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Perceptions of innovations: exploring and developing innovation classification

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ABSTRACT

The capacity to innovate is commonly regarded as a key response mechanism, a critical organisational competence for success, even survival, for organisations operating in turbulent conditions. Understanding how innovation works, therefore, continues to be a significant agenda item for many researchers. Innovation, however, is generally recognised to be a complex and multi-dimensional phenomenon. Classificatory approaches have been used to provide conceptual frameworks for descriptive purposes and to help better understand innovation. Further, by the facility of pattern recognition, classificatory approaches also attempt to elevate theorising from the specific and contextual to something more abstract and generalisable. Over the last 50 years researchers have sought to explain variance in innovation activities and processes, adoption and diffusion patterns and, performance outcomes in terms of these different 'types' of innovation.

Three generic approaches to the classification of innovations can be found in the literature (innovation newness, area of focus and attributes). In this research, several limitations of these approaches are identified: narrow specification, inconsistent application across studies and, indistinct and permeable boundaries between categories. One consequence is that opportunities for cumulative and comparative research are hampered.

The assumption underpinning this research is that, given artefact multidimensionality, it is not unreasonable to assume that we might expect to see the diversity of attributes being patterned into distinct configurations. In a mixed-method study, comprising of three empirical phases, the innovation classification problem is addressed through the design, testing and application of a multi-dimensional framework of innovation, predicated on perceived attributes. Phase I is characterised by an iterative process, in which data from four case studies of successful innovation in the UK National Health Service are synthesised with those drawn from an extensive thematic interrogation of the literature, in order to develop the framework.

The second phase is concerned with identifying whether or not innovations configure into discrete, identifiable types based on the multidimensional conceptualisation of innovation artefact, construed in terms of innovation attributes. The framework is operationalised in the form of a 56-item survey instrument, administered to a sample consisting of 310 different innovations. 196 returns were analysed using methods developed in biological systematics. From this analysis, a taxonomy consisting of three discrete types (type 1, type 2 and type 3 innovations) emerges. The taxonomy provides the basis for additional theoretical development. In phase III of the research, the utility of the taxonomy is explored in a qualitative investigation of the processes underpinning the development of exemplar cases of each of the three innovation types.

This research presents an integrative approach to the study of innovation based on the attributes of the innovation itself, rather than its effects. Where the challenge is to manage multiple discrete data combinations along a number of dimensions, the configurational approach is especially relevant and can provide a richer understanding

and description of the phenomenon of interest. Whilst none of the dimensions that comprise the proposed framework are new in themselves, what is original is the attempt to deal with them simultaneously in order that innovations may be classified according to differences in the way in which their attributes configure. This more sensitive classification of the artefact permits a clearer exploration of relationship issues between the innovation, its processes and outcomes.

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Undertaking a PhD, for whatever reason, is a challenge. It is also an indulgence which, curiously for something which is essentially a solitary task, relies on the support and encouragement of others, much of it given unconditionally.

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"A wit has said that one might divide mankind into officers, serving maids and chimney sweeps. To my mind this remark is not only witty but profound, and it would require a great speculative talent to devise a better classification"
(Kierkegaard, 1941; 56).

1 INTRODUCTION

1.1 Introduction

The research reported on in this thesis focuses on the question of the classification of innovations. The research addresses the question of whether or not innovations, conceptualised as configurations of a range of 'attributes'[1], may be grouped into discrete and distinct categories, and consequently classified. Classification plays an important role in the social sciences. Bailey (1994) identifies some of its benefits: classification is an aid to description, it can help to reduce complexity and enable comparison, classifications can be used as the basis for the identification of similarities and differences and contribute to the study of relationships. Classification is then, not an end in itself but has some instrumental purpose. Consequently, although the main contribution of this research is the development of a novel taxonomy of innovation, its instrumentality is demonstrated by its application in the context of innovation process and its relationship to innovation artefact.

It is partly true to say that this research was borne out of frustration. Frustration at being unable to find a satisfactory and justifiable system for the comparison of innovations one against the other. As is often the case though, the devil was in the detail and the apparently innocuous question stimulated a line of enquiry not initially envisaged. The research question has its origins in pragmatic concerns with regard to innovation management in organisational settings but is addressed in a sectoral-specific study, namely the UK National Health Service (NHS). Nevertheless, it is thought that the results of the research can at the very least, be helpful in suggesting propositions that may be generalisable beyond that sector and explored in others.

There is though, also a more fundamental issue that forms the theoretical core of this thesis. By adopting a configurational approach, the thesis investigates how and to what extent a conceptualisation of innovations more sensitive to their multidimensionality presents the opportunity to gain new insights into key innovation management issues.

In this research there are two clear foci of attention: the substantive issue and the context. The substantive issue of the research is the conceptualisation and consequent classification of innovation in the context is the NHS. The purpose of this introductory chapter is to outline the origins of this doctoral research project, to delimit its boundaries and indicate the shape and content of the following chapters.

1.2 Rationale

Change is a fundamental condition of human existence and the potential for change exists wherever there is turbulence within an environment or system (Smith, 1982). The history of mankind is characterised by patterns of crises, turbulence and responses in which the ability to adapt is recognised as being crucial to survival. As members of

[1] The terms 'attributes', 'perceived characteristics' and 'properties' are used interchangeably in the literature to describe individuals' perceptions of their innovations. In this thesis, the term 'attributes' is used throughout.

systems pass through stages of increasing turbulence, their adaptive response mechanisms are challenged by the complexity and change implicit in that turbulence (McCann and Selsky, 1984). Members who face an overload of demand for change relative to their capacity to accommodate that demand must innovate or contemplate extinction. The capacity to innovate is regarded as one key response mechanism in turbulent conditions (Sastry, 1997).

It is argued that the rate of the pace of change in the world continues to accelerate. Many organisations describe themselves as operating in hyper-competitive, turbulent environments where short periods of advantage are punctuated by frequent disruptions (Johannessen et al., 1999). Rapid technological change, shortening product lifecycles, fragmented niche markets, dynamic regulatory environments, increasingly mobile workforces, and changing customer demographics and expectations characterise the environment for many organisations. Many organisations describe themselves as operating in such turbulent environments and in order to remain competitive they must constantly create new strategies, processes, products and ways of working (Nonaka and Yamanouchi, 1989; DTI, 1998). This accelerated competitive environment has highlighted the continued importance of innovation for an organisation's ability to compete, even survive: indeed few issues are characterised by as much agreement as the importance of innovation for social and economic development (Van de Ven, 1986).

Innovation, then, continues to remain important for organisations of all types. In order to meet the demands of a competitive environment, to cope in the face of aggressive product innovation and increased and changing customer expectations, to develop new products for long-term survival or adapt in order to be able to deliver new services as a result of technological change, organisations are required to make changes in order to survive. Giaoutzi et al.’s (1988) view is potentially apocalyptic. They envisage a scenario in which, without morphogenic or morphostatic transformation, economies and organisations would stagnate and eventually crumble.

Understanding, therefore, how innovation works, continues to be a significant agenda item for many researchers. In the field of organisations and management innovation is broadly associated with economic advancement, improved prosperity, health, welfare and education and, advances in knowledge and other human endeavours. Schumpeter (1934) argued that innovations were a most potent source of competitive advantage. If a strategy of innovation can be purposefully chosen as a device for organisational survival, competitive advantage or adaptation, then the processual aspects of its management are crucial. At the most fundamental level, innovation is conceived to be about two things: the processes by which inputs are converted into something new and, the results or outcome of those processes. Innovation is both a process and an outcome.

The concept of organisational survival is suggestive of an evolutionary perspective and whilst this research borrows little from evolutionary theory it does make use of some of its analytic techniques and broader perspectives and so it would be useful to delineate those areas. The management sciences, particularly organisational research and aspects of strategic management research, have already learned much from the biological sciences in which many of the principles and techniques of classificatory science have been developed.

In the same way that there is an enormous diversity of life on earth there is too a diversity of innovations. As biologists communicate with each other about organisms by classifying them into groups so too do innovation theorists with their phenomenon of interest. Ideally, the classification, which is the identification and description of groups, should be meaningful and not arbitrary (though Gold (2002) argues that ultimately all classifications might be described as arbitrary).

