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Creating the Conditions for Innovation

Executive Summary

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**Submitted in partial fulfilment of the requirements for the Degree
of Doctor of Engineering**

**Warwick Manufacturing Group
School of Engineering
University of Warwick**

December 2001



Abstract

This Executive Summary describes a four-year Engineering Doctorate programme at the University of Warwick's, Warwick Manufacturing Group. The objective of the doctorate was to investigate how to "create the conditions for innovation". The Executive Summary presents three aspects of the work. Firstly, the methodology that was employed, secondly, a set of guidelines that show how companies can create the conditions for innovation, and finally, two innovations that the author had primary responsibility for developing. These innovations are TaxiCall and a business training game entitled "The Business of Innovation". The conditions for innovation that have been identified are, senior management support and commitment, organisational capacity and structure, processes that facilitate risk and exploration, people who are committed and motivated to innovate, the integration of ideas and people from contexts alien to the business, a deep understanding of customers' expressed and unexpressed needs. TaxiCall is an innovative solution to the problem taxi passengers face when hailing a vehicle. It provides a means for a passenger to speak directly to the driver of the nearest available "for hire" taxi to arrange a journey. The author was responsible for developing the idea for TaxiCall into a defined business proposal. This proposal included strategy development, market analysis, a financial and marketing plan and a technical solution. The proposal received £0.5m to further develop the concept of TaxiCall into a viable business. As a consequence of this further development, £8m investment was made in order to launch TaxiCall as a service branded Zingo into the London market late in 2002. The Business of Innovation is a training game that has been designed to address the issue of why companies, who succeed with one technology, often fail to succeed with the one that follows it. It does this by allowing participants to experience why incumbent companies struggle to successfully manage technological discontinuous innovations. The author used this game with approximately 100 participants of Warwick Manufacturing Group's MSc and Executive Development programmes. Evidence was gathered concerning its ability to meet its stated objectives with a majority of 86% of participants finding it a useful learning experience. The game has subsequently been adopted by a number of training organisations serving a variety of industry sectors.

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Declaration

I, Andrew White, hereby declare that the work contained in this dissertation is my own unless otherwise stated.

Chapter One – The Introduction

1.1 Innovation

Innovation form an important basis upon which modern companies compete. It can be defined as "any idea, practice or material artefact perceived to be new by the relevant unit of adoption" (Zaltman, 1973) and "the generation, acceptance and implementation of new ideas, processes, products or services" (Kanter, 1985). Thus they are the configuration of technologies or ideas that are the principal elements in the entities, or methods of construction and delivery, of products and services. Over time, these innovations are, more often than not, subject to the law of relative diminishing returns. These returns can be measured in terms of revenue, profit margin and product performance. This is due to the advent of superior customer offerings being introduced within the marketplace. These diminishing returns are the core motivating force driving the development of innovations by companies both incumbent to, and entering into an industry.

The process of delivering an innovation to the market is one that is fraught with complexity and uncertainty. This is due to the interaction between diverse elements within, and external to the business, and high levels of unpredictability in the process of breaking new ground. However, leading companies have become increasingly competent at delivering a defined concept and subsequent product through pre-established processes and organisational structures. Moreover, generating and defining inputs to this process are important areas where many companies need to improve their performance; as to date they have largely left this activity to chance, sometimes with devastating consequences. These inputs are ideas and concepts for new technologies, products and services

1.2 Industrial Context

For innovation to mean anything of value to companies, it must contribute to their fundamental purpose: the delivery of shareholder value. Two different, but equally valid, perspectives can be taken as to what this means. The first is positive in nature, it asks, what is the relationship between innovation and profitability? The second, negative in nature, asks, what happens when companies fail to innovate successfully?

1.2.1 Innovation and Financial Performance

The international professional services companies, PriceWaterhouseCoopers and PA Consulting Group have both conducted and published research that has shown a

strong relationship between financial performance of a company and innovation. PriceWaterhouseCoopers (1999) surveyed three hundred Times 1000 companies, from a broad spectrum of industries. All the companies had turnovers greater than £100m. The research reported that the top 20% of performers were diverse in terms of size and industry. Moreover, that there is a relationship between stock-market growth and the percentage of turnover derived from new products and services. This relationship, shown in figure 1, identifies that companies that have a high level of turnover from new products and services tend to have higher levels of growth in stock-market capitalisation. New products are defined as being those where the product is less than five years old.

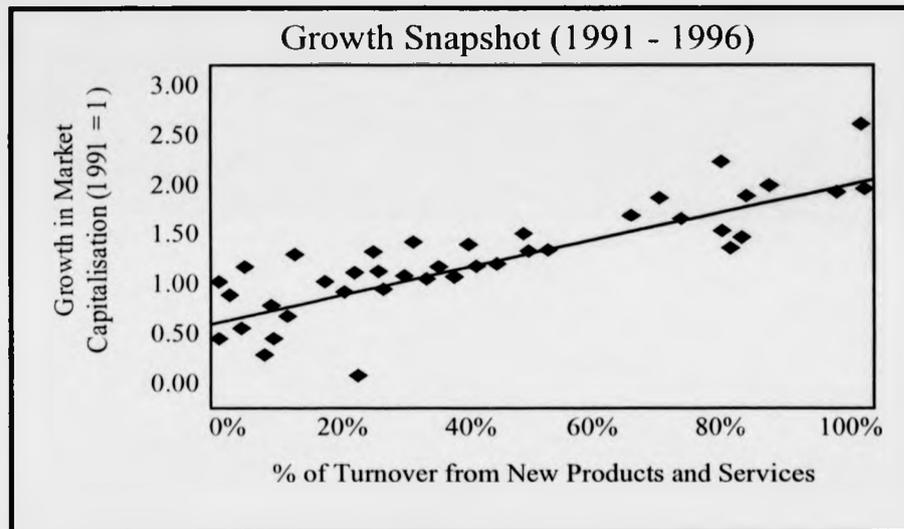


Figure 1. The relationship between innovation and financial performance.
PriceWaterhouseCoopers (1999)

A further study by PA Consulting (1999) showed that companies that defined innovation in terms of “the successful commercialisation of significant new revenue streams from distinctive new products, process and services” were more profitable than those that did not. In surveying one hundred and fifty companies, representing the five hundred highest R&D spenders in the UK, they drew the conclusion that the most profitable companies place far more emphasis on innovation in the marketplace than the less profitable companies. The difference between the most profitable companies and the rest is that they:

- a) Focus on distinctive new products and services rather than sustaining existing ones;
- b) Focus on new revenue streams with new products and services rather than using science and technology to create distinctive products and services;
- c) Focus on the renewal of the way in which offerings are marketed and presented to customers.

1.2.2 Innovation and Survival

Several studies have been conducted that show how incumbent companies that fail to innovate successfully, lose dominant market positions along with suffering severe financial consequences. Utterback (1996), Christensen (1997) and Anderson and Tushman (1990) and (1991) all show a pattern of established firms failing to develop the technical competencies needed to offer innovations to the marketplace that give customers discontinuous improvements in the performance of products. They show that as a discontinuous technology enters a market, companies will struggle for leadership before a dominant design emerges. Incumbent companies, more often than not, have started the technological development process that is necessary to compete too late. This leaves the battle for new market leadership positions to new entrants. As already stated, this often creates severe consequences for the incumbents. The reasons for this are complex, and are described in detail in Submission I, but the role of a company's culture plays a critical part. This shapes the environment in which people working for the company operate and, to an extent, determines the behaviours, policies and decisions that are made. These in turn determine the company's future direction and ultimate destiny.

1.3 The Scope of this Executive Summary

This Executive Summary will describe the work undertaken on a four-year Engineering Doctorate programme at the University of Warwick's Warwick Manufacturing Group. The objective of the doctorate was to investigate how to "create the conditions for innovation". This Executive Summary presents a detailed overview of the following aspects of the work:

- 1. The methodology that was used in order to address the project objectives;
- 2. A synthesis of case study evidence and supporting literature, that will demonstrate how companies can create the conditions for innovation;
- 3. The innovations that have been developed by the author.

The Executive Summary draws heavily upon three documents in presenting evidence for the aforementioned aspects of the work:

1. White (1999), M.Sc. dissertation submitted in September 1999 entitled "The Sources and Enabling Factors of Product Innovation".
2. Submission I (White, 2001) - The Business of Innovation: A Training Intervention for Senior Managers.
3. Submission II (White, 2001a) - TaxiCall: A Case Study of a Strategic Innovation.

1.4 Project Objectives

This project has the principal objective of the production of guidelines, for companies, showing them how to create the conditions for innovation. These conditions specifically address how companies can create and exploit knowledge, in the form of products and services, at the front end of the product development process. This is addressed by means of seeking to innovate by the application of knowledge. Hence the innovation that is developed will be deemed successful by virtue of its ability to contribute to a company's performance.

