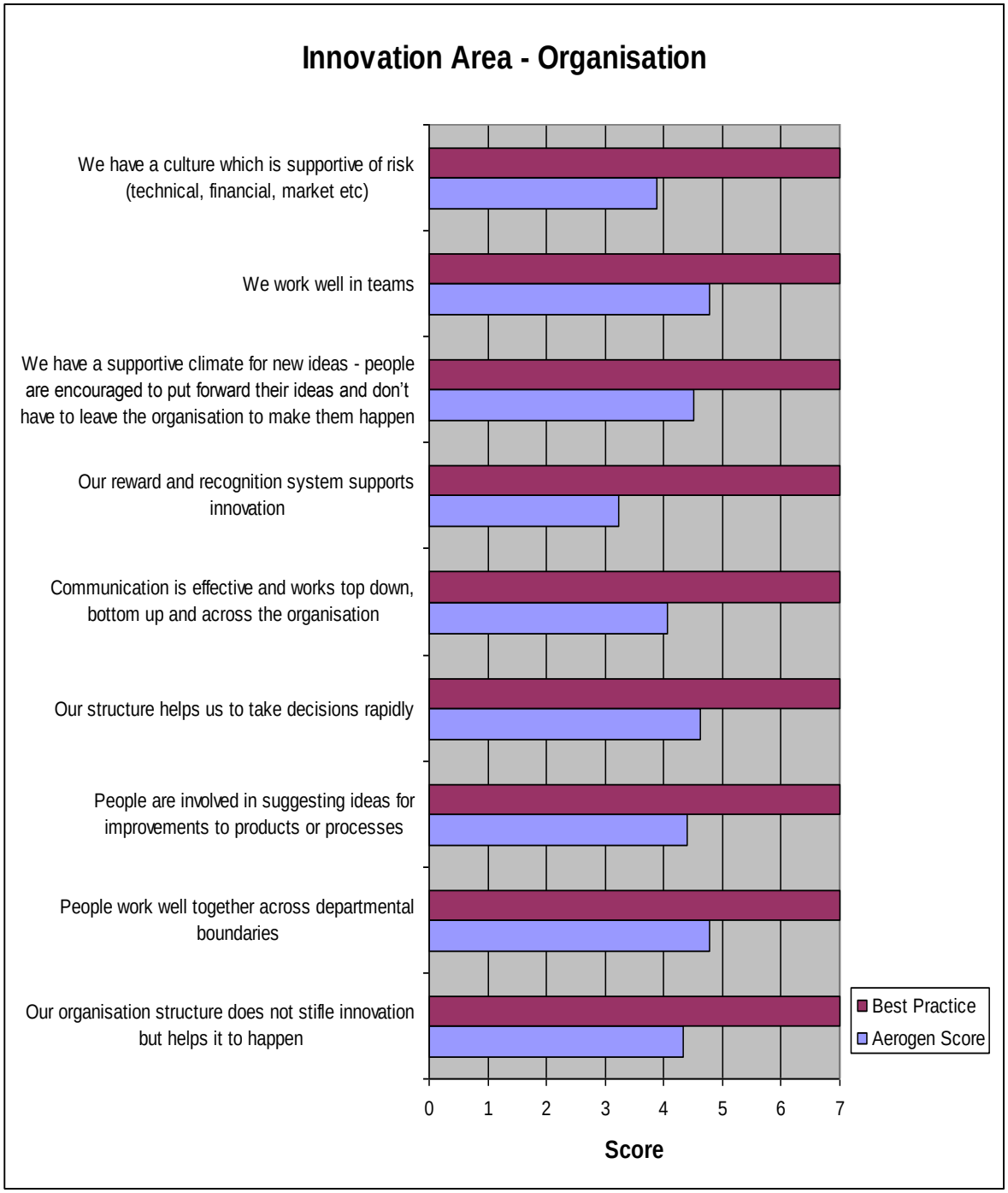

Figure 6.6 Innovation Area 3: Innovation Organisation – Company Mean Ratings

6.5.5 Results from Innovation Area 4: Linkages

Figure 6.7 provides the average rating for each of the 9 survey questions pertaining to the area of Innovation Linkages, which has been highlighted as an area of particular relevance to SMEs. The linkages assessed include supplier and customer links and collaboration with external specialists, research centres and other firms. The questions below correspond with questions 5, 10, 14, 19, 24, 29, 34, 39 and 44 from the Phase 2 survey.

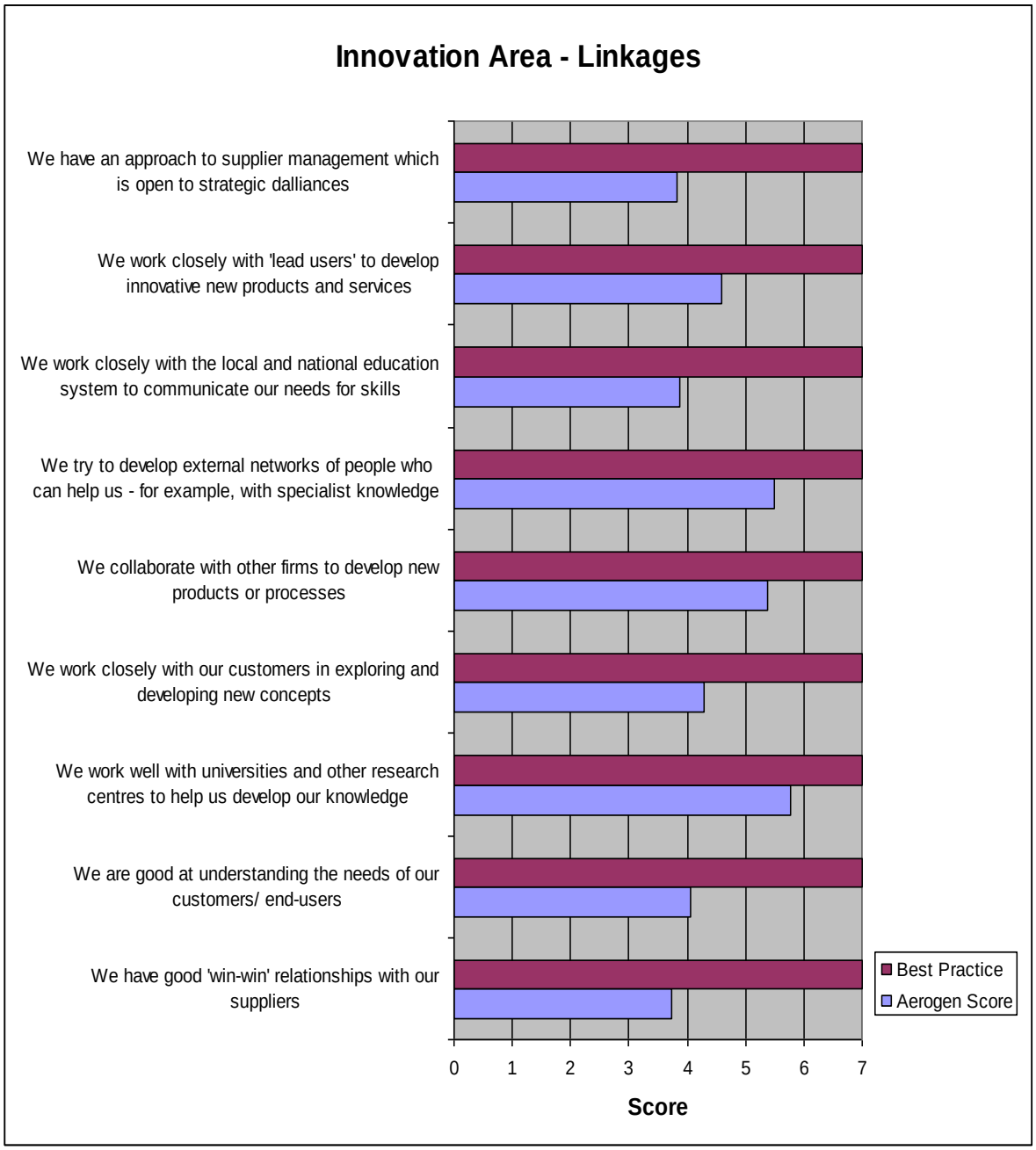

Figure 6.7 Innovation Area 4: External Linkages – Company Mean Ratings

6.5.6 Results from Innovation Area 5: Learning

Figure 6.8 details the average rating for each of the 9 survey questions pertaining to the area of Organisational Learning, which has been highlighted throughout the literature review as being critical for sustained and continuous innovation. The questions assess the organisations propensity to learn from both the external environment, as well from mistakes made throughout the innovation process. The area of measurement is also assessed here. The questions below correspond to questions 4, 9, 15, 20, 25, 30, 35, 40 and 45 from the Phase 2 survey.

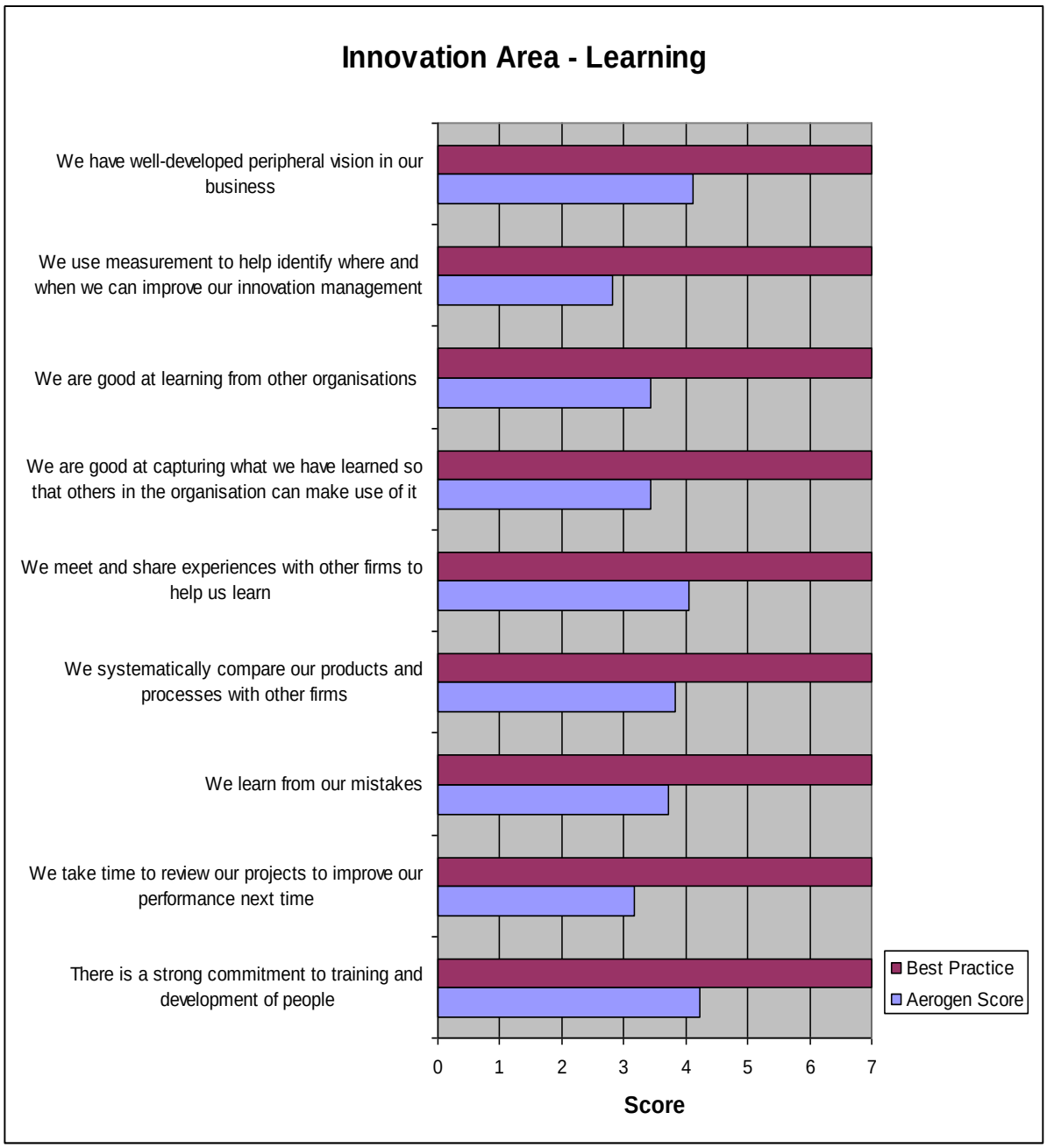

Figure 6.8 Innovation Area 5: Organisational Learning – Company Mean Ratings

6.6 Phase 2 Survey/Interviews – Detailed Results Analysis

6.6.1 Innovation Management Area 1 – Strategy

Figure 6.9 and Table 6.1 provide the results achieved in the area of strategy, from a cross-functional, hierarchical and long-term/newly-hired management perspective. The highest ratings were provided by the 'Long-Term Management' group, with significantly lower ratings being provided by the newer members of the management team.

Cross-functional perspectives were generally well-aligned and the average overall score achieved was 4.3 out of a possible 7, which represents 'best practice'.

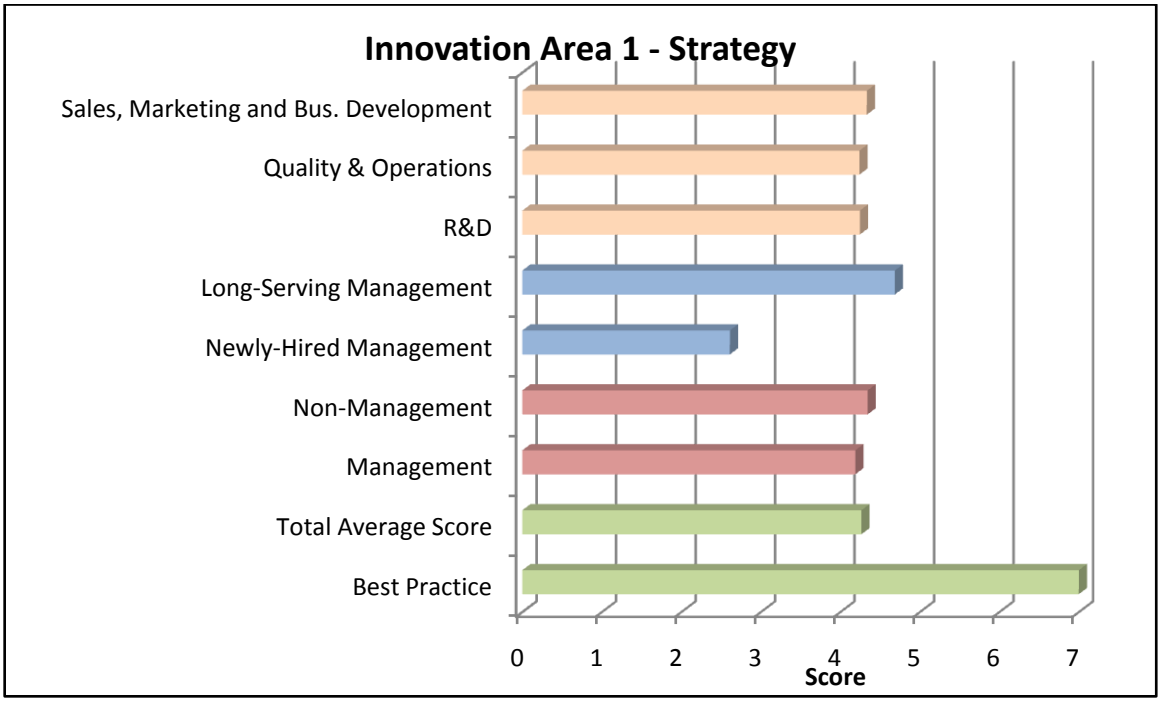

Figure 6.9 Innovation Management Area 1 – Strategy: Results

	Average Scores										
Participant Group	Q1	Q6	Q11	Q16	Q21	Q26	Q31	Q36	Q41	Mean	St. Dev.
R&D	5.4	2.4	5.9	3.4	5.7	4.7	2.8	4.9	3.0	4.3	1.8
Quality & Operations	5.2	3.3	5.7	3.2	4.5	5.0	3.5	4.3	3.5	4.2	1.7
Sales, Marketing and Bus. Dev.	5.0	3.6	5.6	3.6	4.6	5.8	3.2	4.2	3.4	4.3	1.6
Long-Serving Management	5.0	3.8	6.0	3.3	5.3	6.0	4.3	4.7	3.7	4.7	1.4
Newly-Hired Management	4.5	1.5	3.5	1.0	3.0	4.5	1.5	3.0	1.0	2.6	1.5
Management	4.9	3.3	5.4	2.8	4.8	5.6	3.6	4.3	3.0	4.2	1.7
Non-Management	5.5	2.9	6.0	3.9	5.1	4.7	2.8	4.7	3.5	4.3	1.7
Mean for Question	5.2	3.1	5.7	3.4	4.9	5.1	3.2	4.5	3.3	4.3	1.7

Table 6.1 Innovation Management Area 1 – Strategy: Detailed Results

Results Analysis

The results indicate that all participants have a clear idea of how innovation can help the company to achieve competitive success (Q1), with 94% of the population rating this statement with a score of 4 or higher. The core competencies of the company are well understood across the participating groups (Q11), and respondents generally agree that there is top management commitment and support for innovation (Q26). The data confirms that the top team have a shared vision of how the company will develop through innovation (Q21). There is also a relatively clear link between the innovation projects carried out and the overall strategy of the company (Q36).

A number of poorer performing areas are further highlighted. Only a marginal percentage of the population perceived that the company's innovation strategy is clearly communicated throughout the organisation (Q6), indicated by an average score of 3.1. In relation to the use of systems and tools in innovation management, there was a general recognition that forecasting tools and systems are not systematically utilised to imagine future threats and opportunities (Q16). Comments on this section indicate that the approach taken here is more ad-hoc in nature. Further, while the long-serving members of management concur that there are some processes in place to review external technological or market developments (Q31); this area achieved a lower rating from all participant groups outside of the long-term management team.

The final aspect of the strategy assessment evaluated the company's strategic approach to radical or breakthrough innovations (Q41). This area achieved a low rating, indicating that 'probe and learn' approaches advised within the literature in the exploration of new directions in technologies and markets, are sometimes, but not regularly, taken. Comments in this area suggest that the 'probe and learn' approach is being taken with current radical innovation endeavours, but not for other NPD types, which aligns with the best practices identified in the research. Therefore, while quantitative results indicate that this is a poor performing area, it could be considered that in fact, these practices correlate well with best practice.