Pinder and Moore (1979), for example, describe the succession of criteria used as the basis for delineating between species: first, 'character discontinuity' (physical differences), second 'genetic compatibility' (ability to create progeny together) and, thirdly, 'evolutionary lineage' (commonality of ancestry). Each of these classification systems has developed as a response to insufficiencies in previous approaches. For example, the move from 'character discontinuity' to 'genetic compatibility' was prompted by the observation that

> "*…geneticists continually encountered instances in which plants or animals that were thought to be of a common species could not produce progeny together, whereas individuals from what were thought to be different species were able to procreate successfully*" (Pinder and Moore, 1979: 109).

This research locates itself in a similar school of thought. Existing classification systems are argued to be insufficient and an alternative is proposed. Classification, however, is only one aspect of the much larger field of phylogenetic systematics. Systematics is an attempt to understand the evolutionary interrelationships of living things, trying to interpret the way in which life has diversified and changed over time. While classification is primarily the creation of names for groups, systematics goes beyond this to elucidate new theories of the mechanisms of evolution. In this sense this research is more about classification than it is about systematics. The over-riding objective of the research is to explore the viability of a classification system based on new criteria. However, given that the viability of a system of classification is largely determined by its usefulness (Everitt et al., 2001), observations about the viability of the system are drawn, in this research, from an investigation of the processes underpinning each of the categories in the classification system. This is similar to the case in the biological sciences in which relationships between specie characteristics and evolutionary processes have been a focus.

Darwin famously describes scientists as being of one of two types, lumpers or splitters: Splitters disaggregate phenomena into very small units - their opponents say that if they can tell two animals apart, they place them in different genera, and if they cannot tell them apart, they place them in different species. Lumpers aggregate into large units: their opponents say that if a carnivore is neither a dog nor a bear they call it a cat (Simpson, 1945). That is, splitters maintain that small differences in salient characteristics should be the basis for new species. Splitters might be construed as specialists and lumpers as generalists.

In offering a configurational approach to innovation conceptualisation this research owes a debt to the splitters without whose work the construction of a multidimensional framework would have been considerably more difficult. But, in suggesting a configurational or holistic approach to the study of the phenomenon of interest this research aligns itself with similar approaches in other disciplines. The approach is somewhat reflected in health care, Peckham (1998) underscores the apparent paradox of genetic research tantalisingly holding the promise of understanding an individual's uniqueness and yet people are seeking 'whole person' forms of health care. In strategic management Mintzberg, Ahlstrand and Lampel (1998) want a view of the 'whole beast' of strategy formation rather than just its constituent parts. Finally, in organisational studies scholars have argued strongly for a configurational approach that allows for the analysis of synthesis rather than component parts (Miller and Mintzberg, 1983; Meyer et al., 1993). Each of these is driven by the belief that the configurational approach offers potentially richer insights and understanding, as Miller and Mintzberg conclude

> "*…it can open the eyes of the researcher to the study of whole beasts, each a logical combination of its own characteristics, similar to all members of its own species, yet fundamentally different from those of other species*" (1983; 72).

1.3 <u>Aims of the research</u>

It is held to be common to many PhD projects that the substance of the research question modifies over the lifetime of the study. It has been no different for this research project. An initial research question was posed, structured around the issue of the relationship between team processes and innovation outcomes, gestated over a 10-year period working in a variety of teams in the transitional economies of the former Warsaw Pact countries. Underpinning many of the studies of innovation is the assertion that innovations differ one from the other and that it is these differences that explain variance in organisational performance, innovation performance and innovation process. To research a question in this area required, not least, a stable and constant framework to enable the comparison of innovations, one against another. Whilst many innovation classification frameworks exist in the literature they appear to lack any strong scientific basis and, consequently, the use of them is difficult to justify.

What was found, instead, was a large number of competing classifications, which themselves could be categorised into one of three different types (classification by newness, area of focus and attribute, see Chapter four). The justification for operationalising any of these approaches appears largely to be a matter of analytic convenience and historic convention. In and of themselves each of these approaches and schemes provide the mechanisms by which some sense can be made of the diversity of innovation. However, cumulatively studies operationalising these systems of classification have tended to be associated with inconsistent or contradictory results (Wolfe, 1994). Furthermore, there appears to be no scientific or warranted basis for inclusion in further studies of innovation. Part of the difficulty in generalising from previous innovation studies, with subsequent implications for theory, is the problem of the innovation/context relationship. Innovations are developed and applied in different social contexts which gives each innovation process unique, context-specific characteristics. So, whilst there have previously been attempts to describe the innovative outcomes, comparison of outcomes across cases has been made difficult by local contextualisation rendering generalisation difficult. These confounding observations largely motivate this research.

The dominant theme of the research, which in the early stages focused on team processes underpinning innovation outcomes, consequently became subsumed by the over-riding priority of developing a theoretically-derived and empirically-developed, scientifically derived and practical framework for the comparison of innovations. The focus on process diminished.

It is something of a truism for any of the sciences, that it is on the basis of formal and agreed classifications, that diversity can first be managed and second, begun to be understood (McCarthy and Ridgway, 2000; Hey, 2001). In the absence of a formal, warranted, scientifically justifiable and agreed classification of innovations suitable for operationalisation in large multi-innovation studies, the initial research proposition (comparison of team processes) became untenable. Consequently, an imperative developed to consider how a formal framework of innovation outcome classification might look.

Knowledge creation is underpinned by the availability of widely accepted and usable classification schemes. Differences between innovations tend to have been articulated by invoking one of three categories of classification (newness, area of focus or attribute – see Chapter four). These systems have contributed to the development of a vast body of contextual research but have thwarted efforts to build a cumulative and generalisable body of theory. The premise underpinning this research is that it is due to the inadequacies of under-specification, inappropriateness and absence of scientific method in the classification systems that distinguish innovations that theory tends to remain at a low level. Indeed there tends to be little in the way of mid-range and no general or universal theories of innovation. Such a thing remains beyond the grasp of researchers. The myriad of past approaches to the study of innovation led Wolfe (1994; 405) to observe that "*the most consistent theme found in the organizational innovation literature is that its research results have been inconsistent*" (original emphasis).

Pinder and Moore (1979) provide a useful illustration of how sub-groups of theory might eventually contribute to the development of higher order theories based on a more complete understanding of the various dimensions of the phenomenon of interest (see figure 1-1).

This research proposes an approach to classification that addresses the issues of under-specification and inappropriateness by further developing one of the existing classification systems. This approach, classification according to the attributes of an innovation, has received some theoretical attention but examples of operationalised multidimensional attribute frameworks are rare. A theoretically derived and empirically developed framework is operationalised in order to explore whether or not this more sensitive (in terms of its multidimensionality) conceptualisation contributes to generating new insights into the nature of innovation.