1.5 Projects

Three major projects have been undertaken as part of the research. These were:

1. **White (1999)**, an investigation into the sources and enabling factors of product innovation. The project identified and analysed ten innovations, five from the TX1, the taxi launched in October 1997 by London Taxis International¹ (LTI), and five from world-class innovators. Models of the sources and enabling factors of innovation were produced as a result of this work.
2. **TaxiCall – A Case Study of a Strategic Innovation (Submission II)** The author spent twelve months working on the development of a strategic innovation at LTI. He was responsible for taking the innovation, TaxiCall, from being an idea presented on half a side of A4 paper, to becoming a defined business proposal with £0.5m funding awarded to it, and a detailed business plan and outline strategic relationship in place. This project has gone on to receive a further £8m funding and is set to become a core part of Manganese Bronze Holdings Plc's business portfolio. The development of this innovation was analysed in order to ascertain whether or not it validated the models developed in the previous project.

3. **The Business of Innovation – A Training Intervention for Senior Managers (Submission 1).** This sought to address one of the key findings from the previous research project (White, 1999) that the role of senior managers is critical to the development of innovations. Moreover, it sought to integrate existing research on discontinuous innovation into a game that simulated this phenomenon. This game has then been applied on company and Masters' level courses run by Warwick Manufacturing Group.

The above projects are inter-linked, and the relationship between these three major projects is shown in figure 2, and described in chapter 3. Together the projects help build a detailed theoretical and experiential knowledge base that facilitated the investigation of the subject under investigation.

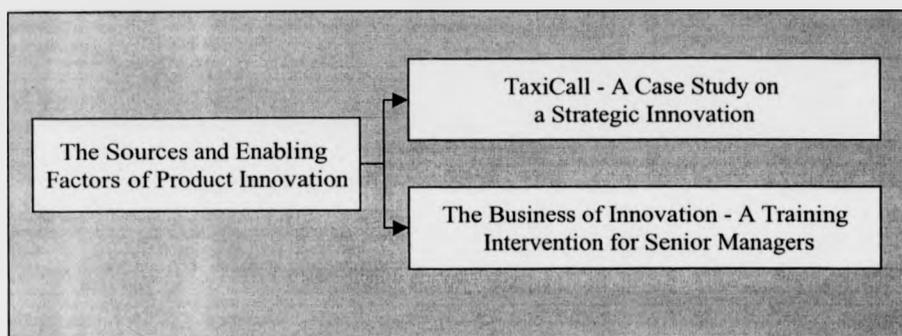


Figure 2. Major projects undertaken.

In summary, the projects demonstrate the following achievements by the author:

- a) Defining conditions for innovation in the form of models of the sources and the enabling factors of innovation;
- b) Making a significant contribution to the development of strategic innovation within LTI;
- c) The development and application of a business game that seeks to simulate the phenomena surrounding the mismanagement of discontinuous innovation by organisations.

¹ The authors sponsoring company

1.6 Summary

This introduction has described the imperative for innovation from both the need to increase shareholder value and ensure that companies survive. It has described what the objects of the Engineering Doctorate project were, and how they have been addressed in terms of the projects undertaken. Finally, it has set the scene for this Executive Summary in terms of what it addressed, and the evidence is used to support the findings presented.

Chapter Two - Project Methodology

2.1 Project Scope

This research into creating the conditions for innovation took place between October 1997 and September 2001. It consisted of three inter-independent projects that sought to develop and to apply knowledge about innovation management (see figure 3). The results from these three projects have been synthesised to produce guidelines for companies that show them how the conditions for innovation may be created. This chapter will concentrate on describing three aspects of the methodology:

1. The objectives, methodology and results of the first project entitled “The Sources and Enabling Factors of Product Innovation” (White, 1999). This project has been profiled in this chapter as it does not have any further chapters dedicated to it and forms an integral part of the overall research process;
2. The outputs from the above project that formed the basis of the rationale for the projects entitled “TaxiCall: A Case Study of Strategic Innovation” and “The Business of Innovation: A Training Game for Senior Managers”;
3. Methodologies for the projects entitled “The Business of Innovation: A Training Game for Senior Managers” and “TaxiCall: A Case Study of Strategic Innovation” are described in chapters 4 and 5;
4. The methodology that was used to construct the company guidelines on how to create the conditions for innovation.

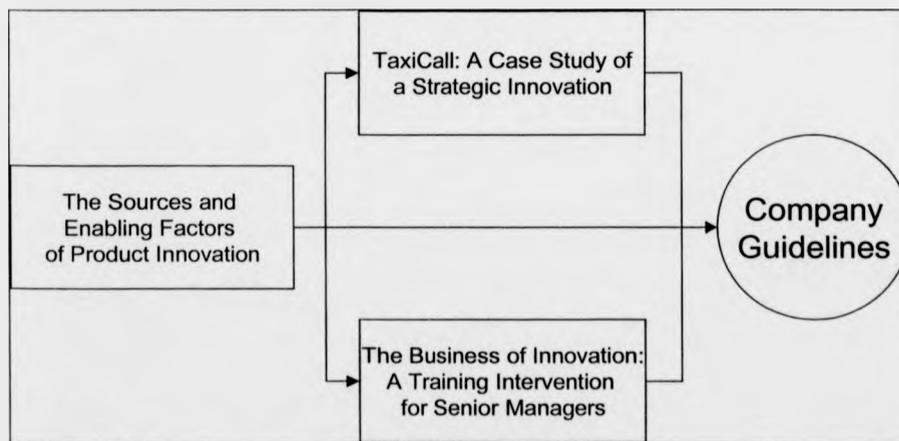


Figure 3. Project methodology

2.2 The Sources and Enabling Factors of Product Innovation

Between January 1998 and September 1999 ten case studies, of innovative products, were undertaken. These case studies focused on the front-end of the new product development process² responsible for bringing these innovations to market. In particular, the case studies sought to understand what were the sources³ and enabling factors⁴ responsible for the innovation's success in the market place. Five case studies were from companies identified as being leading innovators and five from LTI. This section will give a profile of the project objectives, methodology and results. The results will be profiled in the form of models of the sources and enabling factors of innovation and the performance of LTI against the benchmark companies. Two publications have been made as a result of this work (White, 2001b and White, 2002).

2.2.1 Project Objectives

1. Identify where new knowledge is needed in the innovation literature;
 - Define the broad areas needed for successful activity in the front end of the innovation process;
2. Identify the sources and enabling factors of successful innovation;
 - Describe LTI's performance in the area of accessing the sources of innovation and the level to which the enabling factors are present and performing in the company.

2.2.2 Project Methodology and Results

The methodology used to investigate the defined subject area consisted of the following steps:

- A detailed review of the literature was undertaken to establish which areas the methodology should focus on;
- Innovations, that would form the basis of the case studies, were identified via the use of criteria for the world class innovators, and interviews with taxi drivers for the innovations for LTI's, TXI;

² The front end of the development process can be described as the period of time, during the product development process before it formally enters the process to design the product and manufacturing processes and launch and market the product (White, 1999).

³ The sources of innovation can be defined as the place or persons from which the idea(s) that constitute a product emerge (White, 1999).

⁴ The enabling factors can be defined as those things responsible for moving potential product from being an idea to an approved formal business proposal (White, 1999).

- A structured interview pro forma was constructed in order to ascertain data for the case studies. This was then used with individuals from the companies responsible for the development of the innovations.
- These results from the interviews were analysed, and the sources and the enabling factors responsible for the success of the innovations were identified. These are presented as figure 4 and 5. This analysis then formed the basis of the models that were constructed, (these are presented as figure 4 and 5), and the analysis of LTI's performance.

2.2.3 The Sources of Innovation

Figure 4 shows a number of sources of innovation. These originate from two contexts, either internal or external to the organisation, and by two types of processes, formal or informal. They can also be viewed as having occurred as a result of conscious effort or, reacting to external stimuli.

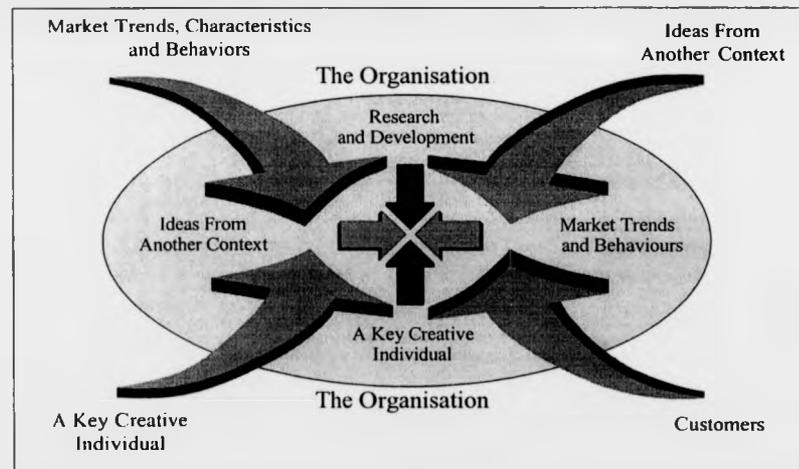


Figure 4. The sources of innovation

2.2.4 The Enabling Factors of Innovation

Figure 5 shows a number of enabling factors of innovation. These are broken down under the areas of Strategy, Organisation, Culture and Process. Within these areas the enabling factors can be classified firstly, in-terms of specific business practices and policies that are employed, with anticipated outcomes, and secondly, behaviours with consequential effects.