While the ratings provided by each functional group generally align with each other, there is a marked difference between the ratings of long-term management and those provided by newly-hired managers, who may have a more large-company external perspective on the company's innovation practices.

6.6.2 Innovation Management Area 2 – Processes

Figure 6.10 and Table 6.2 display the data gathered in the area of Innovation Processes. The highest ratings were those provided by the R&D and 'Long-Term Management' groups, with a significant difference in ratings again provided by the newer members of the management team.

Cross-functional analysis highlights similar average scores in the Sales, Marketing and Business Development and the Quality and Operations groups. The average overall rating achieved was 3.7 out of a possible 7, indicating that this area scores averagely against best practice.

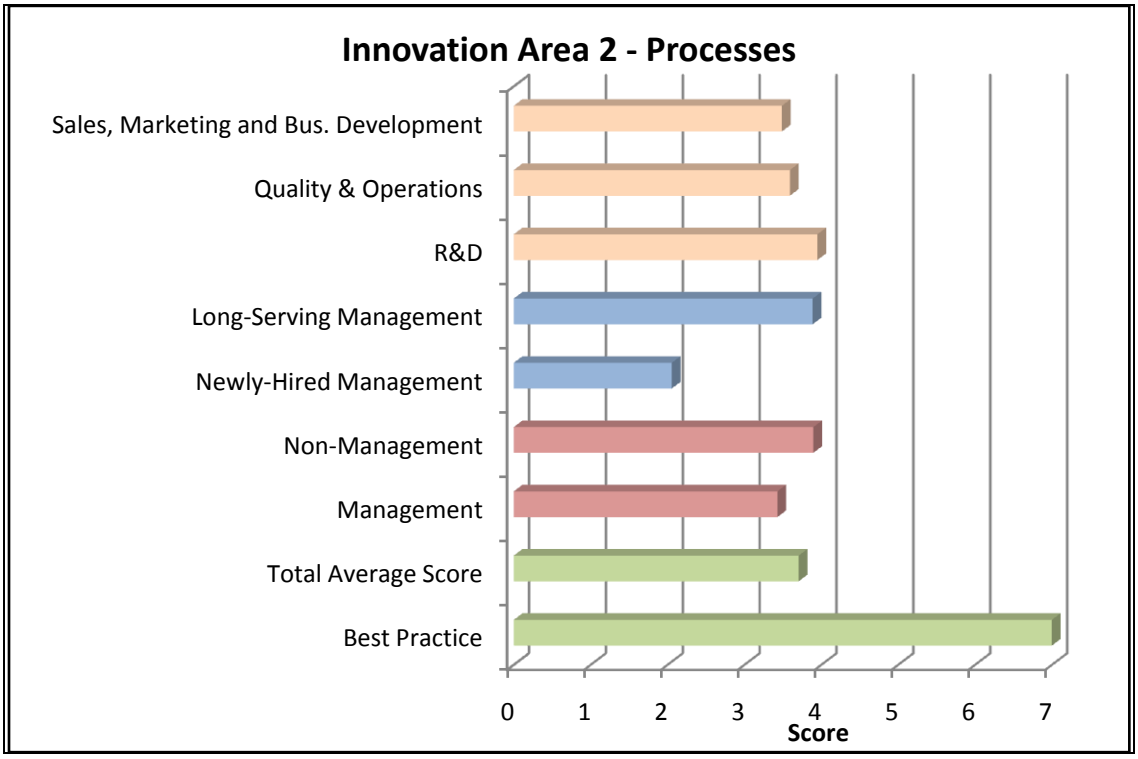

Figure 6.10 Innovation Management Area 2 – Processes: Results

	Average Scores										
Participant Group	Q2	Q7	Q12	Q17	Q22	Q27	Q32	Q37	Q42	Mean	St. Dev.
R&D	6.1	3.0	3.4	5.3	3.7	3.3	4.0	5.3	1.6	4.0	1.9
Quality & Operations	4.7	2.7	3.5	4.8	3.7	3.3	3.7	4.3	1.7	3.6	1.6
Sales, Marketing and Bus. Dev.	4.8	2.6	3.2	3.6	3.8	4.2	3.8	2.6	2.8	3.5	1.8
Long-Serving Management	5.5	2.7	4.2	4.3	4.0	4.2	3.3	4.5	2.3	3.9	1.7
Newly-Hired Management	2.0	1.5	1.5	2.0	2.5	2.5	2.0	2.5	2.0	2.1	0.6
Management	4.6	2.4	3.5	3.8	3.6	3.8	3.0	4.0	2.3	3.4	1.7
Non-Management	5.8	2.9	3.3	5.4	3.8	3.4	4.6	4.4	1.7	3.9	1.8
Mean for Question	5.3	2.8	3.4	4.6	3.7	3.6	3.8	4.2	1.9	3.7	1.8

Table 6.2 Innovation Management Area 2 – Processes: Detailed Results

Results Analysis

In the area of new product development, 89% of all participants agree that there are processes in place to manage NPD effectively from idea to launch (Q2). The R&D team and long-term management rate the effectiveness of the NPD process highly, with 100%

of the participants from both groups providing a rating of 4 or higher. Somewhat less favourable scores were awarded in relation to the management of process change (Q17), with 29% of participants providing a rating of 3 or lower. 86% of the R&D participant group believe that the NPD process allows for small 'fast-track' projects to happen (Q37) however newly-hired management and the Sales & Marketing team rate this area less favourably.

Newly-hired management rate the effectiveness of NPD process and process change management poorly, commenting that this area is perhaps the biggest weak point in the innovation process. Upon discussion, it was determined that the reasons for this low rating were not necessarily related to the Stage-Gate process itself, but more closely related to issues in project planning, prioritisation and resourcing, resulting in projects not being completed on time and within budget (Q7).

In the front-end of innovation, findings suggest that there is scope for improvement in communicating the needs of customers across the organisation (Q12). Respondents from the long-term management and Sales, Marketing and Business Development teams positively indicate that there are appropriate mechanisms in place to ensure early involvement of all departments in developing new products/processes (Q27), however other participant groups rate this area less positively, with over 50% of these participants providing a rating of 3 or less. New product ideas are not systematically sought after; rather, a more ad hoc approach is taken (Q22). The organisation does not allow space and time for people to explore 'wild' ideas, indicated by an average rating of 1.9 (Q42). Comments indicate that the reasons for this poor rating are somewhat outside of the control of the company, and dictated by typical small-company time, money and resourcing constraints.

The final area of assessment relates specifically to more radical innovation projects. 65% of participants indicate that strategic decision-making and project selection mechanisms can effectively deal with more radical proposals outside of the mainstream (Q32). An average score of 3.8 was achieved here.

6.6.3 Innovation Management Area 3 – Organisation

Figure 6.11 and Table 6.3 provide the scores achieved in the area of Innovation Organisation. This area was rated most highly by the R&D group, with Sales, Marketing & Business Development and Quality and Operations personnel providing marginally less favourable scores. The average overall score achieved was 4.3 out of a possible 7, and the most significant differences in perspectives were again found to be between the long-term and newly-hired management teams.

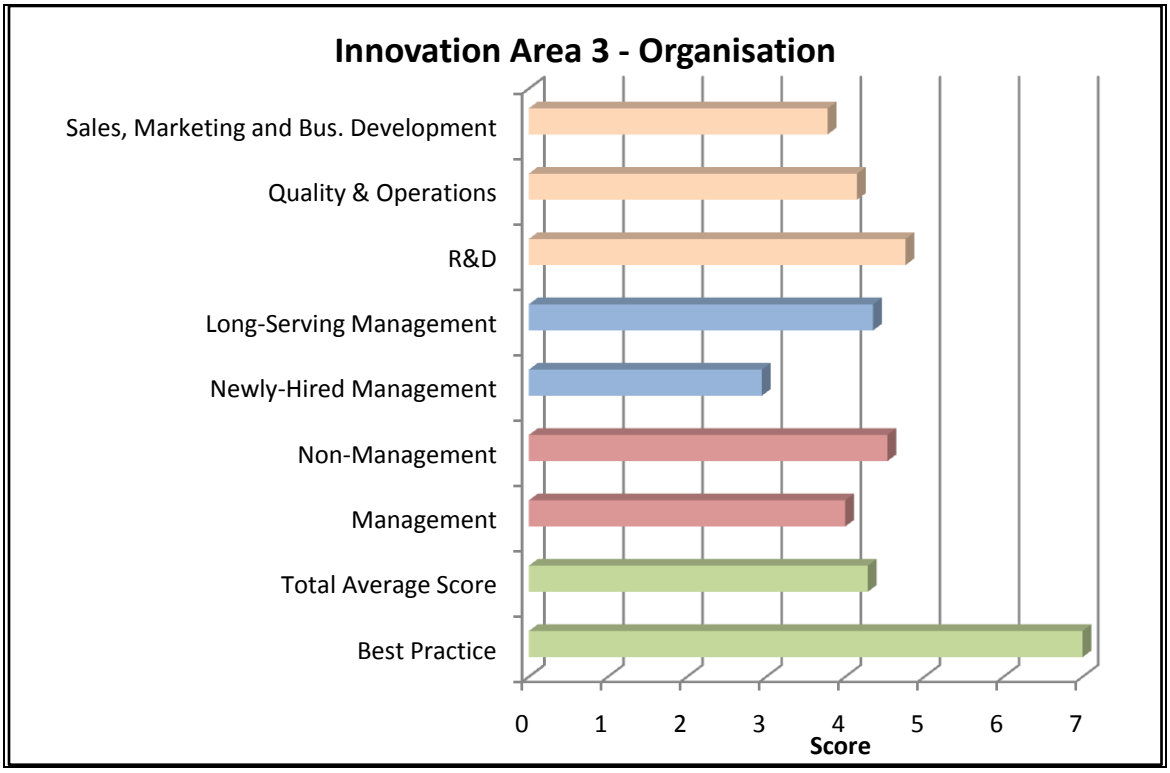

Figure 6.11 Innovation Management Area 3 – Organisation: Results

	Average Scores										
Participant Group	Q3	Q8	Q13	Q18	Q23	Q28	Q33	Q38	Q43	Mean	St. Dev.
R&D	4.7	5.3	5.3	5.7	4.9	2.6	4.6	5.6	4.3	4.8	1.5
Quality & Operations	4.3	4.7	3.7	5.0	4.0	3.7	4.3	4.3	3.3	4.1	1.3
Sales, Marketing and Bus. Dev.	3.8	4.2	4.0	2.6	3.0	3.6	4.6	4.2	4.0	3.8	1.4
Long-Serving Management	3.9	4.1	3.9	4.0	3.6	3.4	4.8	4.4	4.0	4.4	1.3
Newly-Hired Management	2.0	4.0	2.5	4.0	2.5	2.0	4.0	3.0	2.5	2.9	0.9
Management	3.9	4.1	3.9	4.0	3.6	3.4	4.8	4.4	4.0	4.0	1.4
Non-Management	4.7	5.3	4.8	5.1	4.4	3.1	4.3	5.3	3.8	4.5	1.5
Mean for Question	4.3	4.8	4.4	4.6	4.1	3.2	4.5	4.8	3.9	4.3	1.5

Table 6.3 Innovation Management Area 3 – Organisation: Detailed Results

Results Analysis

The nine survey questions on innovation organisation focused on organisational culture, structure, and climate, which have all been highlighted throughout the literature as important influencing factors on the innovation capabilities of a company.

In the area of organisational structure, 78% of respondents indicated that the structure of the organisation does not stifle innovation but helps it to happen (Q3). The highest ratings were provided by the R&D and non-management groups, and the most common rating provided was 5 out of a possible 7. 86% of the population further agreed that the size and structure of the organisation enables decisions to be taken rapidly (Q18).

In the assessment of the effectiveness of teamwork and communication, 96% of the population concurred that people work well together across departmental boundaries (Q8), whereas 83% believe that project teams work well together (Q38). The lowest ratings were provided by the Quality and Operations and Sales, Marketing and Business Development groups, who commented that team-relations only work well when all members have the same priority for the work. Results in the area of cross-organisational communication were mixed, with an average of 4.1 being achieved (Q23).

Question 13 assessed the involvement of people in suggesting ideas for improvements to products or processes. The R&D group provided high ratings in this area, whereas the Operations and Quality, and Sales, Marketing and Business Development groups rated this somewhat less favourably. Newly-hired management provided a mean score of 2.5, whereas long-term management ratings were substantially higher at 3.9. Respondents generally agreed that there is a supportive organisational climate for new ideas (Q33). However, comments indicate that while people are encouraged to put forward new ideas, there is little incentive to do so. These comments are further backed up by the findings of Question 28, which assessed the effectiveness of reward and recognition systems in innovation. The average score achieved here was 3.2, indicating that this statement is generally untrue.

Post-survey interviews clarified that the management team have recently begun to address the issues of idea generation through the introduction of two reward schemes; a suggestion box scheme and an inventor reward scheme. It was pointed out that these schemes are in their infancy and have yet to prove their effectiveness.

The final cultural aspect of assessment relates to the tolerance of risk. Long-serving management provided an average rating of 4.5 in this area, whereas newly-hired management and the Operations and Quality group rated this area poorly.

6.6.4 Innovation Management Area 4 – Linkages

Figure 6.12 and Table 6.4 display the average scores gathered in the area of organisational linkages, which has been highlighted as an area of particular importance for the smaller firm. The linkages assessed include: suppliers, customers and lead users, universities and research centres, external organisations and specialists, and local and national education systems. The mean score of 4.6 achieved in this area was positive, and there was a general consistency in responses across functional and hierarchical boundaries.

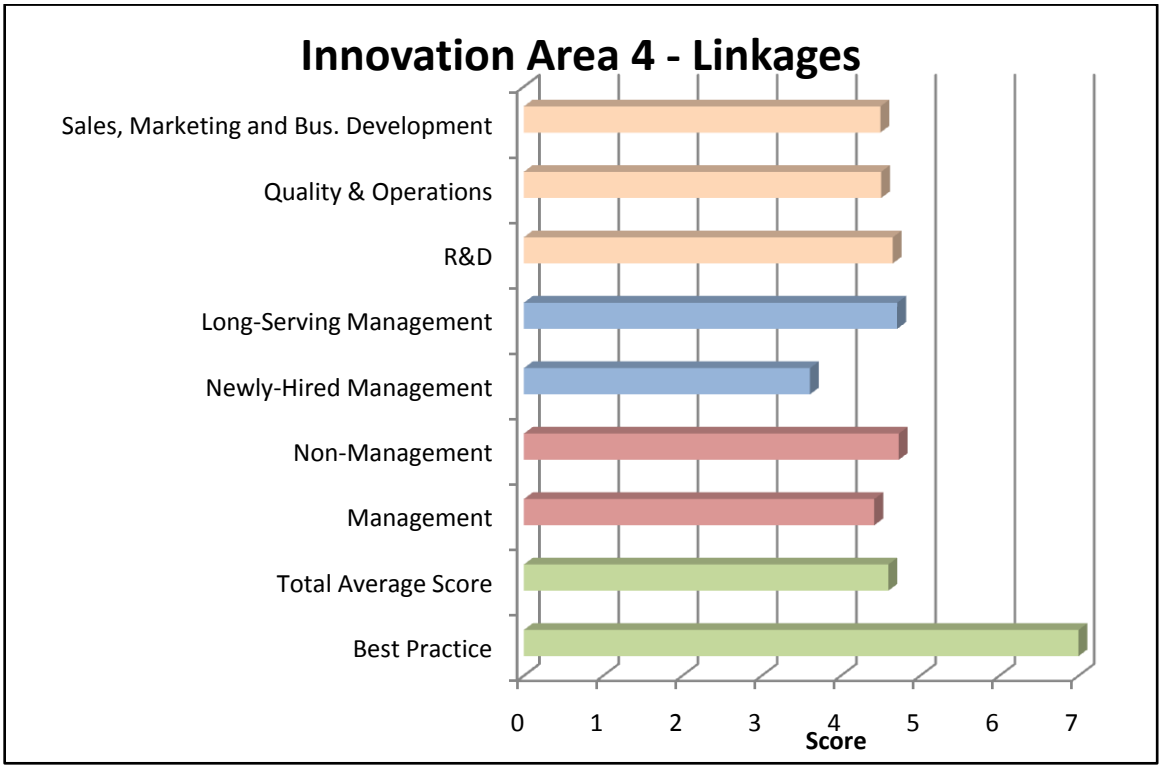

Figure 6.12 Innovation Management Area 4 – Linkages: Results

	Average Scores										
Participant Group	Q5	Q10	Q14	Q19	Q24	Q29	Q34	Q39	Q44	Mean	St. Dev.
R&D	3.9	3.9	6.4	3.9	5.9	5.9	3.5	4.3	4.1	4.7	1.8
Quality & Operations	4.0	4.0	5.5	4.5	5.3	5.5	3.4	4.5	3.7	4.0	1.5
Sales, Marketing and Bus. Dev.	3.2	4.4	5.2	4.6	4.8	5.0	4.8	5.0	3.6	4.5	1.4
Long-Serving Management	3.5	4.5	5.1	4.7	5.7	5.0	5.4	4.7	3.8	4.7	1.3
Newly-Hired Management	2.5	2.0	5.0	3.0	4.0	5.0	3.0	5.5	2.5	3.6	1.3
Management	3.3	3.9	5.1	4.3	5.3	5.0	4.7	4.9	3.5	4.4	1.4
Non-Management	4.1	4.2	6.3	4.3	5.5	5.9	3.2	4.3	4.1	4.7	1.7
Mean for Question	3.7	4.1	5.8	4.3	5.4	5.5	3.9	4.6	3.8	4.6	1.5

Table 6.4 Innovation Area 4 – Linkages: Detailed Results

Results Analysis

The initial area of assessment pertains to supplier management and relations, with 61% of participants perceiving that there are good 'win-win' relationships with the company's suppliers (Q5). The highest scores were provided by the R&D and Quality & Operations

groups, with the management and Sales, Marketing and Business Development teams indicating less favourable perceptions. Post-survey interviews clarified that this mixed response was due to a variance in relations from supplier to supplier. It was further commented that a number of suppliers have the upper-hand in terms of pricing and require much hand-holding, whereas others are more proactive and self-sufficient. Similar comments and results were provided for Question 44, which assessed the supplier management approach and its openness to strategic alliances.