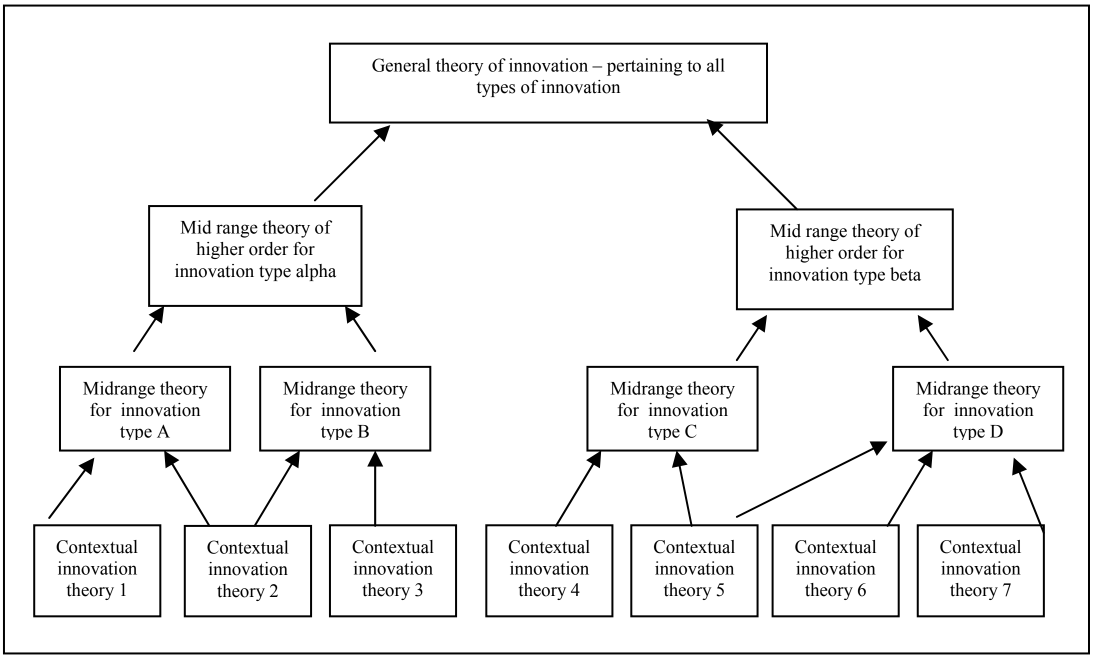

Figure 1-1: Gradual ascension to general theory through the integration of progressively more abstract bodies of midrange theories (Source: adapted from Pinder & Moore, 1979; 108)

The research contends that a conceptualisation of innovation along unconnected, isolated dimensions, as a unidimensional or bi-dimensional construct, is incomplete. A robust and substantive conceptualisation must include a series of dimensions. Further, previous scholars have operationalised existing or modified classificatory systems without questioning the origins of those systems. Whilst these might provide a convenient basis for classification, in highly contextualised studies, their specificity can restrict their use in generating insights across a range of studies.

If innovations can be measured along a series of dimensions, described by their attributes, it would not be unreasonable to expect that innovations would differ, one from another, according to the degree, presence or absence of any of those dimensions. That is, innovations may be distinguished by different configurations of their attributes. The configurational approach is especially relevant to the study of multidimensional phenomena where the challenge is to manage multiple discrete data combinations along dimensions that provide a richer understanding/description of the phenomenon of interest (Ketchen and Shook, 1996). As Chapters three to six demonstrate, innovation can be regarded as a multidimensional phenomenon and the configurational approach adopted for this study makes an important contribution in innovation research. At the heart of configuration analysis is the assumption that by identifying internally consistent and externally distinct groupings of the phenomenon, that hold across all instances of the phenomenon, rich insights and better understanding can be achieved (Ketchen and Shook, 1996).

A configurational approach immediately prompts a series of questions. These questions are listed here for purposes of clarity, but their origination is more fully described in subsequent chapters. Do distinct configurations of innovation exist where innovations are construed in terms of their attributes? Do similarly configured innovations share common origins in terms of process? Hence, the research is underpinned by the assumption that pattern may be representative of process and that the processual origins of innovations may be identified and understood from the identification of similarities and differences in salient distinguishing characteristics (i.e. attributes) of the innovation artefact.

By grouping similarly configured innovations into clusters, any underlying patterning or structuring can provide the researcher with a means of revealing relationships among the observations that is not necessarily possible from individual observations. If the underlying patterning does not directly portray such relationships then at least it may suggest areas for further investigation (Hair et al., 1998).

1.4 Research outline

This section provides a brief overview of the principal methodological features of the study. These are illustrated in figure 1-2.

1.5 Research contribution

Classification is an integral part of innovation research and innovation ‘types’ have been both the dependent and independent variable in previous studies. It is argued that previous approaches have been insufficiently specified resulting in highly contextual studies, poor opportunity for comparative research and the generation of low- and mid-range theory. This thesis builds on previous research that has developed and operationalised frameworks of innovation classification. It augments previous studies that have developed and utilised innovation typologies by empirically deriving basic configurational types from a large base of innovations. In building and proposing a theoretically derived and empirically developed framework of innovation this research fills a well-documented gap in the literature (Downs and Mohr, 1976; Wolfe, 1994) for a robust framework capable of broadly specifying innovations.

This research contributes to the existing body of knowledge by proposing and developing a framework of innovation based on the perceived attributes of the innovation as held by innovators and users. The study also contributes to the movement for a configurational approach in organisational and management studies. Previous studies have tended to conceptualise innovation in narrow terms, on one or maybe two dimensions. The proposed framework has the merit of generality and can thus be deployed for cumulative and comparative research. By facilitating comparisons it promises the opportunity for a series of new insights and propositions on the nature of innovation that can be explored in different contexts and compared back to earlier studies, thereby building up a body of consistent data from which theory development can occur. However, limitations with the framework are also identified and opportunities for refining the research are noted.

ACTIVITY	OBJECTIVE	OBSERVATIONS
Literature Search and Review	Identify gap, develop conceptual framework from a diverse literature: innovation, NPD, services, health care, classification sciences.	Snowballing, conversations database search, authorities, definitionally guided.
4 Exploratory Case Studies	To develop empirically and validate observations drawn from the literature on innovators' perceptions of their innovations and processes.	Personal construct theory, repertory grid analysis, semi-structured interview. Analysis facilitated by NVivo software.
Framework Development	Integration and synthesis of literature and empirical data into a comprehensive but parsimonious framework of innovation.	Content analysis, constant comparison, retroductive method.
Framework Validation	To ensure the validity of qualitative research conclusions.	Case study protocol, data triangulation, structured approach. Conclusions disseminated and validated through conferences & case study teams.
Item Generation	To operationalise the framework in the form of a survey instrument.	Items drawn from the literature and newly generated.
Instrument testing	To establish acceptable levels of validity & reliability.	Validated in pilot amongst discipline and domain relevant experts.
Apply Instrument	To gather data on characteristics of 310 innovations in NHS, drawn from diverse sources.	Postal survey.
Data Analysis	To explore possible cluster solutions for a taxonomy of innovation based on attributes.	Hierarchical and non-hierarchical cluster analysis.
Exploration of Process	To explore the process activities, sequence and enabling conditions underpinning categories of the taxonomy.	9 semi-structured interviews of exemplars and random items from the cluster solution.
Analysis and conclusions		

Figure 1-2: Research outline

Finally, although research into the processes of innovation already forms a sizeable corpus it has been significantly neglected in the context of the NHS. The NHS has recently embarked on an unprecedented journey of change. In the context of medical practice, as clinicians increasingly take on managerial responsibilities, there is a latent demand for frameworks that give new insights into the nature of innovation.

1.6 Structure of the thesis

The thesis comprises of five distinct sections. These sections are described below.

Chapters 1 and 2 set the scene and focus of the research, they include a brief description of the importance of the way in which innovation is conceptualised, how it is conceptualised in the literature and the problems associated with those conceptualisations. The context of the NHS is also discussed and an argument put forward justifying its selection as a suitable context in which to study innovation.

Chapters 3 to 5 review the literature addressing the double issues of classification in innovation research and the development of the conceptual framework and research questions. **Chapter 6** describes the philosophical position, research strategy and method. **Chapters 7 to 10** present the data, results and analysis from three phases of empirical study. The first phase is a study of 4 exemplar innovations in the NHS. The results of this study are integrated with inductively derived data from the literature in order to produce a multi-attribute framework for describing the artefacts of innovation. Subsequently the framework is operationalised as a 56-item survey instrument and administered to 310 innovations in the NHS. Usable responses to the survey numbered 171 and these were subject to cluster analysis techniques in order to provide a systematic and rigorous grouping of items. Cluster analysis delivers a preferred solution of three distinct innovation types. These are then described according to their constitutive characteristics. The three types form the basis of the final round of enquiry into the processes that underpin each of these types. The data and analysis on process is preceded by a discussion of the perspectives on process found in the literature. Nine innovations selected from across the emergent clusters were further interrogated on the processes underpinning their innovations.

Chapter 11 discusses the findings, making links back to the literature and considers the contribution to knowledge made by the study. The limitations of the research are also explored along with implications for practice and opportunities for further research.

1.7 Summary

It is suggested that one way of moving toward new insights and a more generalisable understanding of the nature of innovation is through a multidimensional conceptualisation based on the attributes of innovations. At the heart of this research is a theoretically derived empirically developed formal framework describing innovation outcome. This framework has been developed as a response to calls identifying an absence in the literature of a comprehensive but parsimonious framework capable of facilitating cumulative research.