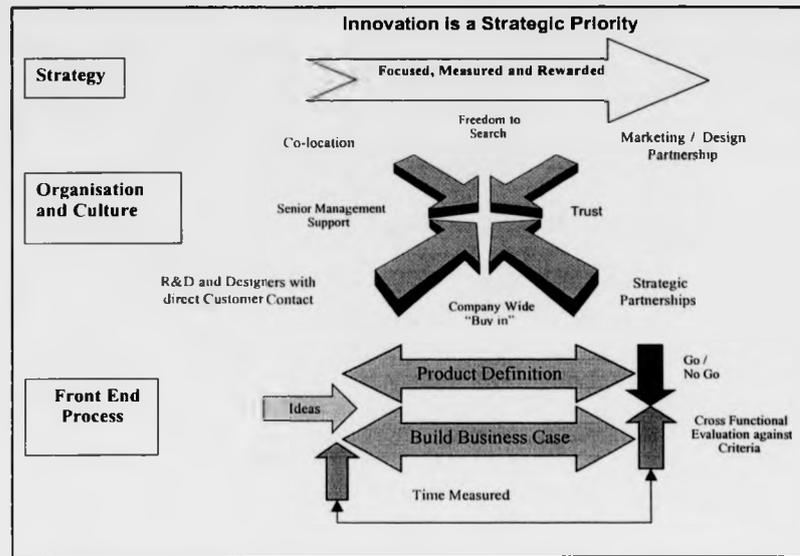


Figure 5. The enabling factors of innovation

2.3 Rational for projects entitled TaxiCall: A Case Study of Strategic Innovation and The Business of Innovation: A Training Game for Senior Managers

2.3.1 TaxiCall: A Case Study of Strategic Innovation

As a result of the investigation into the sources and enabling factors of product innovation two models were produced. The conclusions from this research were that these models needed further validation. As the doctoral project sought to investigate innovation in the application of knowledge to the engineering business environment and the development of certain competencies, a decision was made to work on a project being proposed by the author's sponsoring company. This would be to validate the models produced with the author analysing a business concept that was transformed from an idea to becoming a defined business proposal. This proposal had:

- a) An approved business plan;
- b) Development monies secured;
- c) An outline agreement for working with a strategic partner.

The author would project manage this transformation. This was completed between March 2000 and March 2001. A full description of this work, including the approved

business plan and analysis is presented in submission II. A summary is presented in chapter 5 of this Executive Summary.

2.3.2 The Business of Innovation: A Training Game for Senior Managers

As a result of the research in the sources and enabling factors of product innovation, the only enabling factor common to all innovations studied was the role played by senior managers. Following this, a further investigation into the nature of this role was undertaken by reviewing the literature in this area. This specifically focused on senior management's responsibility to grow the size, increase the profitability and ensure the survival of their companies, in the light of the phenomenon of discontinuous innovation. The result of this investigation was the design and application of a business game, aimed at simulating this phenomenon. The application the game involved its use with:

- a) A group of management consultants and academics from innovation management and technology backgrounds, some of whom had experience of design and using business games;
- b) Eight teams of five participants, all designated senior managers, from AstraZeneca Plc and Marconi Plc.

As a result of these applications 86% of the participants felt the game to be of value to their learning experience, and of this, 50% thought changes were needed. Only 14% of participants thought that it was of little or no value.

2.4 Creating the Conditions for Innovation – The Construction of Company Guidelines

2.4.1 Objectives

This research project has produced insights into the phenomena of managing the innovation process from a variety of perspectives. To date the findings from these investigations have yet to be analysed collectively. This will be done in chapter 3 in the form of the creation of guidelines that inform companies how to create the conditions for innovation. These guidelines specifically focus on the types of activity needed to improve a company's performance at the front end of the innovation process. Moreover, they will improve the chances of a company being responsible for the next wave of discontinuous innovation(s). The guidelines will be based upon data and theory from three sources:

business plan and analysis is presented in submission II. A summary is presented in chapter 5 of this Executive Summary.

2.3.2 The Business of Innovation: A Training Game for Senior Managers

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1. The ten case studies were undertaken to investigate the sources and enabling factors of product innovation;
 2. The case study on TaxiCall;
 3. The literature review conducted into the phenomenon of discontinuous innovation.
- Guidelines will be positioned at the end of each condition presented in chapter 3.

2.4.2 Methodology Rationale

In order to synthesis the three sources into guidelines a methodology call Grounded Theory will be used. Grounded theory is defined by Strauss et al (1998) as “theory that is derived from data, systematically gathered, and analysed through the research process”. They go on to state that the researcher does not start the research with a theory in mind but, rather, allows the theory to emerge from that data. Charmaz (2000) defines it as consisting of “systematic inductive guidelines for collecting and analysing data to build middle-range theoretical frameworks that explain the collected data”. Grounded theory has been chosen as a methodology to product guidelines for the following reasons:

1. A considerable amount of data has been collected and analysed to date, however it has yet to be synthesised into a single set of findings;
2. When compiling a single set of findings there is a need to ensure sufficient rigour in the process undertaken;
3. It has a strong pedigree in being used to analyse qualitative data (Martin and Turner, 1986);

2.4.3 Methodology Process

The methodology of grounded theory is well defined in the literature by authors such as, Martin and Turner (1986), Strauss and Corbin (1998), Sarantakos (1998) and Charmaz (2000). Table 1 has been compiled from these four sources. It describes the individual steps of the process, what the outcome of the steps should be, and how these relate to the compiling of the company guidelines.

Process Action	Description	Link to Research
Coding Data	This is the process where-by data is used in producing concepts. A higher level of	This has been done for each research project individually: The Sources and Enabling Factors of Product Innovation – The sources and

	<p>abstraction is sought to describe the data that allows for the application of a name to the action or occurrence. The aim in deciding on a name for the occurrence is to a) avoid having to create one for every piece of data and b) ensuring that it relates explicitly to the phenomenon being studied Martin and Turner (1986)</p>	<p>enabling factors were identified and coded. Open, axial and selective⁵ methods of coding were used to produce two models: one on the sources and one on the enabling factors of product innovation.</p> <p>TaxiCall: A Case Study on a Strategic Innovation – This project took the form of attempting to validate the models of the sources and enabling factors of product innovation through their identification and coding.</p> <p>The Business of Innovation: A Training Intervention for Senior Managers – A literature review was undertaken seeking to develop further the author's understanding of the phenomenon of innovation. This was from the point of view of the role of senior managers and the phenomenon of discontinuous innovation.</p>
Theoretical Sampling	<p>This is a form of sampling that is different to random. It directs the researcher to additional data, that is collected to explore areas that have been highlighted as important Sarantakos (1998)</p>	<p>Two forms of theoretical sampling took place:</p> <ol style="list-style-type: none"> 1. The investigation of TaxiCall provided further data in order to attempt to validate the models of the sources and enabling factors of innovation; 2. The need for further data on the role of senior managers in the process of managing discontinuous innovation arose from the analysis of 10 case studies on the sources and enabling factors of product innovation. These showed that the one common factor in all case studies was the contribution made by senior managers. A literature review was undertaken to provide this theory. This was then used as the foundation upon which the training intervention was developed.
Memo Writing	<p>Memos relate to coding, ideas, key categories, gaps in analysis. They form the basis of a discussion concerning the coding and actual data Sarantakos</p>	<p>Memos have been written for all concepts in all of the three research projects. At present they exist in the form of submissions I and II and White (1999). These will be used to compile the company guidelines on Creating the Conditions for Innovation.</p>

⁵ According to Sarantakos (1998) Open coding serves to initiate coding and is general, axial coding concentrates on issues related to the axis of a category and selective coding concentrates on coding key categories

	(1998). Strauss and Corbin (1998) define them as devices that depict relationships between concepts.	
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Table 1. The use of grounded theory to compile the company guidelines on creating the conditions for innovation.

2.5 Summary

This chapter has described the methodology used to investigate how to create the conditions for innovation and produce innovation in the application of knowledge within this area.

Chapter Three – The Conditions for Innovation

3.1 Company Guidelines

This chapter presents company guidelines on how to create the conditions for innovation. These guidelines have been constructed from the following sources:

1. A research project focused on identifying the sources and enabling factors of product innovation. This consisted of ten case studies on successful innovations;
2. A case study on TaxiCall, a strategic innovation with the potential to re-engineer a £4.5bn UK industry;
3. A literature review on the phenomenon of discontinuous innovation that sought to:
 - Define and describe the phenomenon of S-curves;
 - Define the scope of their effects in terms of the breadth of industries it covers;
 - Attempt to understand why companies fall victim to new technological S-curves (also known as disruptive technologies or discontinuous innovations);
 - Identify the practices managers can undertake to exploit, rather than fall victim to these discontinuities.

Six conditions have been identified. These are defined and illustrated via the use of examples of practice and theory from the above sources. Guidelines emerge from each of the six conditions analysed in subsection 3.2 – 3.7. These are summarised at the end of each subsection.