The second area of assessment relates to the company's perceptions on its proficiency at understanding the needs of customers (Q10). Again, a mixed result was gathered, with an average rating of 4.1 being provided. The long-serving management and Sales, Marketing and Business Development groups provided the highest scores here, commenting that the value of the 'Voice of the customer' is recognized in the early stages of new product development. These groups further agree that the customer is involved in exploring and developing new concepts (Q19). However, the newly-hired management and R&D groups rate this area less positively, commenting that end-user involvement throughout the NPD process is not effectively managed, outside of partnership projects. Top management made a relevant comment here, stating that many of the NPD projects currently being undertaken are in radically new areas, with no existing market or customer base. Further comments indicate a top-management perception that too much customer involvement can lead towards incremental innovation as opposed to the blue ocean breakthrough innovations being pursued by the company. A key comment in this area was provided by Aerogen CEO, John Power:

"Aerogen's overall vision and strategy is to steer clear of the commodity market. Sure, we need to stay close to the customer, yet we can't purely react to what customers and the competition tells us; this only leads to incremental innovation. We're looking for breakthrough innovations in undiscovered markets with no competition."

There is a preference therefore to work with innovative 'key opinion leaders' and 'lead users' in developing new products (Q39). This area generally scored highly across all participating groups, achieving an average rating of 4.6. Comments from the groups

highlighted that this is particularly true in current radical innovation projects, and that this is an area which is still improving.

Other external linkages pertained to relationships with local and national education system (Q34). Members of the non-management group did not perceive that there are close links here, however, the management and Sales, Marketing and Business Development groups provided evidence to the contrary, highlighting on-going work with the IMDA and other training organisations on subject suggestions for medical device courses within the universities.

The final areas of assessment relate to organisational linkages with universities and external networks of experts (Q14, Q29), and collaborations with other firms (Q24). These three areas were all rated very highly across the population, achieving mean scores of 5.4 or higher.

6.6.5 Innovation Management Area 5 – Organisational Learning

Figure 6.13 and Table 6.5 display the data gathered in the area of organisational learning. The highest average score of 4.1 is provided by the long-term management group, with decidedly lower ratings of 2.3 being provided by the newly-hired management group. Scores across functional groups are generally well-aligned, and overall this area rates poorly against best practice.

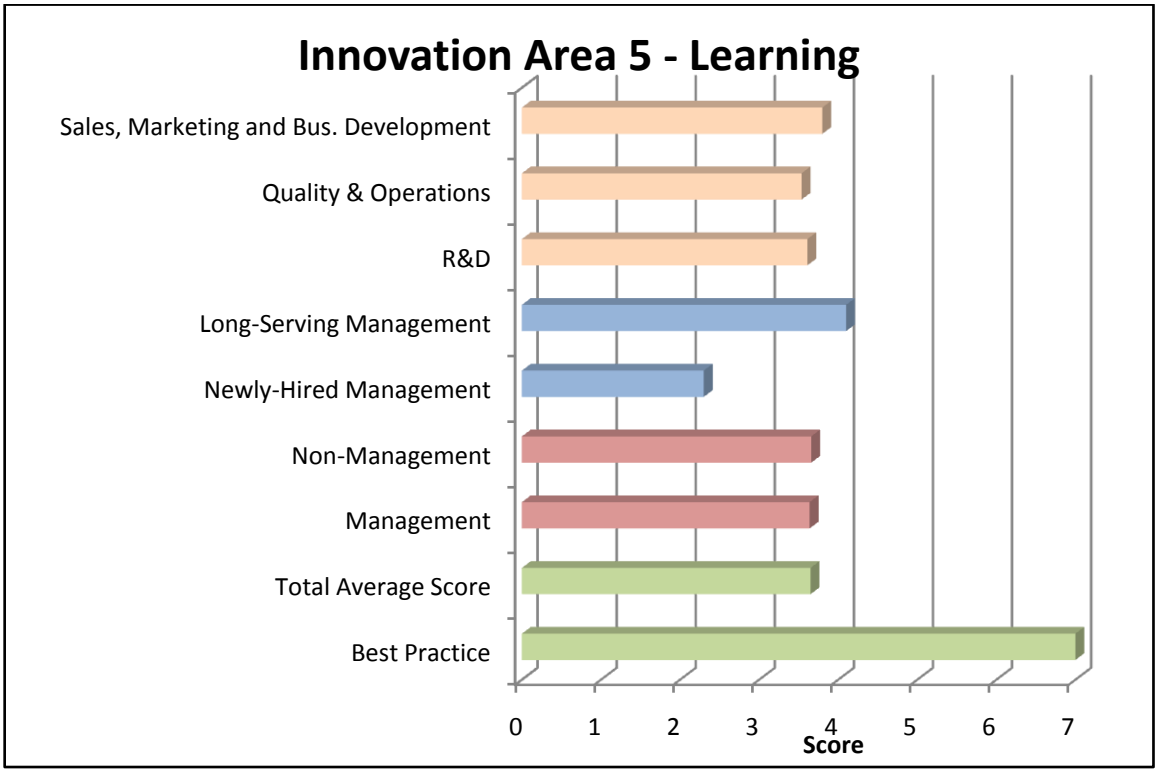

Figure 6.13 Innovation Management Area 5 – Learning: Results

	Average Scores										
Participant Group	Q4	Q9	Q15	Q20	Q25	Q30	Q35	Q40	Q45	Mean	St. Dev.
R&D	4.4	3.0	4.1	4.4	3.3	3.1	3.6	2.2	4.3	3.6	1.6
Quality & Operations	3.7	2.8	3.5	3.7	4.5	3.5	3.2	3.0	4.0	3.5	1.4
Sales, Marketing and Bus. Dev.	4.6	3.8	3.4	3.2	4.4	3.8	3.6	3.4	4.0	3.8	1.4
Long-Serving Management	4.5	3.5	3.7	4.3	4.7	4.2	3.8	3.7	4.3	4.1	1.5
Newly-Hired Management	2.5	1.5	2.0	2.0	4.5	2.0	2.5	1.5	2.5	2.3	1.1
Management	4.0	3.0	3.3	3.8	4.6	3.6	3.5	3.1	3.9	3.6	1.6
Non-Management	4.4	3.3	4.1	3.9	3.6	3.3	3.4	2.6	4.3	3.7	1.5
Mean for Question	4.2	3.2	3.7	3.8	4.1	3.4	3.4	2.8	4.1	3.7	1.5

Table 6.5 Innovation Management Area 5 – Learning: Detailed Results

Results Analysis

The first area of assessment relates to the training and development of human resources (Q4). A mean rating of 4.2 was calculated, with 83% of participants providing a rating of 4 or higher. The least favourable result was that of the newly-hired management group,

whose combined scores averaged at 2.5. Key comments indicated that while the commitment to training is strong, financial and time constraints limit the amount of training which can be provided. Career development is however encouraged, through the encouragement of cross-functional work experience.

In relation to the NPD process, it was found that 67% of respondents feel that insufficient time is taken to review projects to improve future performance (Q9). Furthermore, results indicate a general weakness in organisational learning from mistakes made (Q15). Post-survey interviews verified these findings, indicating that while the company's Stage-Gate process requires post-launch project reviews, these are generally afforded little time and only paid 'lip service'; hence 'lessons learned' are not sufficiently captured, resulting in mistakes being re-made. 44% of respondents feel that the organisation is somewhat good at capturing what has been learned so that others in the organisation can make use of it (Q30), with the highest ratings being provided by the long-term management and Sales, Marketing and Business Development groups. Key comments relate this poor response back to inefficiency in post-launch project reviews.

A number of questions pertained to organisational learning from the external environment. It was found that an ad hoc approach is taken towards comparing products and processes with other firms (Q20), and that this is generally completed by few personnel from the R&D group. The highest rating in this area was provided by the R&D group, with 86% of respondents indicating that this is generally true, whereas less favourable scores were provided by all other participating groups.

The company scored more favourably in relation to meeting and sharing experiences with other firms (Q25), indicated by an average overall score of 4.1, with 100% of the management team rating this area 4 or higher. Comments indicate that the company is a member of ICBE, but that these discussions are generally limited to senior management. A negative cross-organisational rating was achieved in relation to the company's propensity to learn from other organisations (Q35), and a mean score of 4.1 was provided to indicate that there is a well-developed peripheral vision in the company's business (45).

The final area of assessment related to the use of measurement to help identify where and when innovation management can be improved (Q40), an area which scored poorly in the earlier Phase 1 survey. 65% of the population again rated this area poorly, with a general consistency in responses across all participant groups. Post-survey interviews clarified that this is an area which has already been highlighted for improvement within the company.

6.7 Results Summary

The Aerogen innovation capability study spanned a wide range of innovation areas, gathering the perspectives of each key participant group in the innovation process. Many of these perspectives are based on personal opinion, relative to the knowledge available to the individual participant at the time of the surveys, and it is therefore no surprise that the results do not correlate nicely into well-aligned conclusions. A summary of the overall results gathered is provided in Table 6.6. These results will be discussed and conclusions drawn in the final chapters of the research.

	Innovation Area	**Results (<4 = Negative, >=4 = Positive)**
Strategy	Strategy linked to NPD	Positive
	Processes in place to review new technological & market developments	Negative
	Top management commitment and support for innovation	Positive
	Top team have shared strategic vision	Positive
	Structured approach to identifying future threats and opportunities	Negative
	Radical Innovation – "probe and learn" approach taken	Positive (from interview data gathered)
	Awareness of distinctive competence	Positive
	Clear communication of innovation strategy	Negative
	Clear idea of link between innovation and competitive success	Positive
Process	Effectiveness of NPD process	Positive
	NPD completion (on time, on budget)	Negative
	Cross-functional understanding of customer needs	Negative
	Effectiveness of process innovation	Positive
	Systematic approach to idea generation	Negative

	Early involvement of all departments in NPD	Negative
	Project selection and strategic decision-making mechanisms	Negative
	Flexibility of the NPD process	Positive
	Time and space provision for exploring 'wild' ideas	Negative
Organisation	Risk-supporting culture	Positive
	Work well in teams	Positive
	People work well across departmental boundaries	Positive
	Effective organisational communication	Positive
	People-involvement in idea suggestion	Positive
	Climate supportive of new ideas	Positive
	Effective rewards and recognition system	Negative
	Structure encourages innovation	Positive
	Structure enables fast decisions to be taken	Positive
Linkages	'Win-win supplier relationships	Negative
	Supplier management approach encourages strategic partnerships	Negative
	Work closely with 'lead users'	Positive
	Work with customers in new concept development	Positive
	Good understanding of customer needs	Positive
	Linkages with local and national education system	Negative
	Linkages with external specialists	Positive
	Collaboration with other firms	Positive
	Linkages with universities/research centres	Positive
Learning	Well-developed peripheral vision of business	Positive
	Use of measurement for improvement of innovation management	Negative
	Good at learning from other organisations	Negative
	Meet and share experiences with other firms	Positive
	Systematically compare products/processes with other company's	Negative
	We capture what we have learned and learn from our mistakes	Negative
	Post-project reviews are held to improve performance	Negative
	Strong commitment to training and development	Positive

Table 6.6 Phase 2 Innovation Survey: Positive/Negative Results

7. Discussion

7.1 Introduction

Having provided and analysed the results gathered this chapter now discusses the findings in relation to the three key research questions, drawing on the theory discussed throughout the literature review as well as the post-survey interviews which were carried out with various key players in the Aerogen innovation process.

> Q1: How well do the innovation management practices at Aerogen (both at the front end and in new product development) compare with best practices identified in the literature?
>
> Q2: What areas of innovation management can Aerogen improve upon?
>
> Q3: How well do the perceptions of the various players involved in the innovation process align with each other?

This chapter further seeks to determine the reasons behind a key misalignment between the overall results provided by two participant groups: long-term management and newly-hired management.

7.2 Aerogen's Innovation Management Capability versus 'Best Practice'

Discussion Point 1: Aerogen's Innovation Strategy versus Best Practice

The literature recognizes the importance of having a clearly defined and effectively communicated business strategy in place and of aligning all pursued NPD activity with strategic goals in seeking competitive advantage (Cooper and Kleinschmidt, 2004). Khurana and Rosenthal (1998) and Koen (2004) stress the importance of a well-formulated and communicated strategic vision, particularly in the front end of innovation. General theory advises the importance of the external environment, stressing that

technological and market developments be routinely assessed, and that a structured approach be taken to identifying future threats and opportunities.

Cooper et al. (2004) remind us of the importance of balancing available resources and the project portfolio in line with the innovation strategy, to ensure the selection and prioritization of a good balance and mix of high-value projects.

Christensen and Overdorf (2000) state that "*the larger and more complex a company becomes, the more important it is for senior managers to train employees throughout the organisation to make independent decisions about priorities that are consistent with the strategic direction and the business model of the company. A key metric of good management, in fact, is whether such clear, consistent values have permeated the organisation.*"

The findings of this research indicate that Aerogen have identified a clear and bold strategy which is well-aligned with best practice in many areas. Employees generally have a good top-level understanding of the 'blue ocean' strategic approach being taken, and its influence on the choosing and prioritisation of projects. Survey participants understand the core competency of the company and how innovation can lead to competitive success.

Some aspects of the strategic management approach taken are, however, less well-aligned with the best practices advised. For example, an ad hoc approach is taken to identifying, assessing and understanding new developments in the external environment. This is not necessarily seen as a bad thing by management, who comment that the company is small with relatively few NPD projects underway and an abundant bank of further radical opportunities in the pipeline. Some perceive that the introduction of formal 'large-company' strategic processes and procedures might add an inhibiting layer of bureaucracy to what is currently a well-functioning system.

However, the results suggest that there may be a need for a more structured approach in some areas of innovation strategy, particularly in relation to the prioritisation of projects and resources as the company continues to expand and grow.

Discussion Point 2: Aerogen's Innovation Processes versus Best Practice

Christensen and Overdorf (2000) discuss the importance of implementing innovation processes, highlighting that one reason that many young companies collapse after the introduction of an initial "hot" product, is that their "*initial success is grounded in resources – often the founding engineers – and they fail to develop processes that can create a sequence of hot products.*"

Cooper (2001) views effective product innovation as a staged process, proposing his Stage-Gate approach and stressing the importance of project selection and strategic decision-making mechanisms. Amabile's (1999) research highlights both the importance of leadership and the creation of an environment for innovation to flourish. The literature emphasises the need to ensure flexibility in both the front-end and NPD processes (Koen et al., 2002, Cooper, 2001), involving all departments in the NPD endeavour, and the importance of building the 'voice of the customer' into the process of innovation (Cooper, 2004).

Koen et al. (2002) point out that many of the practices at the NPD stage of the innovation process don't apply to the front end, stating that "*the nature of the work, commercialisation date, funding level, revenue expectations and other factors are fundamentally different*". The authors' research discusses the importance of using systematic methods and tools in identifying opportunities, generating ideas and defining concepts at the front-end, stating that the "fuzziness" of the front-end can be tamed if these mechanisms are put in place.

Christensen and Overdorf (2000) discuss innovation processes in relation to the challenge of disruptive change, stating that in the start-up phases of an organisation, "*much of what gets done is attributable to resources – people, in particular. The addition or departure of a few key people can profoundly influence its success. Over time, however, the locus of the organisations capabilities shifts towards its processes and values. As people address recurrent tasks, processes become defined. And as the business model takes shape and it becomes clear which types of business need to be accorded highest priority, values coalesce*".

Aerogen's initial successes can be undoubtedly attributed to its two key core competencies: its core technology and its people. One of the key universal findings of this research was that the company has a broad range of innovators and "ideas" people, but what are now needed are more effective structures and processes by which sustained innovation can be achieved. The study found that Aerogen has gone some way towards building an effective innovation process, but issues in effectively completing NPD projects on time and within budget and involving all departments in the NPD process persist. These issues are attributed to poor project planning, project prioritisation, and the stretching of resources across sustaining engineering and NPD activities. The company currently has in excess of 10 'top-priority' projects underway with a resource-base of just 36, and this is stretching resources to their limits. There is evidence of improvement in this area, with the recent introduction of a Net Present Value (NPV) investment appraisal sheet, intended to help with project selection and prioritisation, however this has yet to be fully implemented within the company.

The best practice mechanisms provided within the literature for "taming" the front end are generally not systematically and methodically utilised within the company, rather a more ad hoc approach is taken. Evidence that this approach has been sufficient to date was provided, however it was accepted that as the company continues to grow, more structure will be required in these areas.

Discussion Point 3: Aerogen's Organisation Management versus Best Practice

Throughout the literature, the importance of organising for effective innovation is repeatedly highlighted. Issues in the areas of structure, culture and organisational climate are discussed. Tidd et al. (2001) stipulate that an organisation's structure must be designed to support innovation. Kanter (1987) advocates structures that develop people in the entrepreneurial spirit and that maintain their commitment to the organisation, while Burns and Stalker (1961) promote organic structures.

The theory on culture generally advocates low external controls, acceptance of risk and ambiguity and the rewarding of creativity and ideas. Schmidt (1990) proposes that culture and cultural fit are most important in SMEs, as such organisations are likely to be entirely enveloped in a culture, unlike large organisations where many different cultures may

exist. Goffin and Mitchell (2005) stress the importance of strategic human resource management with effective rewards and recognition systems, while Cooper (2001) highlights the importance of cross-functional teams and effective communication.

The research found that Aerogen has some structure in its innovation process and further, that a number of best practice procedures and systems are either still in their infancy or are currently being put in place. The company is small, and this brings its own advantages in that leaders and top management are close to the ground and teamwork and communication is effective. The company takes the matrix structure, whereby autonomous project teams are structured for NPD projects, while team members also belong to specific functional groups. There was some indication of a need for improvement here, in that many survey respondents displayed some concern over project team members being frequently pulled from project-related tasks to address short-term functional issues. Further, an organisational culture of "meetings, and meetings about meetings" was highlighted as an area for improvement.

One further key issue was identified, in relation to the rewards and recognition of innovation behaviour. Two pilot rewards systems have recently been introduced – a suggestion box scheme and an inventor reward scheme, however non-management employees have indicated that rewards schemes would be more effective if aligned with general employee performance and individual and team objectives.

Discussion Point 4: Aerogen's Approach to Linkages versus Best Practice

The literature discusses a number of innovation theories which could be seen as "closed" in nature. Chesbrough rejects such theories, along with the notion that *"if you want something done right, you have got to do it yourself",* in favour of an Open Innovation paradigm, which stipulates that innovation can come from both outside and inside of the organisation (2003). This theory champions a collaborative and global approach to innovation, which Chesbrough defines as a *"paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"* (2003).