The principal objective of this research is to develop a new conceptual tool to facilitate cross case and cumulative research in innovation studies. A large number of competing frameworks, that have been successfully operationalised, exist in the literature. This research challenges the approaches to innovation classification that have by historic convention become the *de facto* variables in much innovation research. The objective is to produce a discrete but manageable taxonomy to form the basis of a more sensitive understanding of innovation.

This research builds on previous work by adopting a holistic approach to the conceptualisation of innovation based on the multidimensionality of innovation outcomes. This is accomplished first by combining typologic and taxonomic classifications (Adams and Tranfield, 2002) to create a perceptual framework that informs the development of a survey instrument. Second, the survey instrument is applied to innovations in the NHS and returns subjected to quantitative statistical analysis to yield clusters of innovations whose members are distinct from members of other clusters according to different configurations of attributes.

The framework is deliberately applied exclusively in one sector of the economy, the health sector, specifically the NHS. Generalising the results from one sector into another is clearly problematic. However, concentration of the research focus can help to identify and isolate factors that clarify the nature of the phenomenon in that sector and, at the very least, can be helpful in suggesting propositions that may be generalisable beyond that sector and tested in others (Kimberly and Evanisko, 1981). In addition, given the exploratory nature of this research and the unique circumstances of the NHS (which are expounded upon in the following chapter) this single sector focus is justified.

In summary, this project seeks to develop a useful framework for describing the properties of the products or artefacts of innovation processes. The usefulness of the framework may be determined by the extent to which it facilitates comparison across cases. In doing so a wide range of innovations originating in the NHS are examined according to innovators' perceptions. These innovations are organised into groups according to rules specifying that members of a group are more similar to each other than they are to members of any other group. Subsequently selected examples from each of the groups are further examined with regard to the processes by which they came about. The following Chapter considers the context of the NHS.

2 THE CONTEXT OF THE NHS

2.1 Introduction

During the life of this research project the notion of investigating innovation in the NHS has been met with varying degrees of perplexity, even derision. Eyebrows are raised in quizzical expression as familiar litanies about the inability of the public sector in general and the NHS in particular to innovate and change continually get rehearsed. Regrettably, some of this originates amongst researchers of innovation.

This chapter identifies four reasons justifying the selection of the NHS as a context for the study of innovation. First, characteristics of NHS service are contrasted with characteristics of products from NPD. It is argued that service and product innovations are sufficiently different to suggest that theory generated in one domain may not be generalisable to the other. Second, services in general and healthcare in particular are important features of the UK economy and yet have been neglected in terms of their study. Third, in this chapter organisational characteristics of the NHS are compared against those of organisations from the private sector to determine the extent of similarity between the two organisational types. It is argued that they are sufficiently dissimilar that it is uncertain that results of innovation research generated from studies of new product development (NPD) and innovation in the private sector, from where the bulk of innovation research originates, can reliably be generalised to the NHS. Finally, utilising a framework for analysis developed by Sheth and Ram (1987) it is demonstrated that the NHS is susceptible and subject to similar drivers of innovation as organisations in the private sector. Much of the historical data in this Chapter has been drawn from Rivett's excellent history of the NHS 'From cradle to grave: fifty years of the NHS' (Rivett, 1998).

2.2 Innovation in Products and Services

The separate study of service innovation from product innovation is increasingly being justified in terms of the dissimilarity of the two. Atuahene-Gima (1996) characterised four dimensions along which products and services differ: tangibility, separability, heterogeneity, and perishability. Services can be considered to be intangible, in that they are difficult to evaluate and assess before consumption (Sundbo, 1997). Intangible services are also more difficult to protect from imitation by, say, patenting. Inseparability (simultaneity, synchronicity, co-terminality) describes the concurrent production and consumption of services, which implies the necessity of and opportunity of close connections between personnel and consumers in order to understand better customer needs. Heterogeneity refers to the variability in the quality of services offered. Finally, perishability reflects the fact that services, unlike products cannot be stored thereby leading to problems in matching supply and demand (Atuahene-Gima, 1996). Services, products and the NHS are compared against these dimensions in table 2-1.

Dimension	NPD	Services	NHS
Tangibility	Tangible	Intangible	Predominantly intangible but not easily imitated because of high barriers to entry (e.g. skill requirements, resources).
Separability	Separable	Inseparable	Predominantly inseparable but becoming increasingly separable with time
Homogeneity	Homogenous	Heterogeneous	In principle homogenous, in practice heterogeneous
Perishability	Imperishable	Perishable	Has the potential to be stored in terms of advice given to patients – i.e. if they continue to practice what they have been told. Unlike, say, insurance that in order to be effective requires maintenance of the relationship over time. If the relationship ceases insurance ends – NHS care is not dependent on enduring relationships in this way

Table 2-1: Contrasting products, services and the NHS along Atuahene-Gima's (1996) dimensions

Arguably this separation of products and services is becoming less pronounced, as increasingly manufacturers of products supplement their offerings with extensive service support packages, and product offers often, now, have significant service components as an integral element of the product package (Bharadwaj et al., 1993). As Gallouj and Weinstein (1997) remind us, not only do services provide services but goods, too, provide services. The NHS is a good example of the fluidity of the boundaries that discriminate between characteristics of products and services. And as such warrants focused attention in innovation studies.

2.3 Public and service sector innovation studies

The absence of a significant body of innovation literature addressing public and service sector issues is explainable by the fact that the majority of research has been undertaken in a manufacturing/NPD context, in R&D and technological innovation and innovation in consumer products (Ferguson and Cheyne, 1995; Hobday and Rush, 2000). That is, the literature tends to exclude the service and the public sectors. Clearly the NHS exists in both the service and public sectors.

Table 2-2 gives some indication of this state of neglect. A search was undertaken across three electronic databases in the spring of 2002 for the following keywords in journal article titles: innovation, service* (the * denotes the possibility of service or services), innovation and service* and innovation and health. Between them the keywords 'innovation' and 'service*' generate some 21,044 and 103,736 returns respectively. Combined as 'innovation and service*' they generate only 424 returns whereas 'innovation and health' generates only 202 returns or, 0.9% of the total returns for innovation.

	Social Sciences Citation Index (WoS)	ABI Inform	Infotrac	Total
Innovation	9,421	10,000	1,623	21,044
Service*	58,764	5,829	39,143	103,736
Innovation and Service*	138	108	178	424
Innovation and Health	103	83	16	202
Innovation and Service* as % of innovation	1.5	1.1	10.9	2.0
Innovation and Health as % of innovation	1.1	0.8	0.9	0.9

Table 2-2: Database returns for keyword search on 'innovation', 'service' and 'health'

Culling, to remove duplicates or irrelevant (e.g. where 'health' refers to 'organisational health'), articles reduced by 75% the original total of 202. Table 2-3 provides a brief synopsis of the principal foci of study and methods employed in innovation research in the health sector and demonstrates that there are many gaps for both replication studies and original studies.

Both service and health care innovation are seriously neglected areas of innovation research. Why this should be the case is unclear but it does strongly suggest potential research gaps in the areas of service and, particularly, health innovation. Nevertheless, interest in service and public sector innovation appears to be growing, not least of all because of the growing importance of the service sector in western economies (Atuahene-Gima, 1996). In 1992 private and public services (including healthcare) accounted for almost two-thirds of jobs in most OECD countries (Carroll and Hannan, 1995; Evangelista et al., 1998). Indeed, there is growing interest in health service innovation from several quarters: politically, because it is high on the national agenda; amongst health professionals, as the debate about reform and reorganisation impacts significantly on their work environments and practices; and, increasingly, amongst students of organisational change. Although it is growing, the field remains small. However, it is not safe to assume that results pertaining to private sector new product innovation are generalisable to either health or services innovation. Consequently, the NHS can provide a rich field of study to students of innovation and organisational change.