These conditions are all either, related to, components of, or dependent on, a company's culture. Culture can be defined as the symbols, heroes, rituals and values of an organisation that are manifest in terms of a variety of practices, (Hofstede, 1994). Tushman and O'Reilly (1996) state that organisational culture can be responsible for success in the short-term and long term failure through incorrect management. They go on to state that the active management of cultures that can handle discontinuous innovation is perhaps the most challenging aspect of managing discontinuous innovation and change. The challenge is to create a culture that on the one hand, enable success through focusing on today's customers, technologies and markets, and on the other hand allow for the creation of entirely new ones. Ekvall (1991) identified 10 dimensions of cultures responsible for stimulating innovation. These dimensions are:

1. Challenge – A culture that engenders emotional involvement of employees in an organisations operations and strategies.

2. Freedom – Characterised by independence of people with respect to the exchange of information, discussing problems and generation of plans that transgress established boundaries.
3. Idea support – Defined as being where ideas are positively received and constructively managed.
4. Trust / openness – A culture where people feel safe to put forward ideas and opinions and an absence of a fear of failure.
5. Dynamism / liveliness – The presence of new projects and plans, and different ways of working.
6. Playfulness / humor – The presence of an atmosphere that is relaxed and characterised by jokes and humor.
7. Debates – A culture that encourages people to put forward diverse and conflicting points of view and alternative perspectives to the status quo.
8. Conflicts – Low levels of conflict between people and groups, as apposed to ideas.
9. Risk taking – A high tolerance of uncertainty in the organisation where options are explored through experimentation rather than detailed investigation and analysis.
10. Idea time – Where time is given and used for generating and developing ideas, impulses and suggestions.

The conditions presented in this chapter develop many of these dimensions of innovative culture in terms of how they can be induced and what practices need to be employed in order to fully exploit their presence. Moreover, they show how a company can create a culture that stimulates innovation.

3.2 The Presence of a Deep Understanding of Customers Expressed and Unexpressed Needs

Successful innovations begin and end with whether or not customers adopt them. These innovations fulfil their needs at the right price. However, predicting and understanding these needs is not something that companies find easy. Moreover, Cooper et al (1987) found that having a unique superior product in the eyes of the customer i.e. one with a real differential advantage in the market place was one of only three factors differentiating success and failure in introducing new products. These findings built upon the work of Maidique et al (1984) who found that an in-depth understanding of the customers and the marketplace combined with new products with a high performance to cost ratio, to be factors separating success from

failure at new product introduction. In terms of the effect of the collective effect of failure at introducing new products, Cooper et al (1990) found that:

1. 33% of new products fail at launch;
2. 46% of the resource that US companies spend on New Product Development goes into unsuccessful ventures;
3. 63% of senior executives are "somewhat" or "very" disappointed with the result of their firms' new product development programmes.

These findings all point towards the importance of understanding and fulfilling customers' needs in developing new products. During the course of this research, several phenomena have been identified that help develop understanding on how companies can successfully understand customers' needs.

During the development of TaxiCall a clinic was undertaken where taxi drivers, who were potential customers of the service, were involved in a simulation of the process of hailing a taxi via a mobile phone. They were debriefed following this experience in order that their expressed needs might be understood and observed. Moreover, an understanding of their unexpressed needs were gained via the use of tape recordings of phone conversations and recording their interactions with the passenger through the use of a mobile phone, via a video camera. The results of this exercise were:

1. The concept was verified as potentially being very beneficial to the taxi drivers. Eight out of the nine drivers said they would use it;
2. Potential usability problems, already identified in previous TaxiCall research and analysis, were reiterated;
3. New usability problems were identified;
4. Solutions as to how the usability problems identified could be solved were generated by:
 - a) The drivers at the clinic;
 - b) Members of the TaxiCall staff, both during the clinic and subsequent analysis afterwards;
5. The emotional journey undertaken by the driver and passenger were mapped. These gave an understanding on where effort needed to be focused so as to improve the usability of the system.

White (1999) showed that customers were the sources of many of the ideas behind successful innovations. The nature of their involvement varied from being responsible for the core idea that constituted the innovation, to suggesting ways of refining or

adapting an existing product. One of the case studies identified a practice, known internally within the business as "a day in the life of a customer". This was where engineers spent a day with a customer, observing how, why and when they used the product. This was with a view to understanding:

- b) What product features were redundant;
- c) What expressed and unexpressed needs the customers had.

However, listening to customers' expressed and unexpressed needs does not in itself guarantee against failing victim to a discontinuous innovation. Christensen (1997) found that it was the very principles that are traditionally practised by good managers that cause them to falter in the face of discontinuous innovation. Specifically:

1. Companies depend on customers and investors. Often customers do not want disruptive technologies when they first see them. They are prone to performing at a lower level even though they have greater limits in terms the potential of their performance. When customers do want disruptive technologies, incumbent companies cannot respond quickly enough. As investors take a similar attitude to managers, that of listening to customers, managers have neither the motivation or resource to develop disruptive technologies;
2. Small markets do not solve the growth needs of large companies. Many large companies wait until markets look interesting, in terms of sales volume, before entering. This strategy leaves time for competitors to establish themselves in the market.

Foster (1986) identified a pattern of customers telling companies what they wanted only to change their minds when an alternative, discontinuous innovation had been produced offering greater performance at a lower cost.

3.2.1 Guidelines

1. Understanding customers' expressed and unexpressed needs is essential to the process of conceptualising and designing innovations to meet them;
2. Customers can be a productive source of ideas for developing new, and refining existing products;
3. Current customers may not always provide an insight into what factors will deliver competitive advantage in tomorrow's market place. Predicating and listening to tomorrow's customers is an essential task in seeking to remain competitive.

3.3 The Integration of Ideas and People from other Contexts, Perspectives and Knowledge Bases into the Business

Many of the innovations studied did not arise as new concepts, but used existing concepts that have been used successfully in other contexts. White (1999) showed how an engineer, who was a customer working in a car-body shop, conceived an idea to use a different process to solve a problem he faced. He was aware of the problems that surrounded the use of techniques to detect faults in car paintwork. Whilst caring for his baby, and applying talcum powder to its bottom, he noticed how the powder highlighted the lines on his hands. He then wondered whether a powder would have the same effect on car bodies. Hence, he transferred an application from one situation, or paradigm, to another in order to develop a creative idea. He approached a manufacturer who, after coming to a financial arrangement with him, launched a product that, at the time the research was undertaken, had taken 30% of the European market.

White (1999) also presents a case study that shows how a self-employed painter and decorator developed a concept that formed the basis of a product that, at the time the research was undertaken was sold in twenty two countries world-wide and generated £10m worth of sales. The painter and decorator also came to a financial agreement with a subsidiary of a \$5bn US paint company who developed and marketed this product.

During the development of TaxiCall (Submission II) technologies were selected that were already in use for other applications in different markets. None of the technologies used for TaxiCall had been developed specifically for that product. In acquiring these technologies, partnerships were developed with individuals and organisations that had no previous involvement in the Taxi industry. Hence they came from other contexts. These included specialists in telecommunications technologies and generalists in electronic solutions development.

Dosi (1982) presents the concept of technological trajectories and paradigms. Trajectories are the direction along which a technology is progressing and a paradigm is what frames the context that this trajectory exists in. Discontinuities exist when new paradigms are created and, hence, technologies progress along new trajectories. Tushman and Anderson (1986) developed an understanding of this area by adding that competence-destroying discontinuities exhibited the following characteristics:

1. Competence destroying discontinuities are often initiated by new firms;
2. Competence destroying discontinuities advance the technological frontier of knowledge with skills that are inconsistent with prior know-how;
3. Competence destroying discontinuities are rarer than enhancing ones;
4. Competence destroying discontinuities initiate a period of technological ferment, where alternative technologies compete for dominance.

3.3.1 Guidelines

1. Contexts, other than the one(s) that companies are currently operate within are sources of ideas for innovation;
2. In order to access these sources, companies need to find ways of involving people, not normally associated with their business and industry, in the idea generation and concept development processes;
3. Discontinuous innovations can involve the use of technologies that render companies' current competencies redundant. Hence, ideas for tomorrow's innovations may not come from today's competencies, experiences and current employees. Companies need to take this into account when creating product, business and human resource strategies.

3.4 Senior Management Commitment

The involvement of senior managers in the process of bringing innovative ideas to market, is the most comprehensive factor, in terms of it's presence, responsible for successful innovation, according to White (1999). The roles senior managers play can be defined in terms of the following activities:

1. Generators of ideas;
2. Leaders of innovation development projects;
3. Sponsors and advocates of innovations;
4. Negotiating partnerships to enable innovations to be developed;
5. Evaluating ideas and business proposals.

The success of moving TaxiCall from an idea to a defined business proposal relied strongly on the role played by senior managers. Not only were they actively involved in the development of TaxiCall through generating ideas and formulating strategic relationships, they also released investment monies. Moreover, the TaxiCall project enjoyed a position within the Manganese Bronze Holdings Plc structure of:

- a) Being led by a Managing Director within the group;

b) This Managing Director reported directly to the Chief Executive.

From a review of the literature on discontinuous innovation, senior managers have been found to have critical responsibilities for the future direction of their companies. Nadler (1998) took two views on the roles senior managers play when faced with managing discontinuous change. He found that successful ones exhibited the following roles that act as enablers:

1. Envisioning – An ability to articulate and communicate a vision of the organisation that captures the imagination of the people they lead;
2. Energising – Highlighting examples of success, with a sense of their own personal excitement and total engagement, as a way of building a sense of confidence and accomplishment;
3. Enabling – Finding realistic ways to give people the confidence, authority and resources they need to work towards their shared objectives.