We have noted that SME's in particular need to foster strategic external partnerships in achieving successful product innovation (Hewitt-Dundass, 2006). This need is most apparent given that the luxuries of funding, wide-ranging capabilities and abundant resources are more difficult to acquire.

We have further seen the importance of working closely with 'lead users' and customers in new concept and product development (Von Hippel, 2005), and understand that the innovation area of organisational linkages is of key importance in achieving competitive success.

Aerogen's pursuit and management of external linkages is effective. The company has fostered long-term relationships with innovative key opinion leaders in the area of Respiratory Science, as well as mutually-beneficial linkages with 'lead users' in its breakthrough NPD endeavours. The research indicates that customer's involvement in NPD is well-managed, although customers could be more involved in providing feedback on new product prototypes. There are a number of on-going partnerships and collaborations with external firms, specialists and universities, and post-survey interviews indicated a positive link with the local education system.

One area for improvement has been identified, in that supplier relations and supplier management systems could be improved upon.

Discussion Point 5: Aerogen's Learning Practices versus Best Practice

Porter (1990) states that innovation *"results as much from organisational learning as from formal R&D"* while Luecke and Katz (2003) propose that "*innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services."*

Teece et al. (1997) propose that continual organisational learning and a dynamic approach to the development of organisational capability is crucial given the competitive nature of today's global markets. Cooper et al. (2002) highlight the area of performance measurement and learning as being of significant importance in achieving maturity and

excellence in NPD. Goffin and Mitchell (2005) further stress the importance of employee training and development in successful innovation performance.

Aerogen's approach to organisational learning is not effective. While the company is proactive in learning from external sources, there is inadequate funding to support significant employee training. There is, however, much encouragement, recognition and support for employees who undertake to fund the furthering of their education themselves. The two least performing aspects of this innovation area relate to post-project reviews and lessons learned, both critical for effective and sustained innovation. These areas have to-date only been afforded "lip service", and evidence of mistakes "re-made" were provided by survey participants.

7.3 Key Areas for Improvement

Overall, Aerogen's innovation management capability rates rather well against the best practices identified throughout the research (research question 1). It is reminded that the company is young and growing and that many innovation practices and procedures are still either being developed or are in their infancy, thus have yet to be proven.

A key aspect of this research was to identify those areas in which the company can improve, to enable future company growth and sustained innovation (research question 2). The key areas for improvement are now provided.

Strategy

- Organisation-wide communication of strategic goals and lower-level objectives
- Structured approach to identifying future threats and opportunities, and processes in place to review new technological and market developments.

Processes

- Up front and systematic planning and prioritisation of new products, and project resources

- Consider separating “sustaining engineering” activities from NPD activities i.e. focus NPD resources on NPD projects alone
- Introduce a systematic approach to idea generation
- Earlier involvement of Quality and Operations department in NPD
- More involvement of engineering personnel with the customer

Organisation

- Implement a rewards and recognition system, in line with individual, team and/or department innovation performance

Linkages

- Review entire supplier management system, with a view to improving the propensity for collaboration and strategic partnerships

Learning

- Implement innovation performance measurement systems and align these with rewards and recognition for innovative behaviour
- Revise system for capturing lessons learned throughout the innovation process
- Revise Stage-Gate system to ensure effective post-project reviews are carried out and acted upon
- Implement structured system for comparing products/processes with other company’s
- Routinely investigate sources of external funding for the training and development of personnel (Enterprise Ireland, FAS, etc.)

7.4 Participant Perspectives

The final research question to be addressed is as follows:

Q3: How well do the perceptions of the various players involved in the innovation process align with each other?

Key findings in this area are now discussed.

7.4.1 Functional Perspectives

It was found that participants from the R&D population rate most areas of the innovation management process more favourably than any other functional group. Interviews suggest that these participants are more involved in many stages of the process than other groups assessed, and might therefore have had a better understanding of some aspects of the surveys presented than their peers. The participants from the R&D group are all long-term Aerogen employees, with most having worked with the company for in excess of six years. It might therefore be considered that these participants have a more well-honed all-round perception of the innovation capabilities of the company. It could alternatively be suggested that this group have a more 'sympathetic' or 'empathetic' view of Aerogen's innovation management cabability. It was further found that these R&D participants were members of a tight-knit functional group, hence some very high ratings in areas such as communication and teamwork.

Members of the Quality and Operations group highlighted a perception of being somewhat removed and kept "out of the loop" from some areas of the innovation process, particularly in relation to the front-end of innovation and communication of customer and market-related activities. Both the R&D and Quality and Operations groups highlighted a need for closer links between each group and the customer, particularly in relation to prototype evaluation.

The Sales, Marketing and Business Development group perceived that the development phase of the NPD process was slow and cumbersome, but that front-end and customer-related activities were well addressed by the company. A further perception of this group was that there is little flexibility in the NPD process for 'fast track' projects or quick decision-making.

In general, the perceptions of the functional groups were well-aligned in all other areas of assessment, particularly in the areas of strategy, human resource processes, and organisational linkages.

7.4.2 Hierarchical Perspectives

The non-management group provided higher ratings across all five key areas of the innovation management process assessed. This is a somewhat surprising result as it was expected that management, having developed and being closest to many areas of the innovation process, would rate the entire process more highly than the sub-ordinate participant group. It was determined that the main reason for this unexpected anomaly was due to the poor ratings provided by more newly-hired management participants.

Considering the perspectives of just the longer-term management participants, it was found that this group rated the areas of strategy, linkages and learning more highly than any other group. Interviews with members from this group unearthed a number of examples of organisational linkages and learning processes which other participant groups were not aware of. Some particular examples include linkages with the local education system and external specialists, as well as some high-level strategic processes and practices. It might be suggested that there is no need for organisation-wide communication of such activities; however it was highlighted by participants in general that such communication would be a welcome benefit.

7.4.3 Long-term/Newly-hired Management Perspectives (Internal/External Perceptions)

The final aspect of this discussion addresses a key peculiarity throughout the research. It was found that there was a sharp contrast between the perceptions of the newly-hired management group and all other participants. This contrast in perceptions persisted across all key areas of assessment and was a surprising result, as it was expected that such participants might rate the company more favourably having just joined the ranks. One of the key areas of consideration throughout the interviews was therefore to attempt to uncover the reasons behind these perceptions. Some key points are now provided.

The newly-hired management group was considered for this research as it was expected that such a group would bring an external perspective to the study. The group comprised of members from the Quality and Regulatory Affairs and Business Development teams.

It was found during interterviewing that one member of this participant group had little exposure to the NPD process, having previously worked in high-level business development and opportunity identification. It was further found that prior to joining Aerogen; a second such member had previously spent a number of years working with a large corporation in the locality, whose strategy was commodity-based with little differentiation in products developed. This participant had a leaning towards the process side of innovation, as opposed to the typical small-company focus on technology and invention, and further was not an innovator in product development, rather a wearer of more of a "systems" hat. The ambiguity and uncertainty which is inherent in any blue ocean or breakthrough innovation strategy simply did not sit well with this participant.

One final member of this group made a key comment which might provide an understanding of these differences in perspectives, and might go further to help answer this research hypothesis:

"Having come from a company which had in place all those systems, processes and procedures advised for effective innovation, yet failed to innovate, it is hugely apparent to me that Aerogen must play a certain amount of catch up in structuring its innovation management systems. That's what people like me are now here for. However, there is one key distinguishing difference between Aerogen and my now redundant place of employment – Aerogen is a company of innovators."

8. Conclusion

8.1 Introduction

This final chapter summarises the findings of the study. The hypothesis under test and the key research questions are recalled and concluded upon. Recommendations for future research are finally provided.

8.2 Summary of Research Aims Achieved

The hypothesis under test throughout this research was as follows:

> **Aerogen's approach to innovation management can serve to effectively lead the company in its future product innovation and growth endeavours.**

The study aimed to test this hypothesis by addressing three key research questions.

> Q1: How well do the innovation management practices at Aerogen (both at the front end and in new product development) compare with best practices identified in the literature?
>
> Q2: What areas of innovation management can Aerogen improve upon?
>
> Q3: How well do the perceptions of the various players involved in the innovation process align with each other?

It was found that the innovation management practices at Aerogen generally compare adequately with best practices identified within the literature. However, a number of key areas for improvement were identified and shared with Aerogen management for follow-up. Perhaps the most significant of these relate to project planning, prioritisation and learning, and the effective utilisation and rewarding of key resources.

One of the most interesting aspects of the study was the varied perceptions of the many players involved in the Aerogen innovation process. It was found that the R&D group were a group of long-term Aerogen innovators and were closest to the overall innovation process. This group displayed a certain level of comfort with the innovation process which is reflected throughout the data gathered. The biggest potential opportunity advised by this group was a possible separation of "sustaining engineering" and NPD tasks. Many participants from the Quality and Operations group approached the surveys from a "systems" and compliance perspective, and their comments implied a general feeling of being left out of the loop in many aspects of the front-end of innovation and customer-related activities. The Sales, Marketing and Business Development group indicated a certain level of satisfaction with all things customer-related, but some dissatisfaction with the rates of completion of projects and some product development process and activities.

A final point of note is the difference in perspectives between the long-term and newly-hired management groups. It transpired that this anomaly was due in no small part to an individual level of discomfort with Aerogen's disruptive blue ocean strategy, its emphasis on technology and invention, and its somewhat ad hoc approach to certain aspects of the innovation process.

In response to this finding, Aerogen founder and CEO, John Power, points out:

"At the fore, we are ideas people. As disruptive innovators we will always be in for a challenging ride. There is a certain level of ambiguity and uncertainty in breakthrough innovation that some personality types will never be comfortable with. While this will always lead to conflicts, tensions and discomfort, it is part and parcel of our disruptive environment and is not necessarily a bad thing. It keeps us on our toes."

Yet, as Christensen and Overdorf (2000) point out, while any entrepreneurial company's initial success is firmly attributed to resources, failure to subsequently develop and implement effectively structured innovation management processes will inevitably result in organisational problems. It is therefore now of the utmost importance that Aerogen address the issues as highlighted to ensure continued growth and success.

8.3 Recommendations for Further Research

This section presents a number of recommendations for future research in the area of innovation management.

1. The first suggestion for further research would be to carry out a longitudinal study of Aerogen's progress in addressing the issues identified and implementing effective innovation management systems, inclusive of some measures of innovation performance in each key area, which were omitted from this study due to timing and scope issues. Such a study would be further useful in tracking the perspectives of the various players in the innovation process over time. As the process may begin to lean more on systems and procedures, as opposed to technology and invention, it would be interesting to determine how the views of the more innovative members of the innovation group might react.

2. A benchmarking exercise may be completed on companies of similar size and industry within the locality, to provide data for comparison across a range of firms.

3. One of the key outputs of the innovation survey was a perception that engineering resources were regularly being pulled from NPD activity to address short-term "sustaining engineering" issues. A study of similar SME's who have chosen to separate their engineering groups into distinct "sustaining engineering" and "product development" groups, and the success or otherwise of such endeavours might be useful.

4. A study on the innovation management practices of other SMEs who practice the "blue ocean" strategy, as advised by Kim and Mauborgne (2005) might be useful in determining specific approaches which should be taken in structuring an organisation for effective innovation.

5. Finally, a study on the differences in perceptions towards innovation, from a large/small company perspective would be of interest.

8.4 Concluding Note

On conducting a concluding interview with Aerogen founder and CEO, John Power, this author noticed a brightly-coloured Post-It placed prominently on his desk. It put John's priorities for the business into perspective, stating:

Clear Vision
Bold Strategy
Committed Team
Strong Brand

Perhaps one final element should be added to this list:

'Best Practice' Innovation Management Systems

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Appendices

Appendix A: Phase 1 Innovation Scorecard

Appendix B: Phase 2 Innovation Survey

Appendix C: Phase 1 Graphical Results

Appendix D: Phase 2 Survey Raw Data

Appendix E: Abbreviations

Appendix A - Aerogen Innovation Capability Audit – Phase 1 Scorecard

For each topic listed in the "Innovation Area" column below, please enter into the "Score" column, the number of the statement which you feel most closely matches Aerogen's organisational practice (i.e. 1, 2, 3 or 4)

	Innovation Area	1	2	3	4	SCORE
CONCEPT DEVELOPMENT	Generating new product concepts	Ad hoc development of new product concepts	Product concepts developed within single functions, ideas internally based. Limited customer contact.	New product ideas sought in the marketplace and research into customer needs. Involvement of marketing and technical functions in developing and screening new product concepts.	Direct links with customer and lead users to identify expressed and latent needs. Broad range of functions involved in concept development and screening of opportunities. Early analysis of new concepts.	
	Product innovation planning	No product planning	Planning for next generation of products	Planning for up to two generations of products	Long-term planning for three generations of products. 5-15 years horizon. Market-driven innovation planning.	
	Innovativeness and creativity	Control systems and organisation discourage creativity.	New ideas encouraged, but risk avoided.	Risk taking encouraged and champions for new ideas sought and supported.	Employees' innovative and entrepreneurial behaviour encouraged and rewarded. Mechanisms available to fund unplanned activities.	

Phase 1 Innovation Scorecard – Concept Development

	Innovation Area	1	2	3	4	SCORE
Product Development and Process Innovation	The product development process	No product development procedures.	Simple procedures applied to all projects but no parallel activities.	Project development on major products planned in phases with reviews.	Established processes and objectives with flexibility to allow small projects to move through quickly. Parallel and integrated activities.	
	Team work and Organisation	No teamwork and little communication between functions	Some use of functionally based teams but with weak project management and no involvement of other functions prior to start-up.	Widespread use of multidiscipline teams. Clear project authority, internal cross-functional review prior to development but limited involvement from purchasing and suppliers.	Wide use of multidiscipline teams with early involvement by all. Strong team leadership and with team and leader empowered to make decisions.	
	Industrial Design	No consideration of industrial design.	Design introduced at a late stage in the process.	Use of internal designers or external design consultancies.	Industrial designers involved as core part of project team from concept stage.	
	Generating Process Innovations	Serious differences between process requirements and technology available.	No manufacturing strategy: process technology bought off the shelf.	Manufacturing strategy ensures that process capabilities support market needs. Investment in improving existing and developing technologies.	Strong links between product and process development. Information on new process technology actively sought and new processes tested to gain experience.	
	Continuous Improvement	If it isn't broken, don't fix it.	Focus on maintenance of processes, not improvement.	Need for continuous improvement of processes recognized - primarily the responsibility of process engineering function.	Work teams encouraged to identify opportunities for improvement. Use of wide range of internal and external data to support improvement.	

Phase 1 Innovation Scorecard – NPD and Process Innovation

	Innovation Area	1	2	3	4	SCORE
Technology Acquisition Process	Technology Strategy	No technology strategy and no mechanisms for understanding technology.	Inward-looking technology strategy identifies needs on a project-by-project basis.	Understanding of technical needs in each function with monitoring of trends and product-driven joint ventures and technical alliances.	The company understands its core competencies in technology and innovation and has policies for allocating resources to build and strengthen them. Monitoring of the technologies used by competitors.	
	Selection, generation, and sourcing of technology	"Not invented here syndrome" – No R&D sourcing plan.	Participation in industry technical associations but little external technology sourcing.	Ongoing contacts with universities, government agencies, industry consortia, etc., and close relationships with leading suppliers and customer.	Explicit policies for sourcing technologies, including in-house R&D, licensing in and out, partnerships and external linkages.	
	Environment and Regulation	No policies or controls – get away with what you can.	Formal policies and procedures to deal with environmental and regulatory issues but passive general management.	Active management to promote compliance and improvement.	Proactive, anticipating trends with line responsibility for compliance. Products and processes designed to minimize environmental impact and health and safety standards.	

Phase 1 Innovation Scorecard – Technology Acquisition Process

	Innovation Area	1	2	3	4	SCORE
Leadership Process	Innovation Goals	No management involvement in innovation	No innovation goals and technical functions not represented at board level.	Innovation and technology capability seen as a means of gaining competitive edge and incorporated in the mission statement.	Explicit and challenging goals set for innovation with a long-term corporate understanding of how it can shape business strategy.	
	Process for generating and implementing innovation	Management not concerned.	Management encourages good practice in innovation management.	Innovation management, product realization, and technology acquisition presented to and discussed at board level.	Management is proactive in ensuring best practice in innovation and product realization.	
	Climate for innovation	Management encourages short-term profitability and risk minimization by managers and employees at the expense of innovation.	General encouragement for innovation, but no measurement or reward.	Performance measures for innovation reviewed regularly by board with a customer-led climate encouraged.	Management ensures that risk taking is encouraged rather than penalized and new ideas rewarded. It ensures that the technology mission of the company is shared and understood throughout the company.	

	Innovation Area	1	2	3	4	SCORE
Resource Provision Process	Human Resources	No human resource planning for innovation; key skills missing.	The human resources needed for innovation generally known and available, but usually slow to be applied.	The skills required for innovation are identified and are fully resourced through recruitment and training.	Career structures support innovation through development in all functions.	
	Funding	Last year's spend adjusted up fro inflation and down for cash availability.	Industry average levels R&D and innovation budgets subject to sharp fluctuations from year to year.	Policies on how R&D should be funded. Some mechanisms to ensure that capacity is available in suppliers, manufacturing, and support functions.	Related to potential business contribution over short- and long-term with minimal fluctuations despite cash flow variation.	

Phase 1 Innovation Scorecard – Leadership and Resource Provision Processes

	Innovation Area	1	2	3	4	SCORE
Systems and Tools Provision Process	Systems	Limited use of information systems such as CAD.	Information system usage within functions.	Widespread information system usage, primarily for one-way information flow including CAD, CAD/CAM, and process simulation on a functional basis to improve design effectiveness. System links with suppliers and customers.	Systems geared to improving design effectiveness and to shortening product development lead times.	
	Tools for Innovation	No significant usage of management and design tools.	Ad hoc tool usage, with no clear objectives.	Some use of design tools to improve product and process design effectiveness and/or creativity.	Widespread use of appropriate tools to capture customer needs and to ensure the effectiveness of product and process design. Established protocols such as design for manufacture, design for test, design for customer use.	
	Quality Assurance	Limited quality management.	Quality control in manufacturing, but little involvement by engineering, ISO 9000 possibly in place, but focus on procedure only.	Quality practices and procedures in place for quality assurance of products and processes.	TQM program in place including a focus on achieving improved innovation performance.	