	Method, predominantly			
Focus of study	**Survey**	**Case study**	**Observations from practice**	**Action research**
Innovation process	Adoption of technological innovations influenced more by individual, organisational and contextual factors than administrative innovations (Kimberly and Evanisko, 1981). Importance of institutional forces to innovation diffusion, particularly in uncertain environments (Walston et al., 2001).	Recursive model of innovation characterised by shocks, setbacks, proliferation of ideas and feedback found to more accurately represent process by which radical innovations come about (King, 1992). Communication of innovations according to perceived attributes influences rate of adoption (Meyer et al., 1997). Not all innovations develop following the same pattern, but each is determined by the radical nature of the innovation (Fernández, 2001).There may be no uniform pattern of innovation diffusion. Diffusion influenced by interplay of multiple factors (Fitzgerald et al., 2002). Observations on reasons for failure to diffuse an exemplar of organisational practice (Peck et al. 2002).	Checklist of tactics to use in order to promote dissemination and adoption of clinical innovations (Wyatt, 2000).	
Group factors	Management concern for control rather than flexibility impacts on nature of innovation (West and Anderson, 1992). Support for Innovation emerged as the best predictor of overall innovation and the only predictor of innovation novelty. Participative safety emerged as best for number of innovations and, task orientation as predictor of administrative effectiveness (Anderson and West, 1998).	Evaluation of TQM at NHS demonstration sites. Mixed results. No improvement in health status found. Highlights importance of top management commitment and need for regard to cultural, structural and systems context (Joss, 1994).		
Roles, behaviour & quality		BPR is difficult to implement in the politicised context of a hospital (Buchanan, 1997). Challenges rationalistic conception of change that underpins evidence-based medicine (Wood et al., 1998). Gains from BPR are contentious, radical change is difficult in public sector organisations, senior management commitment is necessary to secure change (Packwood et al. 1998). Highlights a number of controversial issues unique to health care professionals particularly in the areas of job redesign, multi-skilling and empowerment (Leverment et al., 1998). Success in quality programmes linked with high job security and a co-operative relationship with trade unions. A favourable view of quality was strongest where monitoring was most intense (Edwards et al., 1998). Highlights problems with rationalistic models of behaviour change such as those that underpin evidence-based medicine (Dawson et al., 1999). Clinical expertise is privileged over managerial expertise, and the new organisational position (clinician/manager) is made vulnerable by lack of financial management expertise (Llewellyn, 2001).		Action research methodology used to improve quality in three hospital departments (Potter et al., 1994).
Organisational level innovation	10 year study provides support for the relationship between inter-organisational links and innovation (Goes and Ho Park, 1997). Impression management in a study of organisational restructuring (Arndt and Bigelow, 2000).	Impact of changing structural and regulatory environment on biomedical innovation (Cheng and Van de Ven, 1996).		

Table 2-3: Innovation research in the health sector

2.4 The context of the NHS

The NHS is a dynamic environment in which to study innovation. The NHS, anecdotally the largest employer in the western world and with an estimated expenditure of £75 billion in 2003, has recently embarked on an unprecedented journey of change "*to increase the quality of patient care, ensure better patient outcomes and contribute to improved health in the wider community*" (Cameron et al., 2001; 3). In some respects it shares characteristics with organisations in the private sector but, in many respects, it is a unique organisation. The NHS is contrasted against organisations in the private sector in table 2-4.

NHS	Characteristic	Private sector
High, multiple interest groups	**Politicisation**	Low
Public	**Property rights**	Private
Multiple and conflicting	**Organisational performance measures**	Singular - profit
Low, slow	**Market forces influence**	High, immediate
Constrained	**Behaviour & power of management**	Free
Bureaucratic, risk averse, politically mindful	**Management style**	Risk taking
Professional dominance	**Management context**	Management dominance
Stochastic & susceptible to political fadism	**Orientation to change**	Continuous, perpetual, simultaneous, dynamic
Non-continuous	**Production processes**	Continuous
Complex, differentiated & unpredictable.	**Nature of work**	Largely predictable

Table 2-4: Contrasting characteristics of NHS and private sector organisations (Source: adapted from McNulty and Ferlie, 2002)

The NHS employs more than 70 different professions, ranging from the obvious medical professions through estate management, engineering, legal, financial and administrative occupations. It is a complex organisation with a range and diversity of stakeholders; complex ownership and resourcing arrangements and a professional, largely autonomous, staff sometimes in conflict with management colleagues (Iles and Sutherland, 2001).

In spite of more than a decade's worth of attempts to inject market-type reforms in the NHS, its management style is largely regarded as bureaucratic, risk averse and more attuned to political whim than the needs of patients or staff (McNulty and Ferlie, 2002). Arguably the NHS also differs from private sector organisations in its orientation to change. Spurgeon (1998) employed a construction industry metaphor to describe change in the NHS, rather than building on the previous platform, there has been a tendency of digging up the foundations and starting again. In the private sector there is a sense, much more of change being continuous and simultaneous (Bowen et al., 1994; Bessant and Caffyn, 1997).

Nevertheless, at the macro level, the public sector, it has been argued (McNulty and Ferlie, 2002), is losing its distinctiveness. A series of reforms has attempted to create a more 'business-like' NHS (Rivett, 1998). The intersectoral blurring of the boundaries between public and private health care, the quasi-privatisation of some services, the integration of professional clinicians into management roles and so forth, have all brought the NHS closer to resembling private sector organisations.

In spite of this putative confluence, Iles and Sutherland (2001) point out two important reasons why change in the NHS is different from change in the private sector. First, two professional cadres exist within the NHS, medical and management. Whilst top management support is generally recognised as essential for the successful implementation of change and innovation programmes (West and Anderson, 1996), senior medical professionals have not always seen themselves as members of this (management) group (Llewellyn, 2001). Tensions between these cadres have been identified as a possible reason for apparent difficulties in implementing change within the NHS (McNulty and Ferlie, 2002). That is not to say though, that senior medical professionals are not a significant nor influential group. Second, the scale of the change required in the NHS is considered, by some commentators to be vulnerable to and challenged by the inherent complexity, traditions and power dynamics of public sector organisations (Iles and Sutherland, 2001).

There is no doubt about the pressures for change within the NHS. Since its inception in 1948 the fundamental questions that have tested Health Ministers are 'how is the health service best organised and managed, and how is it to be paid for?'. Since then, management and delivery of services has been a focus of concern for successive national administrations. From its beginnings the NHS has been characterised as being what Mintzberg (1979) has called a 'professionalised bureaucracy', relying on the standardisation of skills as the co-ordinating mechanism. This is partly due to the architect of the NHS, Aneurin Bevan the post-war Labour Government's Minister for Health, famously 'stuffing their mouths with gold' in order to convince medical consultants to sign up to the plan (Rivett, 1998). Senior clinicians, who jealously guard their autonomy and professional authority, have ever since dominated the NHS.

Since 1948 the NHS has been subject to frequent rounds of investigation, restructuring and reorganisation. Some key dates and events in this history are shown in table 2-5, which serves to illustrate the magnitude and frequency of change within the NHS.