When viewed from a dynamic perspective, they found that CEO's, who had already been through one period of discontinuous change, reacted in one of four ways when faced with the prospect of another discontinuous innovation. These can be classified as inhibitors:

1. Denial;
2. Avoidance;
3. Bowing out;
4. Succession management;

Rarely had they the ability to manage more than one discontinuity. Foster (1986) advocates that because discontinuities will become more common, managing through them will become essential for corporate survival. He states that CEO's should preferably have a technological or marketing background rather than a financial one, and that his relationship with the R&D Director, or Chief Technology Officer, is critical. In the area of technology, he states that there are only a few questions he needs to understand the answers to. These are in the areas of:

1. Markets and solutions;
2. Key parameters in the consumers' buying decision;
3. The distance from the potential limit of performance of the companies current technologies;
4. The value of the remaining potential, within the current technology, and the levels that can be captured by the company;

5. When will each technological alternative be competitive in the market place.

Anderson and Tushman (1991) stated that senior managers should take the following factors into account when making decisions concerning the future strategies of their businesses:

1. Expect discontinuities;
2. When discontinuities occur, expect a period of uncertainty culminating in a single dominant design;
3. Realise that technological innovations may be introduced by a newcomer, but firms that adopt it earliest typically includes a majority of veterans;
4. Consider that technological change, not downturns in demand, are associated with shakeouts.

3.4.1 Guidelines

1. Senior managers play a crucial role in the process of enabling companies to exploit, rather than fall victim to, discontinuous innovations. This is through defining a vision of what companies can do in the form of innovations, being aware of the threat of discontinuities and enthusing people to become involved projects that will deliver discontinuous innovations;
2. The nature of their role can vary, however they have been found responsible for generating ideas, sponsoring ideas and projects, enabling people to become involved in the development of innovations
3. The research suggests that leaders, who have been responsible for one successful innovation, can hinder a company exploiting another. This is possibly caused by the fact that they may have to destroy what they have created, sometimes before it shows signs of serious decline;
4. Develop key relationships with people responsible and capable of, a) making the company aware of coming discontinuities, and b) capable of delivering them is key to successfully managing discontinuous innovation.

3.5 People who are Committed and Motivated to and Capable of Delivering Discontinuous Innovation

Behind all of the innovations studied as part of this research programme were people who were committed, motivated to, and capable of, delivering innovations. But what type of people were they and what did they do?

White (1999) found that key creative individuals were responsible for a large number of the ideas that constituted the innovative products studied. For four of the innovations, the ideas for the products came from sources external to the business. These sources were individuals who had had creative insights in the form of ideas. In one case they had developed a working prototype before approaching the company, and in two they came to a financial agreement with the company. Senior managers act as critical players within the process of delivering innovations and generating ideas. This was the subject addressed in the previous section.

During the development of TaxiCall the profile of the team was studied via the use of a psychometric tool entitled the Creative Problem Solving Profile (Basadur, Graen and Wakabayashi, 1990). The Creative Problem Solving Profile is designed to score a person's preference of innovative thinking in four areas⁶. The aim of the inventory is to describe how a person innovates, not to evaluate innovation ability. The results of the analysis were:

1. The teams' dominant styles were all within the first three stages of the profile, generators, conceptualises and optimisers.
2. There was a clear dominant style within the team towards conceptualising;
3. Two of the three senior managers, who actively worked on the project, were generators;
4. The senior manager responsible for the project during the period of time before that being studied in this submission, i.e. the period of time that the idea was conceived, had a dominant style of an optimiser;
5. The individual responsible for generating the original concept of TaxiCall had a dominant style of a conceptualiser that is positioned on the boarder with a Generator. He was not employed by LTI;

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<p>Quadrant IV - Implementer Style Creates options in the form of actions that get results and gain acceptance for implementing a change or a new idea</p>	<p>Quadrant I - Generator Style Creates options in the form of new possibilities - new problems that might be solved and new opportunities that might be capitalized upon</p>
<p>Quadrant III - Optimizer Style Created options in the form of ways to get an idea to work in practice and uncovering all the factors that go into a successful plan for implementation</p>	<p>Quadrant II - Conceptualizer Style Creates options in the form of alternative ways to understand and define a problem or opportunity and good ideas that help solve it.</p>

6. The team had an even stronger bias towards "using knowledge for ideation". Basadur et al (1990) defines this as "the generation of options without judgement".

What this shows is a team dominated by people who have a preference for generating and conceptualising ideas. This included behaviours such as fact and idea finding, problem definition. Idea evaluation, selection, action and planning were also present but were not as common or significant in the profile of the team.

Hamel (1998) develops the understanding of the type of people who should be involved the development process. He states that companies have focused on strategy innovation, as a thing, rather than the preconditions that are responsible for it emerging, the later as being responsible for a greater chance of success than the former. He defines five preconditions that are responsible for this type of innovation:

1. New voices;
2. New conversations;
3. New passions;
4. New perspectives;
5. New experiments;

3.5.1 Guidelines

1. Individuals, external to the organisation, are a very productive source of innovative ideas;
2. These individuals often come with ideas, experiences and perspectives very different to those of the company;
3. People who have preference for using knowledge for ideation have been found to perform well in the early stages of the development of an innovative product;
4. Individuals operate and contribute to a company's culture. A culture that supports and encourages innovation needs to be developed and sustained in order to maximise the innovative potential of the people working within a company.

3.6 Organisational Capacity and Structure

In all the cases of the innovations analysed, organisational resource was an essential factor in enabling ideas to be generated, sources of innovation to be accessed and these ideas transformed into defined business proposals. In the case studies analysed, organisational capacity can be defined as putting people, with the appropriate skills and resource, in the right positions of authority, to deliver innovative products and

services. Several models of how to create organisational capacity have been identified from the case studies and literature.

3.6.1 Separate Business Development Units

TaxiCall, as a development project, was managed by LTI Developments, a business unit within the Vehicles Division of Manganese Bronze Holdings Plc. LTI Developments was established in January 2000 with the appointment of Mr Jevon Thorpe as its Managing Director. Mr Thorpe had previously been Managing Director of LTI's factory, in Coventry. LTI Developments would be based on the same site, but as a separate business unit within the Vehicles Division of MBH. Its purpose was to create ideas for new products and services, and develop these into business propositions, without the utilisation of LTI's Engineering or Manufacturing resource.

Four strategic issues were identified:

1. The impact of technology on the taxi industry;
2. The exploitation of the icon (taxi) and other assets;
3. The need for geographical diversification;
4. The desire to build on core competencies.

Combinations of both new and existing products and markets were to be considered, giving a brief that was free within the constraints of the strategic issues identified.

When reviewing the literature, the use of separate business development units was identified. Tushman and O'Reilly (1996), stated that organisations, in the short run, must continually strive to increase the fit, or alignment of strategy, culture and structure of organisations with strategic challenges. Producing discontinuous innovation requires managers to, at the rates technological changes demand, destroy the very alignment they have created in order to create organisations capable of tight alignment with the next wave of technological innovation. The authors state that ambidextrous organisations and managers are required. They need to be capable of simultaneously pursuing evolutionary and revolutionary technological innovation. This finding is supported by Rice and Colarelli (1998) who found that organisational approaches for discontinuous innovation were different to those for incremental innovation in twenty-four out of twenty-seven case studies examined. They both found that discontinuous innovation projects occurred in separate organisational units because they were badly aligned with operating businesses' reward structures. Uncertainty was too high, time lines too long and the investment was too high, given the risks. Markides (1998) also advocates the use of separate organisational units for

developing discontinuous innovation. Tushman and O'Reilly (1996) found that organisations that had been successful at discontinuous innovation used small autonomous groups. These have the benefit of keeping decisions about technology and markets close to customers. Reward systems are tailored appropriately to the focus of the business unit, and economies of scale are achieved via the use of co-ordinated manufacturing and marketing activities. Companies are bound together by a sense of shared corporate culture that values openness, autonomy, initiative and risk-taking. These facets are adapted at a local (business unit) level according to the type of innovation required. Cooper et al (1992) found that, when companies attempted to develop technologies that were fundamentally different to their traditional ones, within existing organisational structures, they were unsuccessful. They failed to appreciate the degree of new knowledge that they would need, and consequently, delivered products to the market that were unprofitable and had high-cost bases. Morale problems also existed between functional groups and teams, over the obsolescence of existing products. Cooper et al do point out that separating incremental and discontinuous innovation can lead to destructive rivalries between two, or more, departments. This was shown to be detrimental to the department responsible for delivering discontinuous innovation.

3.6.2 Within Existing Organisational Structures

Several of the case studies (White, 1999) demonstrated that employees were given the freedom to search for and develop innovative ideas. This freedom has the effect of creating organisational capacity. The following means are used to create this freedom:

1. Allowing employees to spend a percentage of their time working on projects of their own choosing, where there is no direct expectation of specific results or guidance as to what areas (contexts) employees should be investigating;
2. Involvement of personnel, from non-customer facing operations, in talking to customers about their needs and the company's products;
3. Markides (1998) found that companies that deliver discontinuous innovation(s) institutionalise a questioning attitude of the status quo that produces continuous experimentation.