Phase 1 Innovation Scorecard – Systems and Tools Provision Process

	Innovation Area	1	2	3	4	SCORE
Increased Competitiveness	Measurement and Goals	No measures of innovation performance or customer satisfaction.	Measures of financial and sales performance of new products and measures of product quality.	Operational targets are set for some aspects of innovation at departmental level.	Customer satisfaction feedback surveys initiated with feedback into the innovation process.	
	Tools for Innovation	Anecdotal evidence only.	Positive trends in most areas.	Good-to-excellent results in major areas with evidence that results are caused by active management of innovation.	Excellent results in major areas with sustained results. Results clearly caused by active management of innovation.	

Phase 1 Innovation Scorecard – Increased Competitiveness

Appendix B - Aerogen Innovation Capability Audit – Phase 2 Survey

Below you will find statements which describe 'the way we do things around here'.
For each statement please put a score between 1 (= Not True at All) to 7 (= Very True), providing examples/comments where appropriate.

#	Statement	SCORE	Please provide examples/comments where appropriate
1	Employees have a clear idea of how innovation can help us compete		
2	We have processes in place to help us manage new product development effectively from idea to launch		
3	Our organisation structure does not stifle innovation but helps it to happen		
4	There is a strong commitment to training and development of people		
5	We have good 'win-win' relationships with our suppliers		
6	Our innovation strategy is clearly communicated so everyone knows the targets for improvement		
7	Our innovation projects are usually completed on time and within budget		
8	People work well together across departmental boundaries		
9	We take time to review our projects to improve our performance next time		
10	We are good at understanding the needs of our customers/ end-users		
11	People know what our distinctive competence is - what gives us a competitive advantage		
12	We have effective mechanisms to make sure everyone (not just Marketing) understands customer needs		

Phase 2 Innovation Survey – Questions 1 – 12

#	Statement	SCORE	Please provide examples/comments where appropriate
13	People are involved in suggesting ideas for improvements to products or processes		
14	We work well with universities and other research centres to help us develop our knowledge		
15	We learn from our mistakes		
16	We look ahead in a structured way (using forecasting tools and techniques) to try and imagine future threats and opportunities		
17	We have effective mechanisms for managing process change from idea through to successful implementation		
18	Our structure helps us to take decisions rapidly		
19	We work closely with our customers in exploring and developing new concepts		
20	We systematically compare our products and processes with other firms		
21	Our top team have a shared vision of how the company will develop through innovation		
22	We systematically search for new product ideas		
23	Communication is effective and works top down, bottom up and across the organisation		
24	We collaborate with other firms to develop new products or processes		
25	We meet and share experiences with other firms to help us learn		
26	There is top management commitment and support for innovation		

Phase 2 Innovation Survey – Questions 13 – 26

#	Statement	SCORE	Please provide examples/comments where appropriate
27	We have mechanisms in place to ensure early involvement of all departments in developing new products/processes		
28	Our reward and recognition system supports innovation		
29	We try to develop external networks of people who can help us – for example, with specialist knowledge		
30	We are good at capturing what we have learned so that others in the organisation can make use of it		
31	We have processes in place to review new technological or market developments and what they mean for our firm's strategy		
32	We have strategic decision-making and project selection mechanisms which can deal with more radical proposals outside of the mainstream		
33	We have a supportive climate for new ideas – people are encouraged to put forward their ideas and don't have to leave the organisation to make them happen		
34	We work closely with the local and national education system to communicate our needs for skills		
35	We are good at learning from other organisations		
36	There is a clear link between the innovation projects we carry out and the overall strategy of the business		
37	There is sufficient flexibility in our system for product development to allow small 'fast track' projects to happen		
38	We work well in teams		
39	We work closely with 'lead users' to develop innovative new products and services		

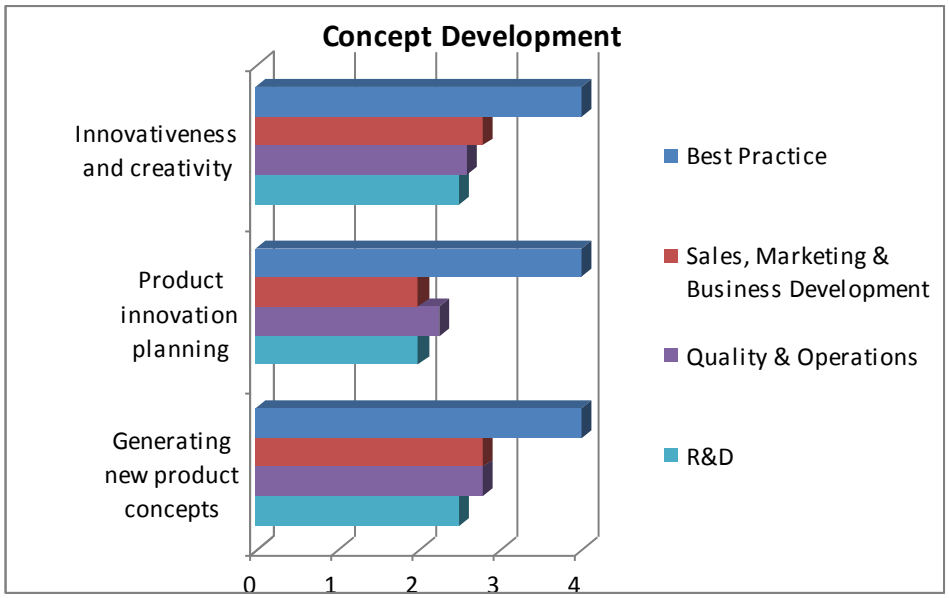
Phase 2 Innovation Survey – Questions 27 - 39

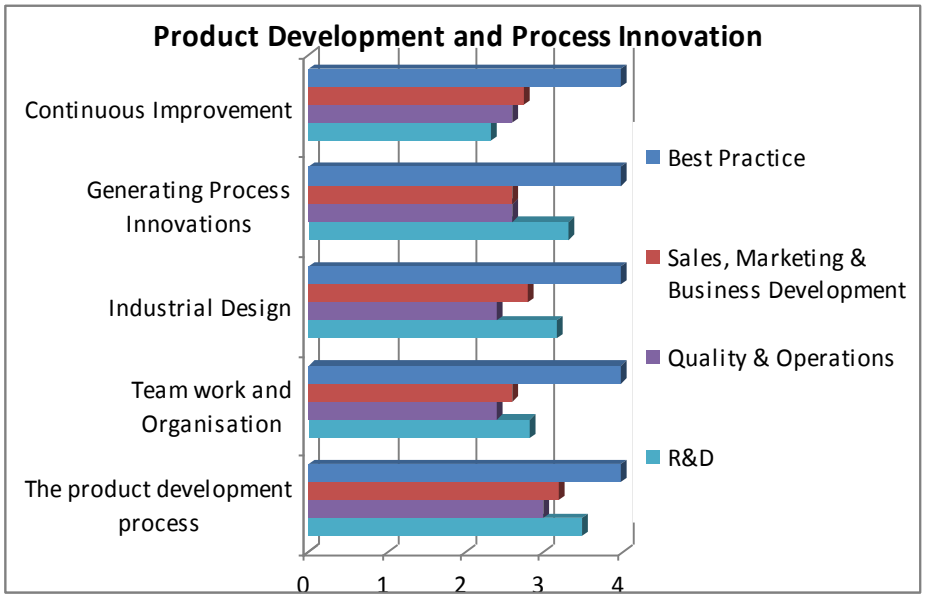
#	Statement	SCORE	Please provide examples/comments where appropriate
40	We use measurement to help identify where and when we can improve our innovation management		
41	We deploy "probe and learn" approaches to explore new directions in technologies and markets		
42	Our organisation allows some space and time for people to explore 'wild' ideas		
43	We have a culture which is supportive of risk (technical, financial, market etc)		
44	We have an approach to supplier management which is open to strategic dalliances		
45	We have well-developed peripheral vision in our business		

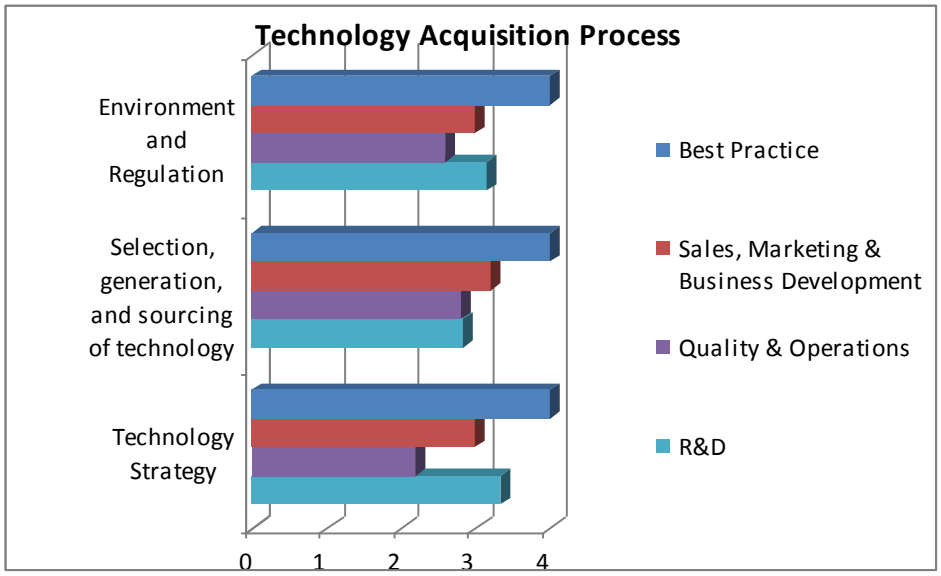
Phase 2 Innovation Survey – Questions 40 - 45

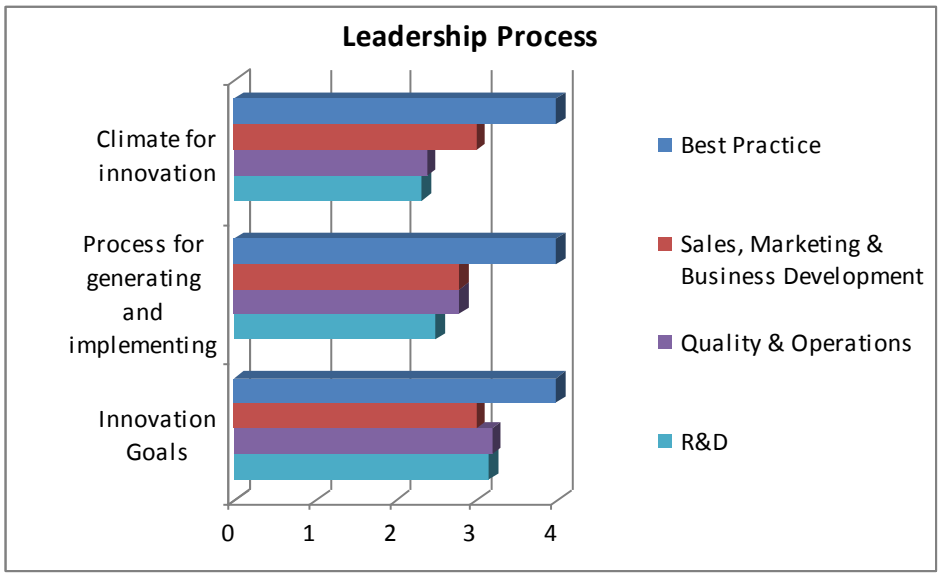
Appendix C - Phase 1 Innovation Scorecard Results Breakdown

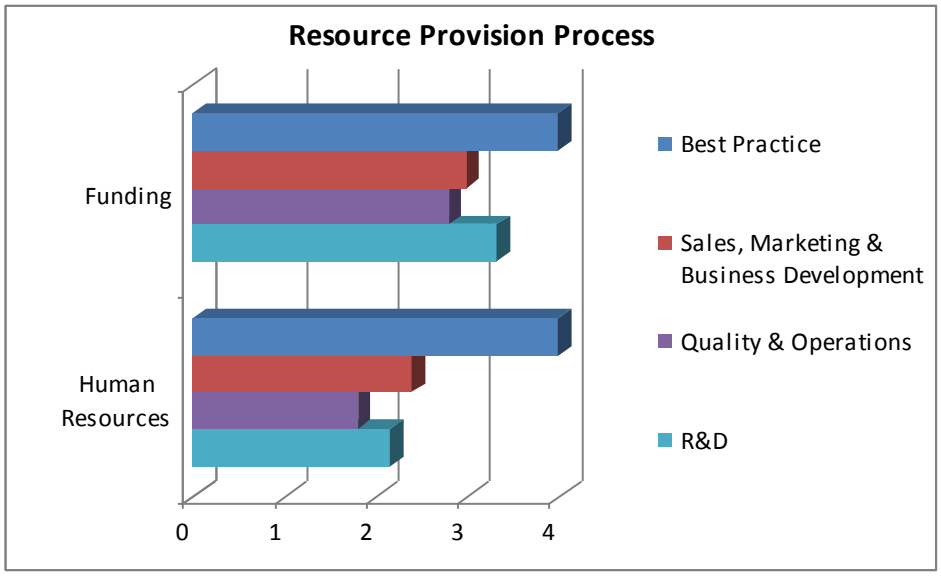
1. Cross-Functional Perspective

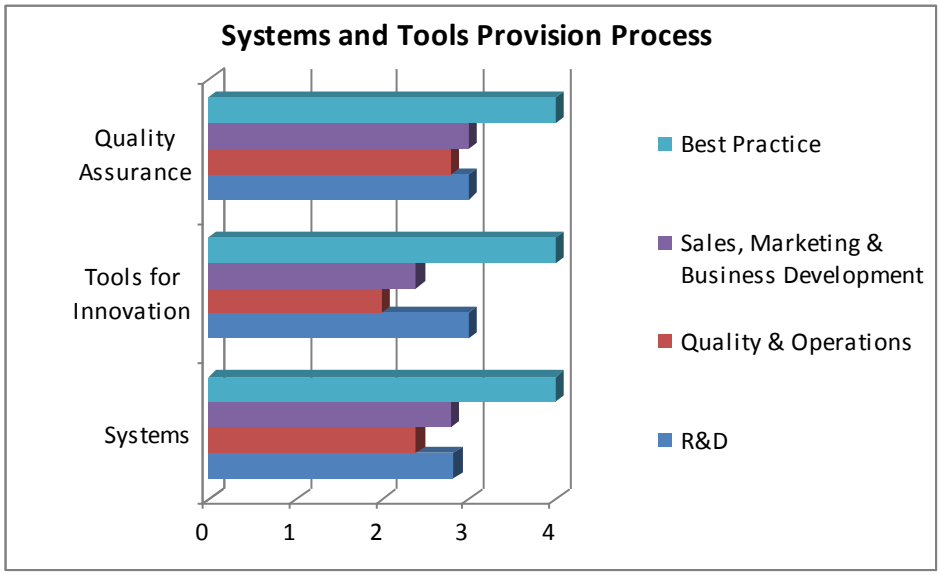


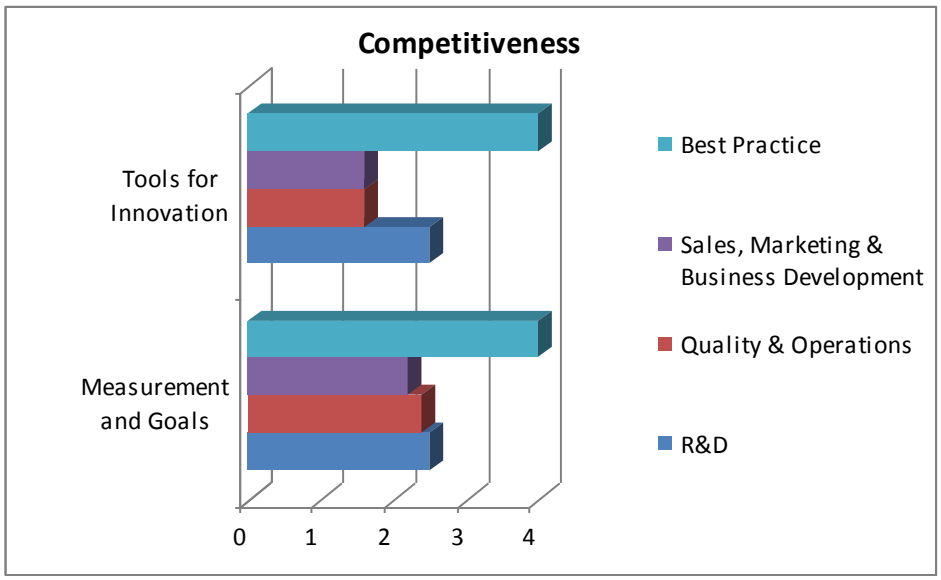



Technology Acquisition Process
Environment and Regulation
Selection, generation, and sourcing of technology
Technology Strategy
0
1
2
3
4
Best Practice
Sales, Marketing & Business Development
Quality & Operations
R&D

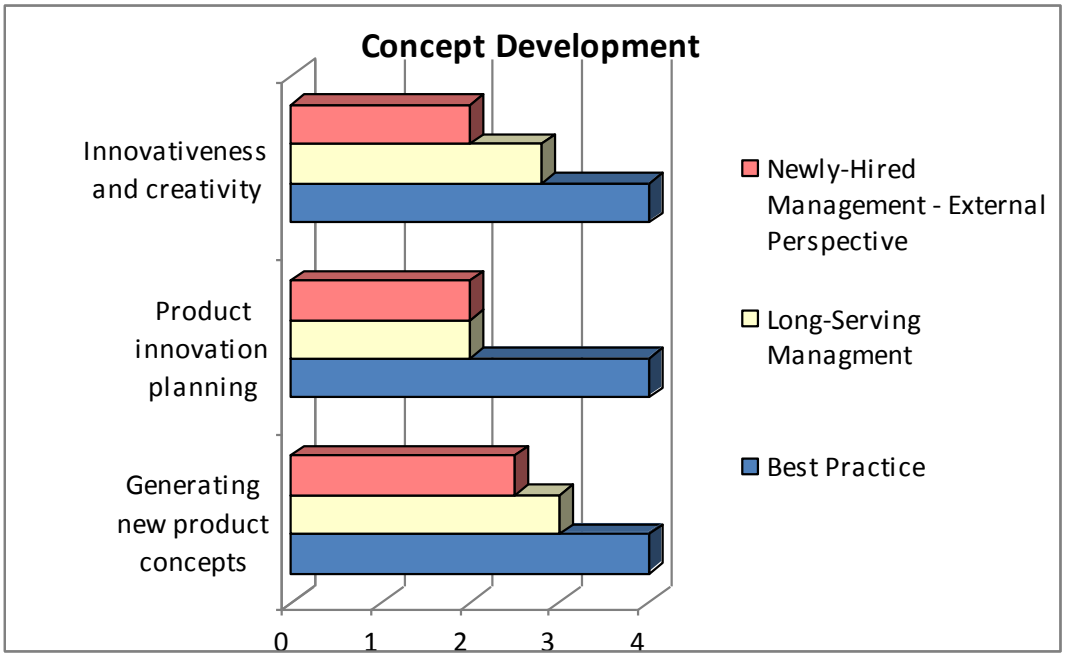

Leadership Process
Climate for innovation
Process for generating and implementing
Innovation Goals
0
1
2
3
4
Best Practice
Sales, Marketing & Business Development
Quality & Operations
R&D