Date	Event	Implication	Source
1948	NHS starts	Professional (clinician) dominance commences.	Rivett, 1998
1962	Porritt report	Criticises organisational structure of NHS.	Rivett, 1998
1967	Cogwheel report	Encouraging clinicians to become involved in management.	Rivett, 1998
1974	NHS reorganisation	Regional health authorities replace regional hospital boards. A new tier of management introduced – Area health authorities.	Rivett, 1998
1982	NHS restructured	To 'simplify' the organisation	Rivett, 1998
1983	Griffiths report	Introduction of general management provides momentum for social and organisational change. NHS to be managed rather than administered on behalf of medical practitioners.	DHSS, 1983; Rivett, 1998; Connelly, 2000
1989	White paper, 'Working for Patients'	Introduction of the internal market to tackle problems of resource constraint and increased demand by increasing free market principles and responsiveness to the customer.	Rivett, 1998
1990-1991	Community care act and NHS reforms	Purchaser (Health authorities) Provider (hospitals) principles introduced.	Rivett, 1998
1991	NHS R&D strategy commences	Aims to support a knowledge-based health service in which clinical, managerial and policy decisions are based on sound information and research findings.	Rivett, 1998
1991-1995	All providers became independent NHS Trusts	Trusts to have independent management intended to encourage competition. Many GPs become fund holders. One outcome regarded to be inequality of provision.	Rivett, 1998
1997	White paper, 'The New NHS. Modern. Dependable'	Internal market scrapped.	Rivett, 1998
2000	White paper, 'NHS Plan: a plan for investment a plan for reform	Increased funding announced and challenges of: partnership, performance, professions and the wider NHS workforce, patient care and prevention. Re-shaping the NHS from the patient's point of view.	NHS, 2000
2001	White paper, 'Shifting the Balance of Power'	Tangible demonstration of shift in emphasis to the value that patients always come first.	Rivett, 1998
2002	White paper, 'Delivering the NHS Plan'	Primary Care Trusts replace Health Authorities. 28 Strategic Health Authorities introduced.	Rivett, 1998
2002	New consultant contracts rejected	Demonstration of continuing dominance of clinicians.	Rivett, 1998
2002	Wanless report	Investigation of funding requirements for next 20 years. Resources should be more effectively and efficiently used.	Rivett, 1998

Table 2-5: Key events in the history of the NHS

2.5 <u>Drivers for change</u>

In recent years a momentum for social and organisational change in the NHS has developed. This can be traced back to the Griffiths report (DHSS, 1983). Peckham (1999; 2000) argues for the need to correct the discrepancy between technical sophistication and organisational dysfunction that has resulted from the progressive uncoupling of medical innovation and organisational development within the NHS. Technological progress has outstripped the social and organisational capacity to deliver and there is increasing onus on social and organisational innovation within the NHS to redress the balance (Fulop et al., 2001). Rising user expectations, political and ideological imperatives, pressure to become more 'business-like', competition and accountability, internal discontent amongst staff all exert pressure on the NHS to change. This pressure emanates from multiple and different stakeholders not just on technological change but also for innovation in the way services are organised and delivered (Fulop et al., 2001). These forces are more fully explored below.

The drivers in private-sector, profit-oriented organisations to innovate have been well documented, for example Sheth and Ram (1987) identify four distinct forces responsible for the increasing importance of product and service innovation for organisational survival in the 1990s. These provide a useful framework for considering drivers for innovation in the NHS and, are presented in figure 2-1. Arguably, these forces remain just as potent in the early years of the 21st century and, as with the private sector, the factors driving innovation in the NHS are intricate and interwoven.

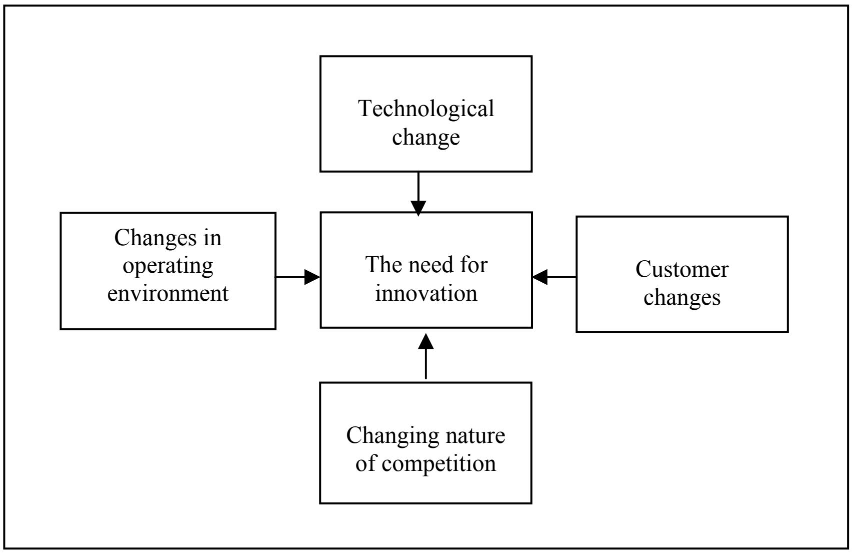

Figure 2-1: Forces driving innovation (Source: adapted from Sheth & Ram, 1987)

2.5.1 Changes in operating environment

Political forces have been instrumental in shaping the modern day health service. From 1948 until 1973 the organisational structure of the NHS remained largely unchanged, since then there have been major structural changes or minor modifications on a regular basis.

Since the 1980s, UK central government has increasingly acted to disturb inherited organisational forms within health care, imposing waves of top-down change (McNulty and Ferlie, 2002), general management, as introduced in the Griffiths report, is an early example. In the belief that consensus management had failed general management of a control and command type was introduced following the Griffiths report. The role of management consequently changed from that of custodian to decision maker. The professional dominance of clinicians was challenged and clinicians continued to be encouraged to adopt the dual role of clinician/manager (Llewellyn, 2001).

At the beginning of the 1990s the Conservative government imposed market-like features (internal competition, separation of purchasers and providers) on the NHS. Subsequently, and in order to address the two major issues of health technology (methods and tools of care, intervention, rehabilitation and so forth) and, the organisation and delivery of services to patients, the NHS Research and Development Programme was introduced (Rivett, 1998).

In 1997 the new Labour administration reversed some of these reforms but, seemingly enamoured of some underlying principles, began to introduce further market-type reforms, such as patient choice. Organisationally, the NHS has vacillated between devolution to front-line decision making and centralisation.

The most recent bout of reform started with the publication of the NHS plan (HMSO, 2000). This laid the groundwork for addressing the specific problems of: a lack of national standards; old-fashioned demarcations between staff and barriers between services; a lack of clear incentives and levers to improve performance; and, over-centralisation and disempowered patients. There is now a plethora of new structures and institutions within the framework of the NHS. Many of these have the remit of redesigning the organisation of the NHS to be patient-centred. They also attempt to optimise or provide a better understanding of the processes of organisational change within the health service (e.g. Modernisation Board, Modernisation Agency, National Institute for Clinical Excellence, Commission for Health Improvement).

Of these the Modernisation Board and the Modernisation Agency are the prime vehicles for change. The former has been established to advise the Secretary of State for Health on the implementation of the NHS Plan. Its role is conceived in terms of three overarching objectives: renewal (tackling historic under investment), redesign (changing the way that services are delivered to make them work better for patients and staff) and respect (in and for the service). The latter, the Modernisation Agency, formed in April 2001, is charged with helping local clinicians and managers redesign local services.

As the NHS Plan states, central to the implementation of the plan is the recently created Modernisation Agency which has been charged with providing the NHS with a centre of excellence as to how knowledge and know-how about best practice can be spread. The plan explicitly commits the NHS to an approach to service redesign that "*mirrors the change management approach taken in much of the private sector*" (NHS, 2000; 60). And, the objective is to continue the journey

> "*…begun with the NHS Plan, which represents nothing less than the replacement of an outdated system…it is time to move beyond the 1940s monolithic topdown centralised NHS towards a devolved health service, offering wider choice and greater diversity bound together by common standards, tough inspection and NHS values*" (NHS, 2002; 3).

This is a challenging agenda for the NHS and includes tackling the over-politicisation of the NHS, excessive centralisation, lack of responsiveness to individuals and communities (King's Fund, 2003) and of prolonged under-investment that has condemned the NHS to operate in a 21st century world with a 1940s system (HMSO, 2000). The impact that these successive reorganisations have had in terms of improved health care, the management of expectations, staff morale, efficiency and effectiveness and so forth are beyond the scope of this research. However, there is an agenda for modernisation that requires a high degree of innovation in the models of health care delivery (Iles & Sutherland, 2001; 81). It is an organisation in a state of change, exemplifying the turbulent environment described in Chapter one wherein the ability to adapt is crucial to survival, and so provides the focus for this enquiry.

2.5.2 Technological change

The quality and nature of health care treatment we receive today is as significantly different from that which our parents received as it will be from that which our children receive in 20 years. More people are being treated in more and complex ways. Much of this can be attributed to advances in medical technology and knowledge. However, new treatments and therapies are only part of the answer to improved healthcare and not the only drivers of innovation in the NHS.