In terms of the organisational structures used to develop innovative products, this research also showed that:

1. R&D staff and designers had direct customer contact rather than through intermediaries such as research companies or a marketing department;

2. Performance in the area of delivering innovative products was rewarded with awards, financial incentives and promotion;
3. The co-location of different functions, or activities, in the innovation process (e.g. Production, Design or Marketing) contributed towards higher perceived performance;
4. Four out of the ten innovations were managed by a partnership, within the company, made up of managers from Marketing and R&D (or Design). This was done in order to find and manage solutions that were technically viable and met customers' needs.

3.6.3 Guidelines

1. The creation of discontinuous innovations often renders current operations redundant, or does not require their experience and inputs. Using separate business development units is a method of creating the distance and capacity to facilitate the process of developing innovative products;
2. New business development units can be a source of considerable conflict within companies due to the perceived threat they pose to current operations;
3. Giving employees the freedom to search for new and innovative solutions in areas, not previously associated with the company, can facilitate creative thinking and activity and enable the accessing of sources of innovation external to the company;
4. Organisational structures need to be aligned with customers' needs in terms of ensuring the right people are talking to customers and working in a manner that ensures their perspectives work in synergy rather than conflict;
5. Rewards for success in developing innovations are used to reinforce what behaviours are considered valued by companies.

3.7 New Business and Product Development Processes that Facilitate Risk and Experimentation

Implicit and explicate processes are responsible for the generation and development of innovative ideas and business proposals. White (1999) identified processes that were aimed at defining products, building business cases, analysing markets and capturing ideas. The result of these processes in delivering acceptable outputs deemed successful, by cross-functional teams, using evaluation criteria, resulted in funding and people being allocated to develop the proposal further.

However, an explicit development process was not responsible for all of the development of all of the innovations studied. TaxiCall was not developed using a formal development process. As it was unique in terms of its composition and focus for MBH, its development meant the company pursued a path that had not been chartered before. A detailed process can only be designed for a process that is understood, and, as this was new territory for the company, it was not. The same argument also applies to measuring the time taken to complete various elements of the process. However, the areas of defining the product and building a business case were focused on.

Two observations can be made concerning the development of the TaxiCall business proposition:

1. Because formal processes were not in place for developing the concept of TaxiCall this does not mean logical steps were not followed;
2. An iterative process of evaluating the project and measuring the time taken to complete tasks was undertaken. This was often referred to in the team meetings and fortnightly updates given to the Chief Executive and Finance Director.

The literature review revealed that to develop discontinuous innovations Lynn (1996) et al discovered that companies probed the market with a series of solutions. This process was undertaken by introducing an early prototype, into a feasible market, with the express objective of learning about:

1. Which customers were most attracted to a product;
2. How receptive customers were to different product features;
3. Whether, and how, production could be scaled-up;
4. Implications of regulations and regulatory approval.

They compared this type of development process with those used in introducing new products that possess incremental levels of innovation. The differences between these two types of product introduction processes are that, the one for developing discontinuous innovations is not aimed at delivering the right product, on time and to cost and quality targets, but rather facilitating the steps that need to be taken to generate the maximum level of information about a product and its potential market(s).

3.7.1 Guidelines

1. In order to successfully develop innovative products certain activities must be undertaken. These are defining products, building business cases, analysing markets and capturing and generating ideas;
2. When companies are breaking new ground, predicting when something can be delivered and how much it will cost, is not always possible. Iterative evaluations of these and other factors, such as partnership development and technologies, need to take place, taking into account past performance and new information about future plans;
3. Processes need to allow for exploring the market with options, rather than producing solution that is right first time.

3.8 Summary

This section has synthesised findings from ten minor and one major case study(s) together with existing theory in the field of the management of discontinuous innovation. It has produced understanding of, and guidelines on how to create the conditions for innovation.

**Chapter Four - Innovation I: The Business of Innovation: A
Training Intervention for Senior Managers**

4.1 The Concept

Submission 1⁷ documents the research, design, development and application of a training intervention entitled the Business of Innovation. The intervention takes the form of a business game that is supported by a lecture and group activity. This innovation fills a gap in the business game and simulation market. It has been designed to address the issue of why companies, who succeed with one technology, often fail to succeed with the one that follows it. It does this by allowing participants to experience why incumbent companies struggle to successfully manage technological discontinuous innovations. The intervention is established on two theoretical bases; the first being the literature on discontinuous innovation, and the second being the literature on the design and use of business games and simulations. The intervention has been used with potential senior managers, and it has been recognised by over 85% of participants as being successful. An outline of the game and the theory underpinning it has been published, (White, 2000)

4.2 The Literature on Discontinuous Innovation

4.2.1 Scope

A detailed literature review was conducted on discontinuous innovation. It sought to address four specific issues:

1. The definition and description of the phenomenon of discontinuous innovation;
2. Defining the scope of the effect of discontinuous innovation in terms of breadth of industries it covers;
3. Understanding why companies fall victim to discontinuous innovations;
4. The identification of the practices managers can undertake to exploit, rather than fall victim to these discontinuities.

4.2.2 Findings

As a result of this literature review the following conclusions can be drawn:

1. When discontinuous innovations enter an industry, they follow a pattern characterised by an initial period of chaos, out of which new dominant-designs or paradigms emerge that replace existing technologies. Firms competing within this paradigm innovate, incrementally or radically in nature, along a given trajectory.

⁷ For full details of the information and arguments presented in this chapter please refer to this document

This innovation is constrained by a dominant-design. As time progresses, a new paradigm emerges that is founded upon a new knowledge base that causes a period of chaos. Out of this chaos new firms, serving new customers, often emerge along with the new dominant design. This view is supported by the findings of Handy (1995) Christensen (1997) Foster (1986) Henderson et al (1990) Tushman et al (1986) Andersen et al (1990) Dosi (1982);

2. Markides (1998) Utterback (1996) Christensen (1997) Foster (1986) Tushman et al (1986) Andersen et al (1990) (1991) Leonard (1995) Henderson et al (1990) Levitt (1975) Sahal (1981) have shown discontinuous innovations to affect a wide variety of industries, from retailing, to computers and automobiles, to pharmaceuticals;
3. The reasons incumbent companies fall victims to discontinuous innovations are complex and vary author by author. However five principles have been identified, all supported by more than one author, that will form the basis of the simulation. These are presented in table 2.

Principle	Reference
Customers and investors, in the short-term, do not want discontinuous innovations.	Christensen (1997) Foster (1996) Leonard (1997)
Companies tend to focus on current operations.	Markides (1999) Foster (1996) Leonard (1997) Levitt (1975)
Investment in discontinuous innovation is difficult to justify.	Utterback (1996) Foster (1996)
Future operations are often not in the interests of the managers of current operations.	Cooper et al (1992) Hamel (1998) Kaplan (1999) Tushman et al (1996)
Incentive structures are designed to reward success in current operations.	Markides (1998) Tushman et al (1996)

Table 2. Principles, from the literature, as to why existing companies often fail to exploit discontinuous innovations.

This literature review presents an overview of the phenomenon of technological discontinuities, who (companies) they affect, why they are affected, and what they can do to benefit from their existence. The studies presented leave no doubt that discontinuities are a real threat to companies and that they affect a wide variety of

industries. However, the detail of the phenomena, due to the narrow focus of some of the studies and industries selected, cannot be validated as being relevant to all industries. Moreover, the same conclusion must apply to the reasons companies fall victim to discontinuities, and what they must do to exploit them. Since discontinuities are about travelling through uncharted waters, an element of luck will always be needed to ensure success.

4.3 Why Business Games?

4.3.1 Possible Training Interventions

Several types of training interventions were identified and are presented in table 3. Each of these interventions were analysed in order that their strengths and weaknesses. This analysis is shown in submission I.

Intervention
Lecture
Discussion
Case Study
Role Play
Simulations and Games
Brainstorming
Coaching

Table 3. Possible training interventions.

Information to define the strengths and weaknesses of these types of interventions was taken from the literature and the author's own insights. As a result of this analysis business games and simulations were chosen as the most appropriate intervention to use. The strengths and weaknesses of business games along with the reasons it has been chosen as the most appropriate intervention are shown in table 4.

Strengths	Weaknesses	Summary
<ol style="list-style-type: none"> 1. Introduces an element of realism (Buckley et al, 1990) (Robinson, 1981) 2. Involves a high level of activity which arouses interest and motivates the participant (Buckley et al, 1990) 3. Participants can make critical decisions in a safe environment (Buckley et al, 1990) (Reid et al, 1997) 4. When present, competition stimulates enthusiasm (Reid et al, 1997) (Robinson, 1981) 	<ol style="list-style-type: none"> 1. Preparation of intervention can be resource (time and money) consuming (Buckley et al, 1990) 2. The effect of participants behaviour on each other; 3. Model can be challenged as unrealistic (Reid et al, 1997) (Robinson, 1981) 4. Time taken to compute results on manual games (Robinson, 1981) 	<p>This type of intervention provides participants with an opportunity to develop a wide set of skills necessary to manage discontinuous innovation. These skills can be tested in an environment that only simulates the consequences so the full effects (often negative) are not experienced.</p> <p>The weaknesses raised by the author can either be significantly reduced or eradicated given the right approach and effort.</p>

Table 4. The strengths and weaknesses of business games and simulations.