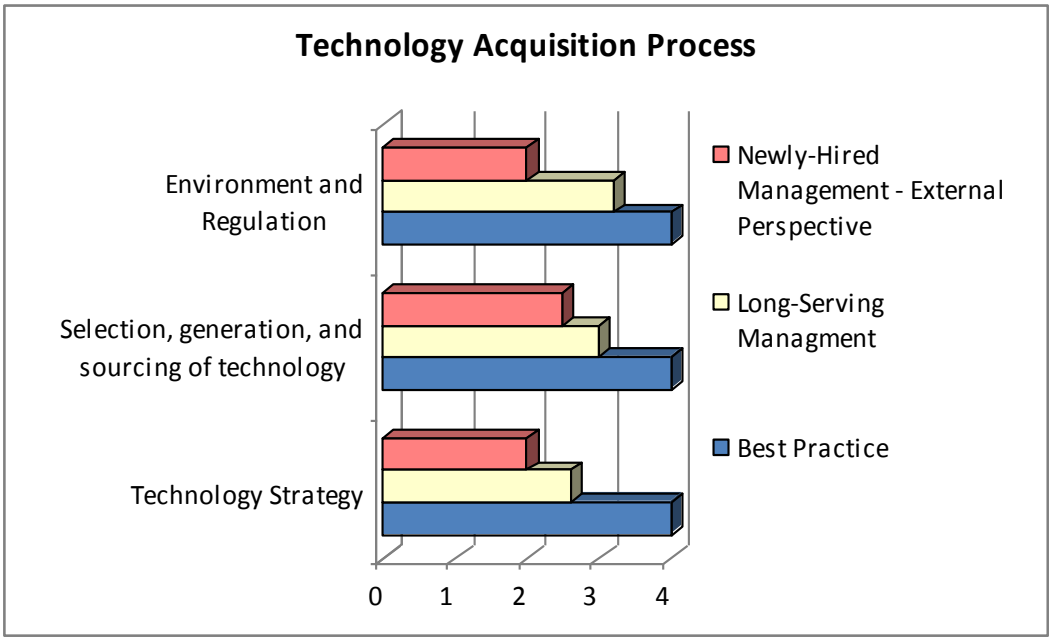

Resource Provision Process
Funding
Human Resources
0
1
2
3
4
Best Practice
Sales, Marketing & Business Development
Quality & Operations
R&D

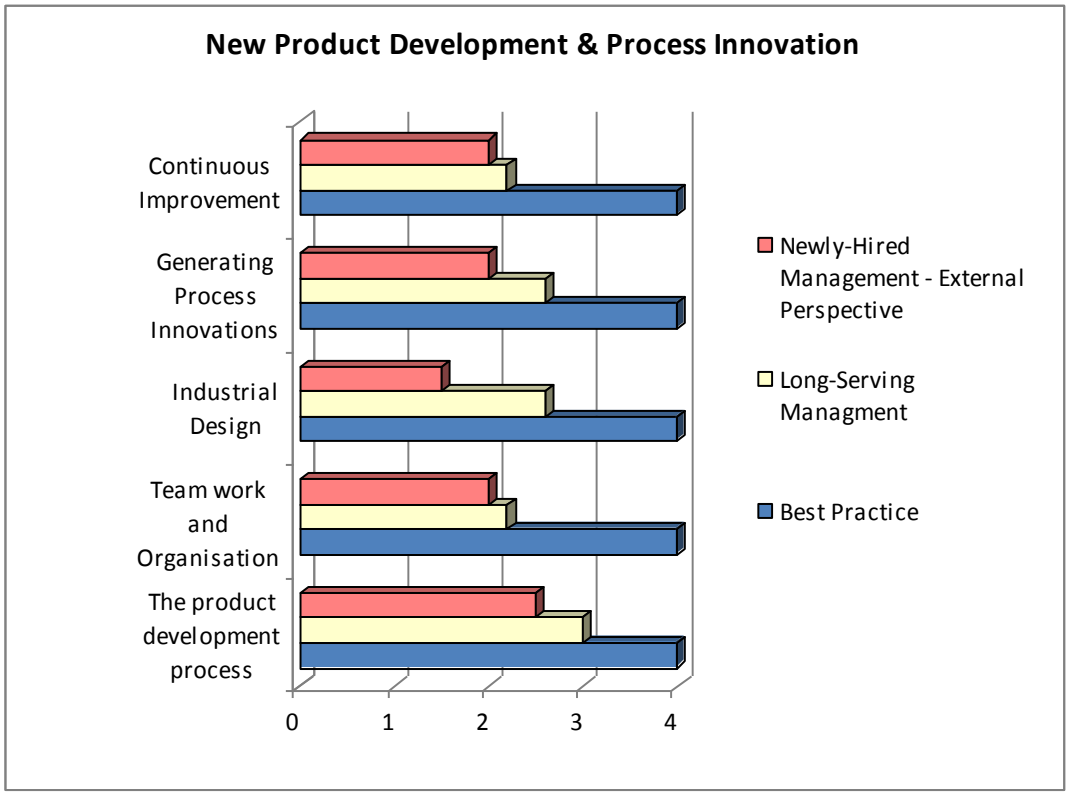

Systems and Tools Provision Process
Quality Assurance
Tools for Innovation
Systems
0
1
2
3
4
Best Practice
Sales, Marketing & Business Development
Quality & Operations
R&D

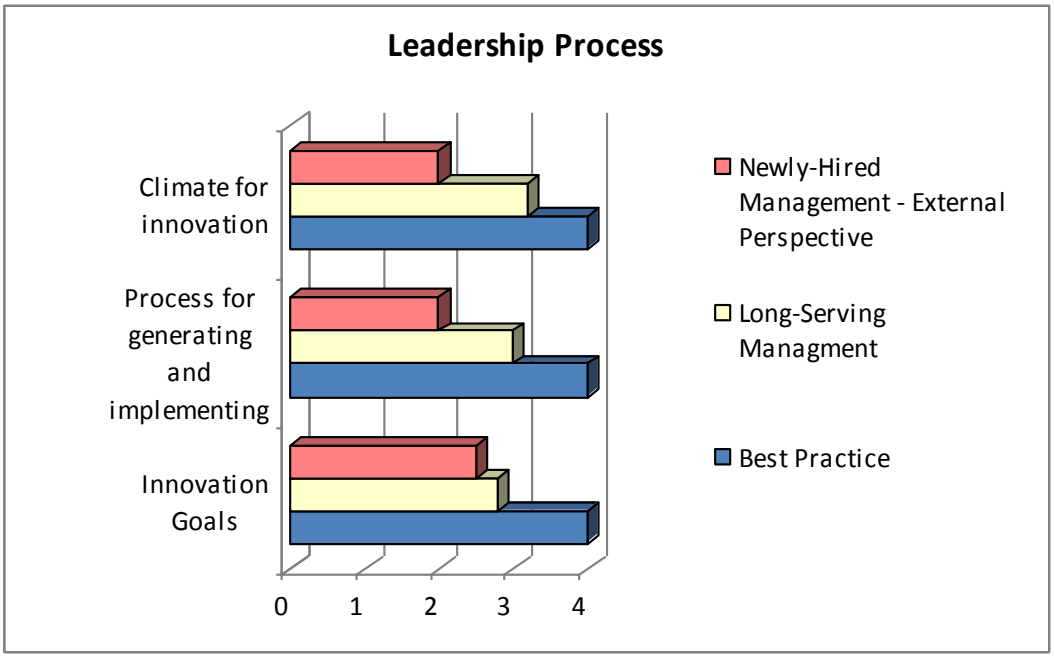

Competitiveness
Tools for Innovation
Measurement and Goals
0
1
2
3
4
Best Practice
Sales, Marketing & Business Development
Quality & Operations
R&D

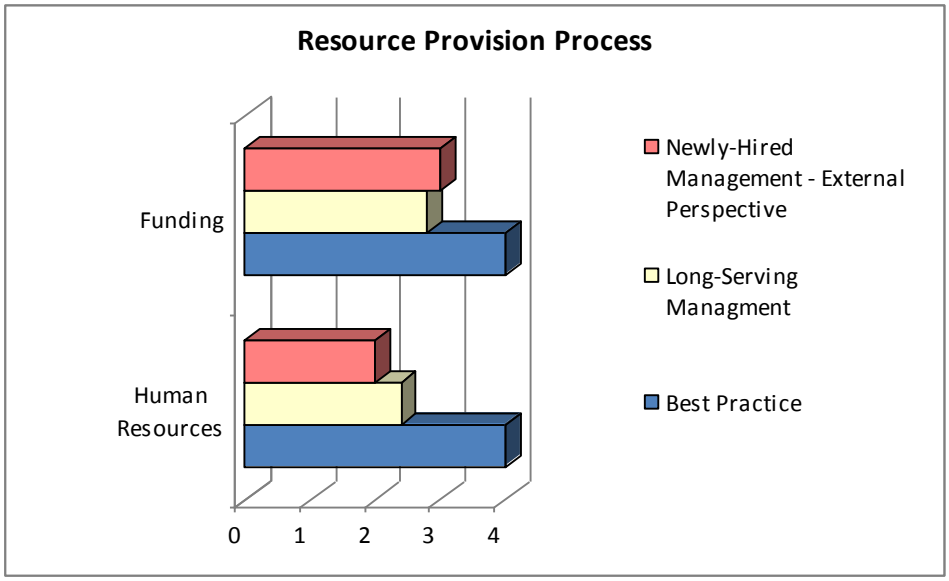
2. Internal/External Management Perspective

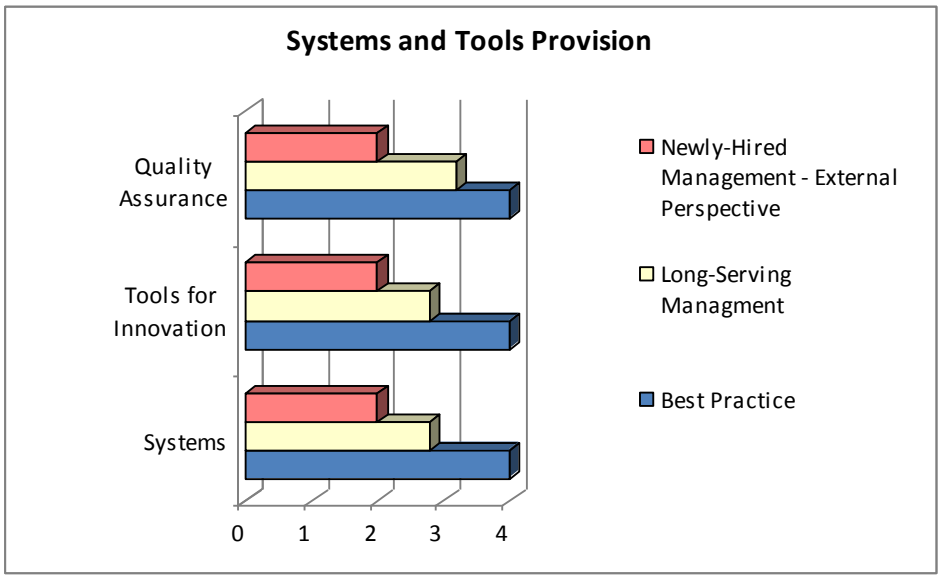


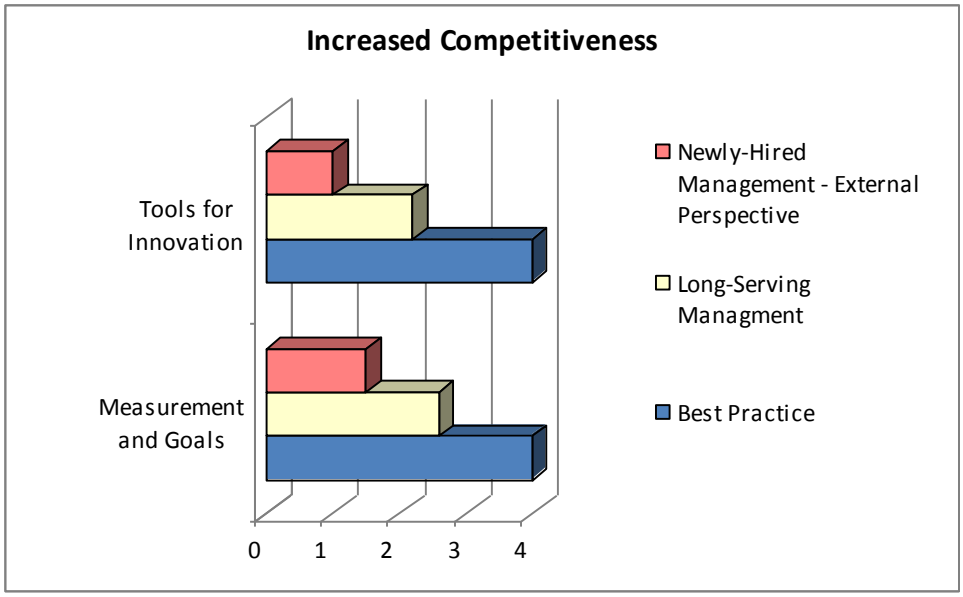



New Product Development & Process Innovation
Continuous Improvement
Generating Process Innovations
Industrial Design
Team work and Organisation
The product development process
0
1
2
3
4
Newly-Hired Management - External Perspective
Long-Serving Managment
Best Practice


Leadership Process
Climate for innovation
Process for generating and implementing
Innovation Goals
0
1
2
3
4
Newly-Hired Management - External Perspective
Long-Serving Managment
Best Practice


Resource Provision Process
Funding
Human Resources
0
1
2
3
4
Newly-Hired Management - External Perspective
Long-Serving Managment
Best Practice


Systems and Tools Provision
Quality Assurance
Tools for Innovation
Systems
0
1
2
3
4
Newly-Hired Management - External Perspective
Long-Serving Managment
Best Practice


Increased Competitiveness
Tools for Innovation
Measurement and Goals
0
1
2
3
4
Newly-Hired Management - External Perspective
Long-Serving Managment
Best Practice

Appendix D - Phase 2 Innovation Audit Results Breakdown

Innovation Area 1: Strategy

Q1 – Employees have a clear idea of how innovation can help us compete.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**6%**	**94%**	**5.2**	**5**
*Management	12%	88%	4.9	6
*Non-Management	0%	100%	5.5	5
Long-Serving Mgmt.	0%	100%	5.0	4
Newly-Hired Mgmt.	50%	50%	4.5	N/A
R&D	0%	100%	5.4	5
Quality & Operations	17%	83%	5.2	6
Sales, Marketing & Business Development	0%	100%	5	5
Answered Question	*100% (18 Participants)*			

Q1 – Key Comments from Surveys/Interviews

*Management:

- The Management team and Engineering team have, but some areas don't seem to get the link.
- Increased awareness of innovation through introduction of patent 'idea' forms and reward scheme (which needs to be followed through).

*Non-Management:

- This is clearly communicated by management at all company meetings (3/4 per year).
- Value of innovation culture communicated by management.
- Yes - The value of new products and new markets means increased sales.

Q6 – Our innovation strategy is clearly communicated so everyone knows the targets for improvement.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**56%**	**44%**	**3.1**	**1**
*Management	50%	50%	3.3	1
*Non-Management	60%	40%	2.9	5
Long-Serving Mgmt.	33%	67%	3.8	4
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	71%	29%	2.4	1
Quality & Operations	50%	50%	3.3	5
Sales, Marketing & Business Development	40%	60%	3.6	4
Answered Question	*100% (18 Participants)*			

Q6 – Key Comments from Surveys/Interviews

*Management:

- The high-level strategic goals are communicated – the means to achieve these and their prioritisation is sometimes unclear.

*Non-Management:

- A 'blue ocean' strategy is communicated at all company meetings, but when money is tight, NPD projects often get bumped down the priority list in favour of short-term, quicker to market or process improvement projects – i.e. a quickest product-to-market approach is taken, which is not radical-innovation based.
- To the Engineering team – yes; other areas – no.
- New innovation targets communicated, but approach not clearly advised.
- Each department is assigned and communicates innovation goals; however, these are not proactively communicated to every other department.

Q11 – People know what our distinctive competence is – what gives us a competitive advantage.

Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**6%**	**94%**	**5.7**	**6**
*Management	12%	88%	5.4	6
*Non-Management	0%	100%	6.0	6
Long-Serving Mgmt.	0%	100%	6.0	6
Newly-Hired Mgmt.	50%	50%	3.5	N/A
R&D	0%	100%	5.9	6
Quality & Operations	0%	100%	5.7	6
Sales, Marketing & Business Development	20%	80%	5.6	6
Answered Question	*100% (18 Participants)*			

Q11 – Key Comments from Surveys/Interviews

*Management

- Yes, generally.

*Non-Management

- Yes - Nebuliser performance/efficiency.
- Most people are aware that Aerogen's OnQ technology and R&D capabilities in medical devices is our competitive advantage.
- Yes, but perhaps not everyone.

Q16 – We look ahead in a structured way (using forecasting tools and techniques) to try and imaging future threats and opportunities.

Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**50%**	**50%**	**3.4**	**1**
*Management	63%	37%	2.8	1
*Non-Management	40%	60%	3.9	6

Long-Serving Mgmt.	50%	50%	3.3	3
Newly-Hired Mgmt.	100%	0%	1.0	1
R&D	57%	43%	3.4	6
Quality & Operations	33%	67%	3.2	4
Sales, Marketing & Business Development	60%	40%	3.6	3
Answered Question	*100% (18 Participants)*			

Q16 – Key Comments from Surveys/Interviews

*Management

- Somewhat, but not in a structured manner.