Twentieth century medicine has been characterised by a high level of technological innovation. It is not necessary to list the considerable technological advances that have taken place during the lifetime of the NHS from organ transplants to the coiling of subarachnoid haemorrhages. However, organisationally the NHS has not always managed to adapt to this technological change. Since the creation of the NHS half a century ago, the sharply accelerated pace of research discovery and technological progress has outstripped the capacity of the health service to adapt to change, and has resulted in a progressive uncoupling of medical innovation and organisational development. The misalignment between technology and social application is seen to a varying extent in all health systems (Peckham, 1999).

Technological and clinical innovation have not proved to be synonymous with organisational innovation and the effort expended on product development, and on the advancement of clinical practice, has in the past had little counterpart in organisational innovation and development (Peckham, 2000).

2.5.3 Customer changes

Demographic changes have been well-documented (Sheth and Ram, 1987). Average ages are increasing as life expectancy increases and fewer children are born. The former has implications for long term care and the latter funding the NHS. There is a tendency for parents to have children later in life, older mothers bring new medical issues to be tackled. Coupled with advances in technology and greater access to information society’s expectations from healthcare are greatly increased (Fulop et al., 2001).

The internet has, to some extent, helped to demystify medical practice and create a patient-led health system. It has proved to be a powerful device for informing patients with details of their own problems and putting them in touch with fellow sufferers.

Patients are consequently better informed about their condition, possible treatments and, even, inequity of service. Finally, in the light of recent, but high profile scandals (e.g. Bristol Heart Unit, Harold Shipman, Alder Hey organ retention and so forth) the way in which medical practitioners are regarded within and as members of society appears to have undergone a transition.

2.5.4 Changing nature of competition

Arguably, the NHS has enjoyed a virtual monopoly on health care. Reforms have, however, attempted to create a sense of internal competition and accountability. Increasing internal competition arrived with fund-holding, Hospital Trusts and, at the time of writing Foundation Hospitals, which will have the freedom and flexibility within the new NHS pay systems to reward staff appropriately, and have full control over all assets and retention of land sales, are being considered.

The designation 'National' has always been something of a misnomer implying, as it does, homogeneity and equity across the nation. In reality the culture and style of institutions and disciplines vary one to the other across the country (Peckham, 2000). Foundation Hospitals, it would seem, have the potential to exacerbate these differences. The dominance and autonomy of medical professionals within the health service has given rise to an organisation that is relatively weak at the administrative core (at least in terms of ability to change) but able to effect change at a micro, local level. Peckham (1998) notes that there are micro cultures within the NHS, with different atmospheres and different ways of doing things even though each institution forms part of one system and has comparable responsibilities:

> "*The UK method of organising hospital-based medical staff into consultant firms encourages isolation both of medical decision making and of support when something goes wrong*" (Peckham, 1998; 207).

McNulty and Ferlie (2002) summarise the situation by arguing that the real power has historically rested with loose coalitions of local clinical groups engaged in the incremental development of their own services, so that macro or strategic organisational change across such groups remains highly problematic.

2.6 Summary

This chapter has demonstrated that the NHS is an organisation that exists in a turbulent environment in which the ability to adapt is crucial to its survival. Innovation, as it was pointed out in Chapter one is one potential response mechanism. Using Sheth and Ram's (1987) model of forces driving innovation, the NHS has been identified as being subject to similar pressures for change as affect the private, commercial sector. However, because of organisational level and product/service level differences between the NHS and private, commercial organisations, that sector that has tended to furnish us with the bulk of our empirical settings for the investigation of innovation, it is difficult to generalise back to the health service.

Health care provision, in terms of its technology and the organisational and social structures through and by which it is delivered, is changing rapidly. In the absence of models for innovation and change developed within its own context the NHS has drawn on those that have been developed in the private sector (e.g. Business Process Re-engineering, Total Quality Management, Project Management). A number of these are reviewed by Iles and Sutherland (2001) and are shown to have met with varying degrees of success. This confirms the view of McNulty and Ferlie (2002) that general management models and tools may not be generalisable across industries and sectors but may vary sharply according to the setting.

Further, this chapter has illustrated that a significant difference exists between manufacturing and NPD environments and the NHS. This difference has been demonstrated in terms of both organisational and service characteristics. At an institutional level, the NHS has witnessed, in recent years, considerable structural innovation and more is planned (see the NHS Plan, 2000). Innovation required for improving health care is required in different and multiple settings: government, hospitals, primary care and the community (Peckham, 1999). At the macro level, a changing political imperative has stimulated ideas for public sector reform. Innovation is driven, too, at the micro level by technological, demographic and social change. Indeed, the designation 'National' may be confusing by the implication of consistency across the nation. At the micro level the NHS consists of small, local units. It is not uncommon for treatment protocols for a given condition to vary within the same specialism and across locations. Also, at the local level the NHS is subject to the multiple, occupational professional and interest groups with competing objectives.

The NHS has been demonstrated to be an economically significant institution as determined either by resource requirements or numbers of employees. The quantitative importance of the NHS as an employer and user of resources contrasts with the prominence of its profile in innovation research. The relative paucity of attention given to innovation research in the context of the NHS has been indicated. Finally, the NHS has been shown to be subject and sensitive to similar drivers for change as are experienced by other organisations.

Although the NHS shares some characteristics in common with private sector organisations it is in many respects different and because of these differences it cannot simply be assumed that models and prescriptions for explaining and understanding innovation in the private sector are generalisable to the NHS. New evidence, models and concepts are needed to help explain and understand innovation in other sectors where demands for innovation appear to be equally high. The research focus of this thesis will therefore be innovation in the NHS.

The following chapters scope out the perspective taken on innovation and culminate in the specification of research questions. Initially, a broad landscape view of the innovation literature is taken before moving to a more focused review of that part of the literature relating specifically to classification of innovation and the notion of innovation attributes. In doing so, these chapters will demonstrate, in part, the predominantly manufacturing and NPD origins of innovation studies thereby further corroborating the relative paucity of research in other sectors.

3 CONCEPTUALISING INNOVATION

3.1 <u>Introduction</u>

The study of innovation is characterised by its multi- and inter-disciplinarity and multiple competing perspectives. Researchers impose structures on the innovation literature and its conceptual content in order to manage the volume and try to make sense of it. There is little agreement though, about the 'right' way to structure the literature. As a consequence, research is characterised by its fragmented and inconsistent nature and the suggestion that it has, historically, been of little practical value to practitioners (Barclay, 1992). In spite of the diversity of discipline and perspective there are, perhaps surprisingly, areas of consensus amongst scholars across themes within the domain of innovation. Some themes bestride these discrete disciplines and the review that follows draws from each of these disciplines in order to attempt a presentation of the current 'state of the art', that looks for synthesis across the various disciplines.

For the last 50 years and more, the study of innovation has engaged the attention of researchers from a diversity of disciplines, bringing with them a diversity of perspectives. Early research focused on identifying the characteristics of so-called innovative organisations and an exploration of the events and activities that together comprise the process of innovation. From around the 1980s new and distinct streams of research, which Wolfe (1994) categorises as organisational innovation, innovation diffusion and innovation process research, began to emerge.

The aim of this chapter is to locate the current research within the wider body of innovation literature. The literature on innovation is of tsunamic proportions and this chapter is necessarily an overview, however, it attempts to establish a position supporting the need for integrative studies providing theory-building opportunities predicated on a broad conceptualisation of innovation. At the end of this chapter the research questions are outlined. These questions are explored and elaborated upon in subsequent chapters that present in-depth reviews of specific sub-domains of the field. The review commences with a discussion of ways in which innovation has been conceptualised

3.2 <u>Conceptualising Innovation</u>

Innovation is a broad church. Debate about its nature, processes, extent, location, determinants and consequences is vigorous and wide-ranging. There is no single theory of innovation, Wolfe (1994) was satisfied that there never would be - innovations are not all similar. They do, however, have certain features in common, which include their pivotal role in processes of change and the embodiment of novel combinations of existing and new knowledge.

As a concept, innovation evokes images of mystery, skill, inspiration creative genius, toil and serendipity. The etymological root of innovation is 'innovare' - to renew (Hanks, 1979). Implicit within its origins is, therefore, a sense of newness and change.