4.4 Defining Business Games and Simulations

Several definitions of business games and simulations were identified from the literature. Synthesising these definitions, a picture of business simulations and games is being built that is characterised by the following factors:

1. Business simulations and games exist as single, separate entities, but can also be combined into a joint entity;
2. When combined they represent many of the facets of a business, enabling decisions to be made and the consequences observed, Carson (1969);
3. They require a model to be used that reflects both the environment a company operates within and the company itself, Carson (1969);
4. Rules are used to govern the manipulation of the model by, and behaviour of, participants, Dempsey et al (1996);
5. Competition is induced through the use of participants being awarded scores, governed by rules, either between teams, or teams competing against themselves, Dempsey et al (1996).

4.4.1 Business Game and Simulation Effectiveness

An accepted measure of the effectiveness of a business game and/or simulation is its ability to teach participants how to make better business decisions. Three types of studies have attempted to carry out measurement by this means. The results of the studies for each method of analysis are:

1. To compare the playing or personality attributes of those engaged in the game with their future success in business careers. Objective measures are used such as job advancement, job satisfaction and salary improvement over time (Wolf and Roberts, 1993);
 - Some studies using this method have shown a positive relationship between students' performance in the game and economic performance later in life, Wolfe and Roberts (1986). In a further study they conducted (Wolf and Roberts, 1993), they found results that supported this view. However, Norris and Snyder (1980) found no relationship between these two factors.
2. To compare the performance of participants of the game with the performance of successful executives playing the same game (Wolf and Roberts, 1993);
 - Partridge and Sculli (1982) sought to define whether or not business games teach the skills of management defined by Mintzberg (1973). In post game rankings, by

students and senior managers, the results showed how senior managers' views, about what were important skills in their work, were diametrically opposed to those of student's views concerning factors responsible for success at the game. This was with the exception of "decision making under ambiguity".

3. To compare the performance of participants of the game with students learning by more traditional methods i.e. case based or lectures (Keys and Wolf, 1990);
- In a review of the literature, Keys and Wolf (1990) found that 70% of studies showed students performed better when using games and simulations. In comparing business games to the case study method of teaching, Wolfe and Guth (1975) found that both the game and case study methods were equal in their ability to impart facts, but the game was superior in teaching students to master principles and concepts. Wolf (1997) in a review of the literature said that business gaming applications produced knowledge-level increases and proved superior to case-based learning.

4.4.2 Conditions for Business Game and Simulation Effectiveness

The following factors were identified from the literature as having an effect on the success or otherwise of a business game:

- Game Objectives, Gredler (1992);
- Game Context, Bredemeier and Greenbalt (1981) Wolfe (1985) Gredler (1992);
- Game Architecture, Wolfe (1985);
- Teams, Wolfe (1985) Gredler (1992);
- Game Process, Wolfe (1985);
- Debriefing, Wolfe (1985) Bredemeier and Greenbalt (1981).

These issues have been addressed in the design of the business game.

4.5 Originality

The degree to which the simulation/game could be defined as being novel was judged against four criteria in two specific areas. These areas and criteria are:

1. Context
 - Discontinuous Innovation;
 - Decision Making;
 - Innovation and Technology Management and Strategy;
2. Audience

- Senior Managers (or those identified as being senior managers of the future);
- A schematic demonstration of these criteria is shown in figure 6.

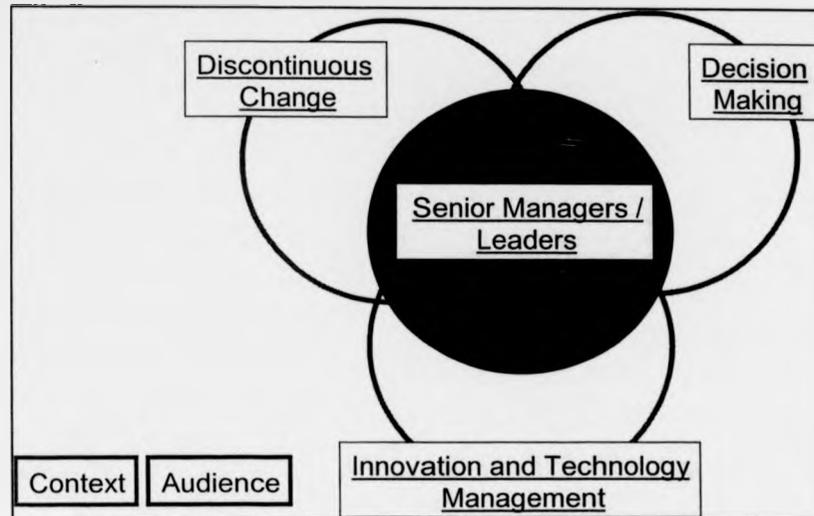


Figure 6. The criteria for accessing novelty.

Using the criteria developed in figure 6, 74 business simulations and games were identified that fit all, or part, of the criteria. Their titles and sources, along with the extent to which they fulfil the criteria, are shown in Submission 1.

74 business games and simulations were identified and analysed. From this analysis the following insights can be drawn:

1. Business games and simulations have been designed to address training needs in a wide variety of industries i.e. from the Swimwear to Boat Building.
2. A large proportion of these interventions are designed to address the training needs of senior managers;
3. Many of the interventions address general business management issues sometimes within the context of specific industries, other times, not;
4. No interventions were identified that addressed the issue of discontinuous change;
5. Ten interventions were identified that address the issue of technology and innovation management.

This demonstrates that there is a gap in the provision of training simulations and games, aimed at senior managers, that simulate the phenomenon of discontinuous innovation.

4.6 Application(s)

The intervention was used with four groups. The detail of these applications and results are presented in the following sections.

4.6.1 Groups

1. Application 1 – A group of six people evaluated the first prototype of the game. Three of these people were Management Consultants in the field of Change Management and New Product Introduction. They all had experience of designing and using Business Games. The other three people were academics, from the University of Warwick, whom were specialists in:
 - Training Intervention Design;
 - Innovation Management;
 - Bio-mass Research and Development.
2. Application 2 – This application was with the Innovative Manager Module (March 2001) that is part of a Manufacturing Excellence Programme run by Warwick Manufacturing Group (University of Warwick) for global pharmaceuticals company, AstraZeneca.
3. Application 3 - This application was with the Innovative Manager Module (June 2001) that is part of a Manufacturing Excellence Programme run by Warwick Manufacturing Group (University of Warwick) for global pharmaceuticals company, AstraZeneca.
4. Application 4 - This application was with the Innovation Strategy Module that is part of a Marconi Masters (MSc) Programme run by Warwick Manufacturing Group (University of Warwick) for the global telecommunications company, Marconi.

4.6.2 Findings

1. The applications of the game led to a number of ideas to be generated for improving the design of the game to be generated. These made it easier for the trainees to understand and the game be more reflective of the business environment in which they work;
2. 86% of the participants felt the game to be of value to their learning experience and of these, 50% thought changes were needed. Only 14% that it was of no value.

This section has shown that, despite that fact that this game was applied in an experimental nature, a clear majority of participants viewed it as being a positive learning experience. The data, gathered from the debrief sessions, would also lead to this view.

4.7 Summary

This chapter has presented the design, development and application of a business game entitled the Business of Innovation. It has described the theoretical ideas upon which it has been based, including a definition of what business games and simulations are and evidence, ambiguous in places, as to their effectiveness. It has defined what issues need to be addressed in ensuring they are successfully designed and applied.

The reasons why the training intervention type was selected and how this concept is original and innovative have been presented. Finally, details concerning how the intervention was applied and evidence for the degree of success it achieved has been discussed.

Chapter Five - Innovation II: TaxiCall

5.1 The Concept

TaxiCall is an innovative solution to the problem taxi passengers face when hailing a vehicle. It provides a means for a passenger to speak directly to the driver of the nearest available "for hire" taxi to arrange a journey. The solution behind TaxiCall is to locate a passenger, calling via a mobile phone or landline, automatically. The nearest "for hire" Taxi will then be selected from a dynamic database and the call routed to the mobile phone in the cab. The driver and passenger will speak, having been connected, arrange journey details and a business transaction will take place. Thus the passengers need for a taxi and the driver's need to maximise his business revenue will be satisfied.

5.2 The Problem

Taxis and Private Hire Cars are an established mode of transport in the UK and many other countries. As an industry it forms a hybrid situation between the individualistic nature of the car with the community aspect of public transport.

This industry suffers from a major inefficiency in the process that is used to bring buyer and seller together. Figure 6 shows an example of a person leaving a theatre, in Central London, and any one of five taxis could potentially supply them. However, owing to the limitations of physically hailing a taxi, and needing line-of-sight and eye-to-eye contact to attract the driver's attention, the passenger does not get a taxi and the driver fails to acquire the business. Therefore, without sight there is no service.