*Non-Management

- Done in an ad hoc manner. It would be beneficial to complete this on a continuous basis and to communicate possibly threats and opportunities throughout the company.
- Recent 'Competitor IP Watch' system put in place, to identify potential competitive threats. Not aware of any similar structured means to identify opportunities.
- Maybe the management team use forecasting tools and techniques. Engineers are not made aware of this, if they do.

Q21 – Our top team have a shared vision of how the company will develop through innovation.

Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**18%**	**82%**	**4.9**	**6**
*Management	25%	75%	4.8	6
*Non-Management	11%	89%	5.1	6
Long-Serving Mgmt.	0%	100%	5.3	6
Newly-Hired Mgmt.	100%	0%	3.0	3
R&D	0%	100%	5.7	6
Quality & Operations	33%	67%	4.5	5
Sales, Marketing & Business Development	20%	80%	4.6	5
Answered Question	*100% (18 Participants)*			

Q21 – Key Comments from Surveys/Interviews

*Management

- Yes, although this vision sometimes gets muffled.

*Non-Management

- Yes, regular company meetings to keep employees abreast of this vision.
- Very full list of "top-priority" projects which must be properly prioritised and resourced if this vision is to be achieved.

Q26 – There is top management commitment and support for innovation.				
Participant All	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**11%**	**89%**	**5.1**	**5**
*Management	0%	100%	5.6	5
*Non-Management	20%	80%	4.7	5
Long-Serving Mgmt.	0%	100%	6.0	5
Newly-Hired Mgmt.	0%	100%	4.5	N/A
R&D	14%	86%	4.7	5
Quality & Operations	17%	83%	5.0	5
Sales, Marketing & Business Development	0%	100%	5.8	5
Answered Question	*100% (18 Participants)*			

Q26 – Key Comments from Surveys/Interviews

*Management

*Non-Management

- There is support on the face of it, but it is somewhat lacking in follow-through.
- True – if somebody has a good idea Aerogen will sponsor it, either through IP or resources.
- Some of them.
- Commitment, yes - but not backed up with resources and time.

Q31 – We have processes in place to review new technological or market developments and what they mean for our firm's strategy.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**65%**	**35%**	**3.2**	**3**
*Management	50%	50%	3.6	5
*Non-Management	78%	22%	2.8	3
Long-Serving Mgmt.	33%	67%	4.3	5
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	67%	33%	2.8	1
Quality & Operations	67%	33%	3.5	3
Sales, Marketing & Business Development	60%	40%	3.2	5
Answered Question	*100% (18 Participants)*			

Q31 – Key Comments from Surveys/Interviews

*Management

- Routine review of competitive IP, to check what competitors are doing.

*Non-Management

- Patent review meetings. Doesn't feed in to strategy though.
- I am not aware of any such processes.

Q36 – There is a clear link between the innovation projects we carry out and the overall strategy of the business.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**28%**	**72%**	**4.5**	**5**
*Management	38%	62%	4.3	3
*Non-Management	20%	80%	4.7	5
Long-Serving Mgmt.	17%	83%	5.0	3
Newly-Hired Mgmt.	100%	0%	3.0	3
R&D	14%	86%	4.9	5
Quality & Operations	33%	67%	4.3	5
Sales, Marketing & Business Development	40%	60%	4.2	6
Answered Question	*100% (18 Participants)*			

Q36 – Key Comments from Surveys/Interviews

*Management

*Non-Management

- Project priorities change regularly based on company strategy.
- I suppose - they all use the core technology.

Q41 – We deploy "probe and learn" approaches to explore new directions in technologies and markets.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**56%**	**44%**	**3.3**	**5**
*Management	63%	38%	3.0	1
*Non-Management	50%	50%	3.5	5
Long-Serving Mgmt.	50%	50%	3.7	3
Newly-Hired Mgmt.	100%	0%	1.0	1
R&D	71%	29%	3.0	3
Quality & Operations	50%	50%	3.5	5
Sales, Marketing & Business Development	40%	60%	3.4	4
Answered Question	*100% (18 Participants)*			

Q41 – Key Comments from Surveys/Interviews

*Management

- This approach is being taken with 3 current radical innovation endeavours.

*Non-Management

- Possibly, for some projects.
- Trial and error or wait and see are more apt statements.
- I am not aware of any such activities.

Innovation Area 2 – Processes

2 – We have processes in place to help us manage new product development effectively from idea to launch.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**11%**	**89%**	**5.3**	**5**
*Management	25%	75%	4.6	2
*Non-Management	0%	100%	5.8	5
Long-Serving Mgmt.	0%	100%	5.5	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	0%	100%	4.1	7
Quality & Operations	17%	83%	4.7	5
Sales, Marketing & Business Development	20	80%	4.8	5
Answered Question	*100% (18 Participants)*			

Q2 – Key Comments from Surveys/Interviews

*Management

- Stage-process in place which is not very effective. Projects don't get completed on time. Resources are spread across too many project and sustaining engineering activities.
- Not an effective process.
- We have the processes but generally no significant sense of urgency.

*Non-Management

- System in place but needs some minor improvements.
- We have gotten much better of late, but we still need to improve on deadlines and priorities.
- There is a formal design procedure in place to take a project from start to finish. This is currently under review to improve effectiveness.

Q7 – Our innovation projects are usually completed on time and within budget.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**89%**	**11%**	**2.8**	**3**
*Management	88%	12%	2.4	3
*Non-Management	90%	10%	2.9	3
Long-Serving Mgmt.	83%	17%	2.7	3
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	86%	14%	3.0	3
Quality & Operations	83%	17%	2.7	3
Sales, Marketing & Business Development	80%	20%	2.6	2
Answered Question	*100% (18 Participants)*			

Q7 – Key Comments from Surveys/Interviews

*Management

- Not true
- This is a big problem for us. Too many projects are underway, all labelled 'top priority', with key resources spread across incremental improvement projects, consultancy work, partnership projects, new product development, as well as sustaining engineering (which takes up to 30% of R&D time).

*Non-Management

- This is perhaps our biggest weak point.
- Budget is rarely a requirement - time can be flexible. In addition hidden costs such as in field fixes not easily quantified.
- Unaware of budgetary issues. Some projects appear not to meet targets.
- Output of new products very poor for an organisation that claims to be primarily R&D.
- Typically, we are not too far off. But usually we are slightly over time and budget. No contingency in project plans.
- Partnership and consultancy projects typically overrun, typically due to partners. This has a knock-on effect on other projects. Better prioritisation up-front on all projects would help.

Q12 – We have effective mechanisms to make sure everyone (not just marketing) understands customer needs.

Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**50%**	**50%**	**3.4**	**2**
*Management	50%	50%	3.5	2
*Non-Management	50%	50%	3.3	2
Long-Serving Mgmt.	33%	67%	4.2	2
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	43%	57%	3.4	2
Quality & Operations	50%	50%	3.5	2
Sales, Marketing & Business Development	40%	60%	3.2	4
Answered Question	*100% (18 Participants)*			

Q12 – Key Comments from Surveys/Interviews

*Management

- This could be improved on, in particular the manufacturing & QA group.

*Non-Management

- Sending the odd engineer to conferences is the limit of it currently.
- This is more a small company "over coffee" culture than a formal mechanism.
- No, Word of mouth/common sense.
- Not as far as I am aware.

Q17 – We have effective mechanisms for managing process change from idea through to successful implementation.				
Participant Group	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**29%**	**71%**	**4.6**	**7**
*Management	50%	50%	3.8	3
*Non-Management	11%	89%	5.4	7
Long-Serving Mgmt.	33%	67%	4.3	5
Newly-Hired Mgmt.	100%	0%	2.0	N/A
R&D	17%	83%	5.3	7
Quality & Operations	17%	83%	4.8	4
Sales, Marketing & Business Development	60%	40%	3.6	4
Answered Question	*100% (18 Participants)*			

Q17 – Key Comments from Surveys/Interviews

*Management

*Non-Management

- Our 5 stage design & development system is robust, effective and compliant to medical standards - needs minor improvements which we are currently addressing.

Q22 – We systematically search for new product ideas.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**44%**	**56%**	**3.7**	**2**
*Management	50%	50%	3.6	5
*Non-Management	40%	60%	3.8	2
Long-Serving Mgmt.	33%	67%	4.0	5
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	43%	57%	3.7	2
Quality & Operations	50%	50%	3.7	2
Sales, Marketing & Business Development	40%	60%	3.8	5
Answered Question	*100% (18 Participants)*			

Q22 – Key Comments from Surveys/Interviews

*Management

- Not really. We do a systematic IP watch to check on rivals, but there are no structured systems to look for new ideas.
- Sales/Marketing people bring ideas back from trade shows, distributors etc. No structured mechanism for seeking new ideas though.

*Non-Management

- This is encouraged at all times by Aerogen management.
- Probably don't need to search that much due to wide and varied applications of Aerogen's technology. Opportunities and ideas find us.
- Aerogen is always looking for the next greatest thing.

- Not needed at the moment, due to large bank of already-identified opportunities and ideas.
- Not systematically

Q27 – We have mechanisms in place to ensure early involvement of all departments in developing new products/processes.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**50%**	**50%**	**3.6**	**5**
*Management	38%	62%	3.8	5
*Non-Management	60%	40%	3.4	5
Long-Serving Mgmt.	17%	83%	4.2	5
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	57%	43%	3.3	5
Quality & Operations	67%	33%	3.3	3
Sales, Marketing & Business Development	20%	80%	4.2	4
Answered Question	*100% (18 Participants)*			

Q27 – Key Comments from Surveys/Interviews

*Management

- To an extent there is still a "them versus us" divide and we need to work better as a team to get all departments involved in the earlier stages of projects.

*Non-Management

- Through our 5 stage process, all departments are somewhat involved at stage 1.
- Not really, although this should be improved as the Stage Gate process is currently being revised and improved.
- No we don't. Involvement of manufacturing is kept as a separate stage to development and brought later on in each project.

Q32 – We have strategic decision-making and project selection mechanisms which can deal with more radical proposals outside of the mainstream.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**35%**	**65%**	**3.8**	**2**
*Management	50%	50%	3.0	2
*Non-Management	22%	78%	4.6	6
Long-Serving Mgmt.	33%	67%	3.3	4
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	33%	67%	4.0	6
Quality & Operations	33%	67%	3.7	4
Sales, Marketing & Business Development	40%	60%	3.8	2
Answered Question	*100% (18 Participants)*			

Q32 – Key Comments from Surveys/Interviews

*Management

- Yes, our blue ocean strategy seeks to prioritise high-risk, breakthrough projects. Project selection mechanisms reflect this. Our weakness might be in selecting too-many high-priority projects to work on at any one time. It would be more effective to work on a smaller number of projects, such that we might have a chance of meeting targets and getting products to the market quickly.

*Non-Management

- A lot of effort is put into deciding on what projects to prioritise or select based on company strategy and market influences. I am not involved in project selection – management only – so can't comment.
- A new NPV investment analysis spreadsheet has recently been developed and is a great step forward. Improvement in this area is expected as a result.

Q37 – There is sufficient flexibility in our system for product development to allow small 'fast-track' projects to happen.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**39%**	**61%**	**4.2**	**6**
*Management	50%	50%	4.0	2
*Non-Management	30%	70%	4.4	6
Long-Serving Mgmt.	33%	67%	4.5	6
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	14%	86%	5.3	6
Quality & Operations	33%	67%	4.3	3
Sales, Marketing & Business Development	80%	20%	2.6	2
Answered Question	*100% (18 Participants)*			

Q37 – Key Comments from Surveys/Interviews

*Management

- The strict Medical Device regulations which must be adhered to, make it difficult to 'fast-track' any projects.

*Non-Management

- Aerogen's quality department new direction is making this less so.
- This capability is there but may be slowed down due to new design procedure implementation. Control on 'fast track' products can be affected.
- Yes, the flexibility exists but the resources may not.

Q42 – Our organisation allows some space and time for people to explore 'wild' ideas.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**89%**	**11%**	**1.9**	**2**
*Management	75%	25%	2.3	2
*Non-Management	100%	0%	1.7	2
Long-Serving Mgmt.	67%	33%	2.3	1
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	100%	0%	1.6	2
Quality & Operations	100%	0%	1.7	2
Sales, Marketing & Business Development	60%	40%	2.8	2
Answered Question	*100% (18 Participants)*			

Q42 – Key Comments from Surveys/Interviews

*Management

- There have been people who worked here in the past who have found time to work away on their own projects.

*Non-Management

- The current work load makes it difficult for people to take time to explore wild ideas.
- Not at all really, too much other work and deadlines to allow time for wild idea exploration.

Innovation Area 3 – Organisation

Q3 – Our organisation structure does not stifle innovation but helps it to happen				
Participant Groups	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**22%**	**78%**	**4.3**	**5**
*Management	38%	62%	3.9	3
*Non-Management	10%	90%	4.7	5
Long-Serving Mgmt.	17%	83%	4.5	4
Newly-Hired Mgmt.	100%	0%	2.0	N/A
R&D	14%	86%	4.7	6
Quality & Operations	17%	83%	4.3	5
Sales, Marketing & Business Development	40%	60%	3.8	5
Answered Question	*100% (18 Participants)*			

Q3 – Key Comments from Surveys/Interviews

*Management

- Project teams are generally given autonomy in carrying out their work. The cross-functional nature of project teams also encourages innovation.
- Employees have freedom to get involved in cross functional activities which I feel helps to promote generation of new ideas.

*Non-Management

- True, although sometimes we can get too-tied up with meetings, and meetings about meetings.
- We are good at structuring project teams, but have difficulty in retaining resources full-time on projects. General functional issues crop up on a regular basis, pulling resources back to their functional duties.

Q8 – People work well together across departmental boundaries.

Participant Groups	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
All	**6%**	**94%**	**4.8**	**4**
*Management	12%	88%	4.1	4
*Non-Management	0%	100%	5.3	6
Long-Serving Mgmt.	17%	83%	4.2	4
Newly-Hired Mgmt.	0%	100%	4.0	4
R&D	0%	100%	5.3	6
Quality & Operations	0%	100%	4.7	4
Sales, Marketing & Business Development	20%	80%	4.2	4
Answered Question	*100% (18 Participants)*			

Q8 – Key Comments from Surveys/Interviews

*Management

- There is some room for improvement (still a "them versus us" perception in some areas).

*Non-Management

- Absolutely.
- Our cross-functional teams work very well together.
- Good interaction between functions.
- Roles need to be defined properly at the start of the project.
- Clear boundaries and responsibilities not always apparent, which can lead to conflict.
- Yes this is generally true. The company is small and it's relatively easy to work well across departmental boundaries because a lot of people have multiple duties from different departments.

Q13 – People are involved in suggesting ideas for improvements to products or processes.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**33%**	**67%**	**4.4**	**6**
*Management	50%	50%	3.9	3
*Non-Management	20%	80%	4.8	6
Long-Serving Mgmt.	33%	67%	4.3	3
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	14%	86%	5.3	6
Quality & Operations	50%	50%	3.7	3
Sales, Marketing & Business Development	40%	60%	4.0	4
Answered Question	*100% (18 Participants)*			

Q13 – Key Comments from Surveys/Interviews

*Management

- Yes, there is an open door policy in place and the company suggestion scheme.

*Non-Management

- A suggestion board scheme has been implemented but there is no active incentive or measure that it is working.
- Yes, this is encouraged and efforts are being made to improve.
- The culture of company has not yet embraced this. R&D is generally told what improvements are required, as opposed to being asked for suggestions. Perhaps if R&D were better exposed to the end use environment, there would be more involvement in suggesting improvements.
- Yes, this is generally true.
- A new suggestion board scheme has recently been put in place to accommodate this. Perhaps a more wide-ranging involvement of R&D and others in brainstorming or idea generating meetings would be more effective. This remains to be seen.

Q18 – Our structure helps us to take decisions rapidly.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**17%**	**83%**	**4.6**	**5**
*Management	25%	75%	4.0	4
*Non-Management	10%	90%	5.1	5
Long-Serving Mgmt.	33%	67%	4.0	6
Newly-Hired Mgmt.	0%	100%	4.0	4
R&D	0%	100%	5.7	5
Quality & Operations	0%	100%	5.0	4
Sales, Marketing & Business Development	60%	40%	2.6	4
Answered Question	*100% (18 Participants)*			

Q18 – Key Comments from Surveys/Interviews

*Management

- Yes, this is one of the benefits of being a small organisation.

*Non-Management

- We have the structure in place, but often we are slow to make decisions

Q23 – Communication is effective and works top down, bottom up and across the organisation.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**33%**	**67%**	**4.1**	**4**
*Management	50%	50%	3.6	2
*Non-Management	20%	80%	4.4	4
Long-Serving Mgmt.	33%	67%	4.0	5
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	14%	86%	4.9	4
Quality & Operations	33%	67%	4.0	4
Sales, Marketing & Business Development	60%	40%	3.0	2
Answered Question	*100% (18 Participants)*			

Q23 – Key Comments from Surveys/Interviews

*Management

- It's pretty good – small organisation.

*Non-Management

- When messages need to be communicated it is done effectively, however there needs to be more communication to keep employees informed of company performance, strategies and targets etc.
- I think the organisation would benefit by making each department more aware of what other departments are working on. For example, engineering would benefit from hearing more about customer and end users responses to products.

Q28 – Our reward and recognition system supports innovation.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**50%**	**50%**	**3.2**	**5**
*Management	50%	50%	3.4	5
*Non-Management	50%	50%	3.1	4
Long-Serving Mgmt.	33%	67%	3.8	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	57%	43%	2.6	1
Quality & Operations	50%	50%	3.7	5
Sales, Marketing & Business Development	40%	60%	3.6	2
Answered Question	*100% (18 Participants)*			

Q28 – Key Comments from Surveys/Interviews

*Management

- Reward system in place as part of a newly set-up suggestion board scheme and the inventor reward scheme. These have yet to prove their effectiveness, as they are only newly introduced.

*Non-Management

- Good work is recognized although there are no effective reward systems in place. Rewards should be directly related to performance – individual performance, project team performance, functional performance. I believe this would be a hugely motivating incentive to employees.
- A proper reward system would give more merit to current ineffective and de-motivating 'lip service' performance reviews.
- Recognition system is in place but (perhaps) has not had the motivating effect that is expected. There is no effective reward system.