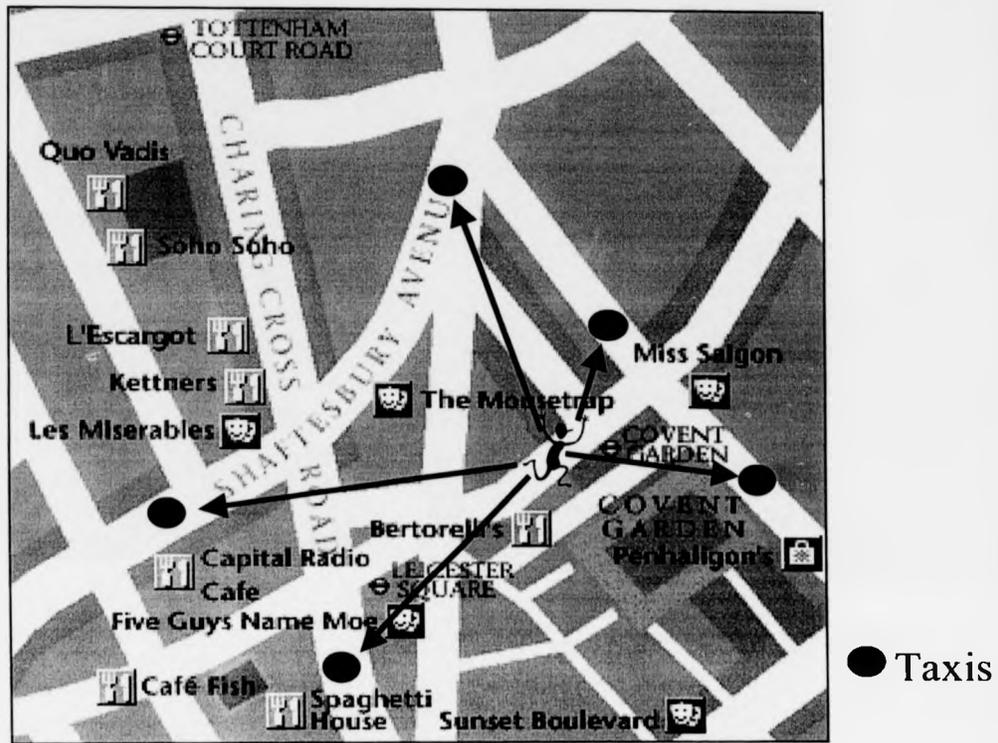


Figure 7. The problem with street hailing a taxi.

5.3 Authors Contribution

During the period March 2000 to March 2001 the author made a significant contribution to the development of the TaxiCall concept. This entailed taking the concept from being an idea, outlined on half a side of A4 paper, to being a full business plan including:

1. Business strategy options identification and analysis.
2. Market analysis that identified what the customer proposition would be, how competitive advantage would be created and what predicted market penetration rate could be expected.
3. A technology specification and outline solution.
4. Marketing communication plan.
5. Detailed business model in the form of a financial plan.
6. Project plan.

A full breakdown of the detail of the author's contribution is given in Submission II, chapter 4.

In order to deliver the business plan LTI needed to utilise technological competencies and market positions that it did not possess. A strategic alliance was chosen as the vehicle to acquire these. A relationship was developed with a major operator within the UK mobile phone market who provided:

1. The use of a data network to transmit taxi status and locations;
2. Joint marketing activities;
3. The provision of additional technological support and services.

The author played a significant role in establishing and defining this relationship. He worked with the Managing Director of LTI Developments in negotiating the type of relationship that would be established. He also analysed various types of relationship concerning what their strengths and weaknesses were.

5.4 Contribution to Manganese Bronze

LTI is a wholly-owned subsidiary of Manganese Bronze Holdings, Plc, a UK-listed engineering company with a turnover of approximately £120m per annum. Work on improving the efficiency of the process that is used to hail taxis has been under investigation, at LTI, since May 1999. In January 2000 LTI set up a new business-unit called London Taxis Developments. Its mission is to exploit the company's icon, knowledge and assets. This would be achieved through moving LTI from being a business that is dependent on one product (Taxis), in one market, (UK), to where it will have several products, (within the Taxi Industry), in a variety of markets, (UK, Europe and the US). TaxiCall is a core project within this business unit.

5.5 The Potential Impact on the Business

5.5.1 The Potential Upside

Over the next 3 years, TaxiCall has an upside potential of becoming a £20m+ business making a significant contribution to the financial performance of MBH Plc. In the medium term, it has the means of re-engineering the taxi industry in the UK and in the long term, 5 years plus, it could change the nature of MBH from being a manufacturing company to a telecommunications solution provider. This is evident when TaxiCall is viewed as a generic concept, devoid of industry association, as it offers a means to improve the performance of both industries e.g. Parcel Couriers, and

Companies e.g. Windscreen Repairers, through the application of the technology developed.

5.5.2 The Potential Downside

TaxiCall will mean an initial investment of £8.5m by MBH Plc. Only through making this investment and realising the market's view of TaxiCall will the business proposal be validated. Should TaxiCall not achieve the target level adoption, by taxi drivers and passengers, there would be a corresponding negative impact on the financial performance of MBH Plc.

5.6 Summary

TaxiCall provided the author with the opportunity to make a significant contribution to the development of a strategic innovation. This contribution involved the use and development of skills in technology, marketing, finance, project management and strategic relationship development. TaxiCall holds the potential to improve significantly the financial performance of Manganese Bronze Holdings, and offers considerable benefits to its customers, both passengers and drivers. A full business plan along with an investigation into the innovation management practices used in the development of TaxiCall is shown in Submission II.

Chapter Six - Conclusions

This Executive Summary has presented the results of a four-year research project, which was conducted with the aim of fulfilling the requirements of the Engineering Doctorate at the University of Warwick. The focus of this research has been to develop innovation in the application of knowledge in the area of creating the conditions for innovation.

Three separate yet interdependent research projects were undertaken as part of this research. These were:

1. The research of ten case studies, focused on the sources and enabling factors of product innovation. Five case studies were from leading innovators and five from the TX1, a taxi launched by LTI in October 1997. Models of the sources and enabling factors of innovation were produced from the data gathered in this exercise;
2. The design and development of a business game that aims to simulate the vulnerability of established companies to discontinuous innovation. The design of the game used theory from research conducted into the phenomenon of discontinuous innovation, and the design, development and application of business games and simulations. This is unique in the field of business games and simulations. The game has been used on training programmes for managers of technology-based companies. 85% of participants found it to be a positive learning experience;
3. The analysis and development of a business concept into a defined proposal, entitled TaxiCall. TaxiCall provides the means for a passenger, using a mobile phone or landline, to call a national rate number. Their call will be forwarded to the mobile phone of the nearest available taxi driver. It was developed as a project within LTI Developments, a business within Manganese Bronze Holdings Plc. This project has gone on to be a business within Manganese Bronze Holdings Plc and it has received £8m funding to establish an operation within the London and UK taxi markets. It has the potential to re-engineer the UK taxi industry and has already become a core part of Manganese Bronze Holdings Plc's strategy.

These three projects provided examples of practice that, through reinforcement with theory from the literature, have been synthesised to produce six conditions for innovation. These conditions have been further developed to the form the production of guidelines for companies on how to create these conditions. These are:

1. The presence of a detailed understanding of customers' expressed and unexpressed needs;
2. The integration of ideas and people from other contexts, perspectives and knowledge bases into the business;
3. Senior management commitment;
4. People who are committed, motivated towards, and capable of delivering, discontinuous innovation;
5. Organisational capacity and structure;
6. New business and product development processes that facilitate risk and experimentation.

Due to the constraints of the case study method used, the results produced need to be considered from the perspective of their wider applicability in companies. The findings presented and conditions for innovation concluded in these studies, may not be transferable to any company without first understanding the specifics of that company and/or industry.

In summary, these conditions advocate how companies, after succeeding in the field of one discontinuous technology, can significantly improve their chances of succeeding in the one(s) that follows it. Through creating an environment that attracts and supports people exploring creative solutions to both existing and new customers' needs, companies can create an environment that is free from the constraints of the past and be able to create its future.

Chapter Severn - Recommendations for Further Work

There are three areas where further work is needed to progress the knowledge of the conditions for innovation and success of the innovations presented in this Executive Summary. Firstly, TaxiCall, at the time of writing continues to progress through the development process. It should be launched sometime in the second quarter of 2002. Once established in the UK market, it holds the potential to be exploited in overseas markets. The opportunities to conduct further research are firstly, how MBH Plc manages the different yet related businesses within its portfolio. Secondly, the issues that they face when seeking to launch and grow TaxiCall, and thus complete the innovation process. The training game invented needs further development. In particular the area of understanding what are the drivers of human behaviour within organisations in the light of the participants' behaviour when playing the game. Moreover the game offers the potential to act as a platform where-by the decisions of senior managers can be modelled and evaluated. Thirdly, the conditions for innovation presented need continual evaluation against the literature within the field of the management of innovation in order to avoid the limitations noted above i.e. the three research projects might not answer all the questions. Finally, the application of these ideas to organisations should be a fruitful endeavour in order to understand how, where and why they may create the conditions for innovation.

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