Q33 – We have a supportive climate for new ideas – people are encouraged to put forward their ideas and don't have to leave the organisation to make them happen.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**17%**	**83%**	**4.5**	**4**
*Management	0%	100%	4.8	4
*Non-Management	30%	70%	4.3	4
Long-Serving Mgmt.	0%	100%	5.0	5
Newly-Hired Mgmt.	0%	100%	4.0	4
R&D	29%	71%	4.6	5
Quality & Operations	17%	83%	4.3	4
Sales, Marketing & Business Development	0%	100%	4.6	4
Answered Question	*100% (18 Participants)*			

Q33 – Key Comments from Surveys/Interviews

*Management

- Absolutely

*Non-Management

- To a certain extent, but more encouragement and incentive is required here.
- True – if somebody has a good idea Aerogen will sponsor it, either through IP or resources.

Q38 – We work well in teams.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**17%**	**83%**	**4.8**	**5**
*Management	38%	62%	4.4	3
*Non-Management	0%	100%	5.3	5
Long-Serving Mgmt.	17%	83%	4.8	5

Newly-Hired Mgmt.	0%	100%	3.0	3
R&D	0%	100%	5.6	5
Quality & Operations	33%	67%	4.3	3
Sales, Marketing & Business Development	40%	60%	4.2	3
Answered Question	*100% (18 Participants)*			

Q38 – Key Comments from Surveys/Interviews

*Management

- Most of us do most of the time

*Non-Management

- Yes, provided all members have the same priority for the work. Sometimes, other team members may have different priority assigned and be somewhat unresponsive as a result due to workloads on other projects.
- Employees work well within their functional teams, cross functionally we could be better.

Q43 – We have a culture which is supportive of risk (technical, financial, market, etc.)

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**39%**	**61%**	**3.9**	**5**
*Management	38%	62%	4.0	4.0
*Non-Management	40%	60%	3.8	5
Long-Serving Mgmt.	17%	83%	4.5	4
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	29%	71%	4.3	5
Quality & Operations	67%	33%	3.3	2
Sales, Marketing & Business Development	20%	80%	4.0	4
Answered Question	*100% (18 Participants)*			

Q43 – Key Comments from Surveys/Interviews

*Management

*Non-Management

- Yes, current new projects underway are a good example.

Innovation Area 4 - Linkages

Q5 – We have good 'win-win' relationships with our suppliers.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**39%**	**61%**	**3.7**	**4**
*Management	63%	38%	3.3	2
*Non-Management	20%	80%	4.1	4

Long-Serving Mgmt.	50%	50%	3.5	2
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	29%	71%	3.9	5
Quality & Operations	33%	67%	4.0	4
Sales, Marketing & Business Development	60%	40%	3.2	3
Answered Question	*100% (18 Participants)*			

Q5 – Key Comments from Surveys/Interviews

*Management

- It often seems our suppliers have the upper hand – prepayment etc. Not sure we effectively manage our suppliers.

*Non-Management

- Our suppliers deliver on time – this is good reflection on our relationship with them.
- Varies from supplier to supplier, but I wouldn't see innovation being high on our suppliers agendas.
- Yes, a good number of our suppliers are smaller scale and need us as much as we need them.
- We have previously run out of components and put pressure on suppliers to deliver at short notice. Therefore we have some strained supplier relationships.
- Some suppliers are not proactive, others are.
- It takes a lot of internal resources to ensure we get what we need from our suppliers.

Q10 – We are good at understanding the needs of our customers/end-users.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**39%**	**61%**	**4.1**	**5**
*Management	38%	62%	3.9	2
*Non-Management	40%	60%	4.2	6
Long-Serving Mgmt.	17%	83%	4.5	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	57%	43%	3.9	6
Quality & Operations	33%	67%	4.0	5
Sales, Marketing & Business Development	20%	80%	4.4	5
Answered Question	93.75% (17 Participants)			

Q10 – Key Comments from Surveys/Interviews

*Management

- Reasonably good at this through feedback from trade shows and customer complaints.

*Non-Management

- I agree but it would be beneficial if engineers & QA support could visit hospitals/clinics to understanding the end-use a bit better.
- Not well done.
- Yes, from customer feedback surveys this seems to be the case.

- Value of VOC recognised.
- We need more end user involvement in prototype testing and evaluation throughout the NPD process.

Q14 – We work well with universities and other research centres to help us develop our knowledge.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**6%**	**94%**	**5.8**	**6**
*Management	13%	87%	5.1	5
*Non-Management	0%	100%	6.3	6
Long-Serving Mgmt.	17%	83%	5.2	5
Newly-Hired Mgmt.	100%	0%	5.0	5
R&D	0%	100%	6.4	7
Quality & Operations	0%	100%	5.5	6
Sales, Marketing & Business Development	20%	80%	5.2	6
Answered Question	100% (18 Participants)			

Q14 – Key Comments from Surveys/Interviews

*Management

- Yes, we have good relationships with local universities and research centres.
- We do, but because it's not clear what work is being undertaken. There is a perception that a lot of money is being spent in this area and employees are not sure what it is being spent on. Communication would help.

*Non-Management

- Recent projects have demonstrated this.
- Yes this is generally true. Lots of work going on with Galway and Limerick Universities.

Q19 – We work closely with our customers in exploring and developing new concepts.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**33%**	**67%**	**4.3**	**5**
*Management	38%	62%	4.3	5
*Non-Management	30%	70%	4.3	5
Long-Serving Mgmt.	17%	83%	4.7	5
Newly-Hired Mgmt.	100%	0%	3.0	3
R&D	43%	57%	3.9	5
Quality & Operations	33%	67%	4.5	6
Sales, Marketing & Business Development	20%	80%	4.6	5
Answered Question	100% (18 Participants)			

Q19 – Key Comments from Surveys/Interviews

*Management
- For the most part we do work closely with customers.

*Non-Management
- Yes, this works well for partnership projects but 100% internal projects do not gather enough real customer requirements feedback.

Q24 – We collaborate with other firms to develop new products or processes.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**6%**	**94%**	**5.4**	**5**
*Management	12%	88%	5.3	5
*Non-Management	0%	100%	5.5	7
Long-Serving Mgmt.	0%	100%	5.7	5
Newly-Hired Mgmt.	50%	50%	4.0	4
R&D	0%	100%	5.9	7
Quality & Operations	0%	100%	5.3	4
Sales, Marketing & Business Development	0%	100%	4.8	4
Answered Question	100% (18 Participants)			

Q24 – Key Comments from Surveys/Interviews

*Management
- Yes, this is a key aspect of our business, and fits with our expansion strategy.

*Non-Management
- We have designed many products with other firms and continue to do so.
- Yes, in so far as integration our products into customers devices goes
- Yes, we have collaborated with some suppliers in new process innovations.

Q29 – We try to develop external networks of people who can help us – for example, with specialist knowledge.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**6%**	**94%**	**5.5**	**6**
*Management	0%	100%	5.0	5
*Non-Management	10%	90%	5.9	6
Long-Serving Mgmt.	0%	100%	5.0	4
Newly-Hired Mgmt.	0%	100%	5.0	5
R&D	0%	100%	5.9	6
Quality & Operations	17%	83%	5.5	6
Sales, Marketing & Business Development	0%	100%	5.0	5
Answered Question	100% (18 Participants)			

Q29 – Key Comments from Surveys/Interviews

*Management
- If specialist knowledge is required, Aerogen will usually find suitable people to advise and provide input.

*Non-Management
- Yes, we are very good at this. Plenty of examples come to mind, including local universities, and aerosol science specialists.
- Yes, especially universities and testing facilities.

Q34 – We work closely with the local and national education system to communicate our needs for skills.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**25%**	**75%**	**3.9**	**4**
*Management	14%	86%	4.7	4
*Non-Management	33%	67%	3.2	4
Long-Serving Mgmt.	0%	100%	5.4	5
Newly-Hired Mgmt.	50%	50%	3.0	N/A
R&D	33%	67%	3.5	4
Quality & Operations	40%	60%	3.4	4
Sales, Marketing & Business Development	0%	100%	4.8	4
Answered Question	100% (18 Participants)			

Q34 – Key Comments from Surveys/Interviews

*Management
- Yes, we are working with the IMDA and other training organisations on subject suggestions for medical device courses within the Universities .We have made some suggestions to NUIG.

*Non-Management
- We make good use of graduate engineers from colleges.
- Don't think we do this at all.
- We have used NUIG and UL for testing and process innovation.
- Could be done through IMDA. Am not aware of any such activities.

Q39 – We work closely with 'lead users' to develop innovative new products and services.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**18%**	**82%**	**4.6**	**5**
*Management	12%	88%	4.9	5
*Non-Management	22%	78%	4.3	4
Long-Serving Mgmt.	17%	83%	4.7	5
Newly-Hired Mgmt.	0%	100%	5.5	N/A
R&D	17%	83%	4.3	4
Quality & Operations	17%	83%	4.5	4
Sales, Marketing & Business Development	20%	80%	5.0	6
Answered Question	100% (18 Participants)			

Q39 – Key Comments from Surveys/Interviews

*Management

- Yes, this is particularly true in current radical innovation projects.

*Non-Management

- Kind of - we would get feedback from companies to feed into a Customer Requirement Document.
- We tend to allow distributors to dominate development direction without direct customer, market or sales feedback.
- This is improving.

Q44 – We have an approach to supplier management which is open to strategic dalliances.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**44%**	**56%**	**3.8**	**6**
*Management	63%	37%	3.5	2
*Non-Management	30%	70%	4.1	1
Long-Serving Mgmt.	50%	50%	3.8	2
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	43%	57%	4.1	1
Quality & Operations	33%	67%	3.7	4
Sales, Marketing & Business Development	60%	40%	3.6	2
Answered Question	100% (18 Participants)			

Q44 – Key Comments from Surveys/Interviews

*Management

- This is an area for improvement.
- This is true in some cases.

*Non-Management

- Due to strict medical device regulations, our suppliers must be qualified, continuously monitored and controlled – our supplier management system is currently undergoing improvements as there have been gaps identified.
- Not convinced we are open to strategic alliances with suppliers. Cost tends to be primary factor as opposed to such factors capability / quality.
- With some supplier we do; with others – absolutely not.
- Selection of lower cost, smaller scale suppliers makes this more common.

Innovation Area 5 – Learning

Q4 – There is a strong commitment to training and development of people.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**17%**	**83%**	**4.2**	**4**
*Management	13%	87%	4	4
*Non-Management	20%	80%	4.4	4
Long-Serving Mgmt.	0%	100%	4.5	4
Newly-Hired Mgmt.	50%	50%	2.5	N/A
R&D	29%	71%	4.4	6
Quality & Operations	17%	83%	3.7	4
Sales, Marketing & Business Development	0%	100%	4.6	4
Answered Question	100% (18 Participants)			

Q4 – Key Comments from Surveys/Interviews

*Management

- We are not good at training mainly due to cash restraints. As a company we are better at development due to the fact employees get good cross functional work experience.
- No dedicated training schemes in place. Any training taken is taken on case by case – no structure. No evidence of six Sigma training in Design/ application of Stats is limited.

*Non-Management

- I believe more resources should be put in place for training/development.
- Training is available if requested.
- Commitment is tempered by financial and time constraints.
- Only when the development is for the good of the company (as opposed to the person) and there are funds made available.
- Employees are encouraged to take on further studies, but funding from the organisation is not available.

Q9 – We take time to review our projects to improve our performance next time.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**67%**	**33%**	**3.2**	**3**
*Management	60%	40%	3	1
*Non-Management	75%	25%	3.3	3
Long-Serving Mgmt.	67%	33%	3.5	3
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	71%	29%	3.0	3
Quality & Operations	67%	33%	2.8	3
Sales, Marketing &	60%	40%	3.8	2

Business Development				
Answered Question	100% (18 Participants)			

Q9 – Key Comments from Surveys/Interviews

*Management

- Pay lip service to it in Stage 5 of our Stage-Gate process.
- This is an area which needs improvement,

*Non-Management

- We could improve on 'lessons learned'.
- Not done properly.
- I don't think we review projects well. There is no evidence of improved performance.

Q15 – We learn from our mistakes.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**50%**	**50%**	**3.7**	**5**
*Management	63%	37%	3.3	2.0
*Non-Management	40%	60%	4.1	3
Long-Serving Mgmt.	50%	50%	3.7	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	43%	57%	4.1	5
Quality & Operations	50%	50%	3.5	3
Sales, Marketing & Business Development	60%	40%	3.4	2
Answered Question	100% (18 Participants)			

Q15 – Key Comments from Surveys/Interviews

*Management

- We could improve on 'lessons learned' through post-launch project reviews.
- Lessons are learned, but not always communicated outside project team. Experience not always called upon.

*Non-Management

- Each project is different. It is difficult to quantify improvement in performance.
- We are poor at capturing lessons learned and they tend to be forgotten as employees leave the company.

Q20 – We systematically compare our products and processes with other firms.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**33%**	**67%**	**3.8**	**4**
*Management	50%	50%	3.8	2
*Non-Management	20%	80%	3.9	4

Long-Serving Mgmt.	33%	67%	4.3	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	14%	86%	4.4	4
Quality & Operations	33%	67%	3.7	4
Sales, Marketing & Business Development	60%	40%	3.2	2
Answered Question	100% (18 Participants)			

Q20 – Key Comments from Surveys/Interviews

*Management

- Not systematically but we have done it

*Non-Management

- We carry out this activity at the start of product design/development projects; we could perform this more regularly throughout the life of the product.
- Products, yes; processes, not so much.
- One or two resources have previously compared our product to competitors, and new devices. This is usually done in an ad hoc manner.

Q25 – We meet and share experiences with other firms to help us learn.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**18%**	**82%**	**4.1**	**4**
*Management	0%	100	4.6	4
*Non-Management	33%	67%	3.6	4
Long-Serving Mgmt.	0%	100%	4.7	4
Newly-Hired Mgmt.	0%	100%	4.5	N/A
R&D	33%	67%	3.3	4
Quality & Operations	17%	83%	4.5	4
Sales, Marketing & Business Development	0%	100%	4.4	4
Answered Question	100% (18 Participants)			

Q25 – Key Comments from Surveys/Interviews

*Management

- Yes, we do.
- Informally. The company is a member of ICBE but these discussions are limited to senior management and general attendance at networking events is poor.

*Non-Management

- I feel we could learn more from other firms, in particular their QA systems.
- Not really done.

Q30– We are good at capturing what we have learned so that others in the organisation can make use of it.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode

Total	**56%**	**44%**	**3.4**	**2**
*Management	50%	50%	3.6	2
*Non-Management	60%	40%	3.3	2
Long-Serving Mgmt.	33%	67%	4.2	5
Newly-Hired Mgmt.	100%	0%	2.0	2
R&D	57%	43%	3.1	2
Quality & Operations	67%	33%	3.5	3
Sales, Marketing & Business Development	40%	60%	3.8	5
Answered Question	100% (18 Participants)			

Q30 – Key Comments from Surveys/Interviews

*Management

- We do share experiences to each others - forwarding presentations, articles etc. all the time.
- We don't publish information gained, apart from IP's.

*Non-Management

- Weak in this area.
- This relates back to not doing Stage 5 project reviews properly.
- There is a lot of knowledge and experience, but only in people's heads. This is getting better.

Q35 – We are good at learning from other organisations.

Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**67%**	**33%**	**3.4**	**3**
*Management	63%	37%	3.5	3
*Non-Management	70%	30%	3.4	3
Long-Serving Mgmt.	50%	50%	3.8	3
Newly-Hired Mgmt.	100%	0%	2.5	N/A
R&D	57%	43%	3.6	3
Quality & Operations	83%	17%	3.2	3
Sales, Marketing & Business Development	60%	40%	3.6	3
Answered Question	100% (18 Participants)			

Q35 – Key Comments from Surveys/Interviews

*Management

- We are good at copying what other companies have done from a systems point of view. Not sure about learning.

*Non-Management

- I can't think of any examples of this so I guess we are not good at learning from other organisations.
- Working on integrated projects is useful; I think we have learned a lot from this.
- This ties in with training – the only other mechanism for bringing in this knowledge is through hiring.

Q40 – We use measurement to help identify where and when we can improve our innovation management.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**65%**	**35%**	**2.8**	**1**
*Management	63%	37%	3.1	1
*Non-Management	67%	33%	2.6	1
Long-Serving Mgmt.	50%	50%	3.7	3
Newly-Hired Mgmt.	100%	0%	1.5	N/A
R&D	67%	33%	2.2	2
Quality & Operations	67%	33%	3.0	2
Sales, Marketing & Business Development	60%	40%	3.4	3
Answered Question	100% (18 Participants)			

Q40 – Key Comments from Surveys/Interviews

*Management

- This is a key area for improvement.

*Non-Management

- Not practised.
- We track customer complaints, but that's about it.

Q45 – We have well-developed peripheral vision in our business.				
Participant Perspectives	Score 1-3 (Not True at All – Generally Untrue)	Score 4-7 (Somewhat True – Very True)	Mean	Mode
Total	**39%**	**61%**	**4.1**	**5**
*Management	50%	50%	3.9	3
*Non-Management	30%	70%	4.3	5
Long-Serving Mgmt.	33%	67%	4.3	6
Newly-Hired Mgmt.	100%	0%	2.5	2
R&D	29%	71%	4.3	6
Quality & Operations	50%	50%	4.0	5
Sales, Marketing & Business Development	40%	60%	4.0	5
Answered Question	100% (18 Participants)			

Q45 – Key Comments from Surveys/Interviews

*Management

- We do reasonably well in market and competitor watching (my interpretation of peripheral vision); especially with recent IP watch implementation.

*Non-Management

- We compare our product to competitors, and new devices
- Senior management should have the bigger picture

Abbreviations

CEO: Chief Executive Officer

COPD: Chronic Obstructive Pulmonary Disease

FEI: Front End of Innovation

FFE: Fuzzy Front End of Innovation

ICBE: Irish Centre for Business Excellence

IMDA: Irish Medical Devices Association

IP: Intellectual Property

KPA: Key Process Area

Ltd.: Limited

MD: Managing Director

MDI: Metered Dose Inhaler

MBO: Management Buyout

MSRA: Methicillin-resistant Staphylococcus aureus

NCD: New Concept Development

NPD: New Product Development

NPV: Net Present Value

OECD: Organisation for Economic and Co-operative Development

R&D: Research and Design

SME: Small and Medium Enterprise

SVN: Small Volume Nebuliser

USN: Ultrasonic Nebuliser