However, there has been considerable debate about the meaning, location and nature of 'newness' and 'change' (Becker and Whisler, 1973; Damanpour, 1992).

Various theoretical perspectives have been employed in efforts to understand innovation as it happens across the full range of organisational levels. The emphasis in the literature has developed from one in which innovation was seen as serendipitous, not an activity that can be deliberately pursued but is retrospectively rationalised, to one that regards it as a rational, purposive action (Nelson and Winter, 1982). Early proponents of the rational and purposive view argued that innovation is a problem-driven response to declining organisational performance or to the fear of future decline (Bolton, 1993). Similarly, Nelson and Winter's (1982) evolutionary view is purposive, in which the fundamental mechanisms are the search for better techniques and the selection of successful innovations by the market (Ruttan, 1997). Other perspectives include the population/ecology perspective (Hannan and Freeman, 1984), general systems (von Bertalanffy, 1962) and, contingency theory (Burns and Stalker, 1961). The population approach, in which innovation is a randomly occurring phenomenon distributed through a population of firms over time during which problems and solutions drift together, owes much to the pioneering work of Hannan and Freeman (1977). The population ecology approach is particularly suited to examining how specific forms arise, grow in numbers up to some Malthusian maximum tolerable level and then level out or decline. General systems theory locates innovations in an environment that is pervasive. That is innovation does not stand alone in splendid isolation, rather it is an element of a wider system with which it is integrally connected. Contingency theorists have it that organisation type influences innovation (Burns and Stalker, 1961). Characterising innovation as a purposeful and adaptively rational activity suggests a process, the end of which is a better place to be than at its commencement at the core of which is an explication of the relationships between inputs, processes and outcomes (Cheng and Van de Ven, 1996).

Schumpeter's (1934) view of innovation was broad. He proposed a typology of organisational innovation arranged under five categories: new goods (or modified existing products), new processes, new markets, new sources of raw material supply and the creation of new types of industrial organisation. Implicit within this typology are several of the key themes that have emerged from innovation research in subsequent years. Specifically, typologising innovations (do different types of innovation exist, and with what implications?), the nature of newness (what is it and what does it mean?), and the temporal dynamic (innovation as a process rather than an event).

Newness is conceptualised in several different ways in the literature. Coopey et al. (1998) regard innovation as a particular form of change characterised by the introduction of something new. The 'new' idea may be a recombination of old ideas so long as the idea is perceived as new to the people involved: it is an innovation even though it may appear to others to be an "*imitation*" of something that exists elsewhere (Van de Ven, 1986; 592). The view is endorsed by Zaltman et al. (1973; 10) who define an innovation as "*any idea, practice, or material artifact perceived to be new by the relevant unit of adoption*".

In this view, newness may vary in magnitude and scope. Innovations may be radical (new to the world) or incremental (slight modification of some pre-existing state) and they may impact only the manager's own role or have implications for the whole organisation or a wider constituency (McAdam and McClelland, 2002). The view contrasts with the alternative that considers innovation to be the first use of a new to the world artefact, for example Becker and Whisler (1973) differentiate (by degree of risk) between first users and imitators. This is a minority view in the literature. The assumption that first users necessarily take the largest risk has been challenged and risk has been more sensitively construed in terms of the implied new behaviours that the innovation represents for organisational subsystems and their members. For example Burns and Stalker (1961) observed that the adoption of innovation creates changes in the structure and functioning of an organisation. Nonaka and Yamanouchi (1989; 299) note that "*...eventually new and existing information may be integrated to produce a change in organizational cognitive and behavioural patterns*".

Schumpeter does not dwell on the creative origins of innovations, indeed he makes a strong distinction between invention and innovation. However, invention and creativity are increasingly recognised as integral parts of the innovation process (Amabile, 1983; Amabile, 1988; Amabile et al., 1996; Rivett, 1998; Kirton, 1980; Kirton, 1988; Kirton, 1994). Invention is the creation of ideas, that Amabile et al. (1996; 1155) define as "*the production of novel and useful ideas in any domain*". Successful innovation has its roots in creativity, all innovation begins with creative ideas and, innovation is the successful implementation of creative ideas within an organisation or social context (Amabile et al., 1996). On its own, however, creativity or invention is not sufficient for innovation. Creativity must also be appropriate, useful and actionable (Amabile, 1998).

Dougherty (1992) reinforces the view, she conceives of innovation as the creation and exploitation of new and existing knowledge that links market and technological possibilities. Dougherty's (1992) view includes within it senses of combinations, utility and purpose. Creativity is evidently, then, a part of innovation and, whilst it can be separated temporally and spatially (Holbek, 1988), its isolation from mainstream innovation studies appears largely to have been an analytic convenience.

In addition to being combinatorial, innovation is also a collaborative, social process that brings benefits to identifiable stakeholders or beneficiaries (Van de Ven, 1986; Damanpour, 1990; Dougherty, 1992; Quintas et al., 1997). Innovation rarely takes place throughout the whole organisation at the same time (Rabson and DeMarco, 1999). Innovation is usually a group process (Leonard and Sensiper, 1998) and, much of the early innovation research overlooked the role of the group in innovation focusing instead on the relation of the innovation to the organisation (Dougherty and Hardy, 1996).

In its broadest sense, then, innovation is about the creation and implementation of a new idea in a social context with the purpose of delivering benefit(s). West and Farr's (1990; 9) definition succinctly captures these ideas, "*the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, organization or wider society*",

and is adopted to guide this research.

The key elements of the definition are that innovations are the embodied artefacts of ideas that are new to the context of their intentional use and application and bring benefit. The definition provides a wide perspective on the concept of innovation. It underpins a complex conceptualisation of innovation, implying through the presence, absence or degree of these elements potentially many types of innovations.

There is a range of models, conceptual and empirical, that attempt to encapsulate some of the complexities of innovation. That these derive from diverse scholastic origins and reflect different theoretical perspectives has already been alluded to. Underlying each of these though, is the tendency to adopt a view of innovating as consisting of a series of inputs which is converted by a process to deliver a series of outputs. This input-process-output model has become a widely-adopted generic model for the study of innovation (see figure 3-1).

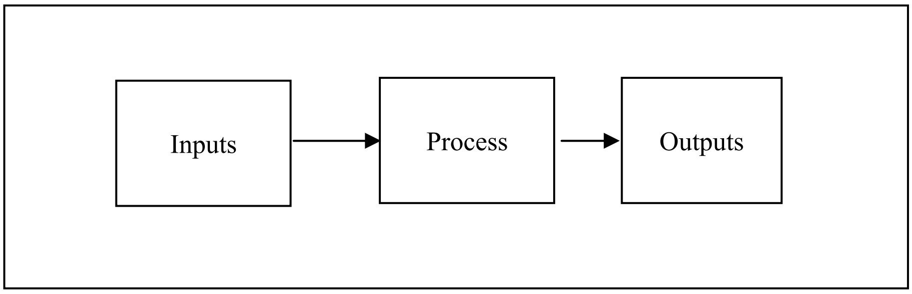

Figure 3-1: Input-process-output model

Wolfe (1994) identifies three distinct streams of research in organisational innovation, which broadly coincide with the framework of the input-process-output model. Wolfe's streams are organisational innovativeness (by which he means the variables antecedent to or predisposing organisational innovation, equivalent to inputs), process theory (process), and innovation diffusion (outputs). A fourth category, one that Wolfe (1994) does not identify as a distinct stream but rather as a factor that should be considered in all innovation research (the absence of which confounds comparative research), is innovation type.

Mapping these categories against the four levels at which innovation research has taken place (individual, group, organisation, supra-organisation) illustrates where the relative weight of effort has fallen (see table 3-1, in which the dotted lines indicate the permeability of cell boundaries). Using this table as a template for discussion the following sections review this literature, takes and expands upon Wolfe's categorisation and, drawing upon the various approaches in innovation research, develops a conceptual framework around the input-process-output model to frame the current research programme.

	Individual	Group/Project	Organisation	Supra-organisational
Inputs	Baldridge and Burnham, 1975; Kirton, 1976; Keller and Holland, 1978; Kirton, 1980; Kirton, 1988; King, 1990; Amabile et al., 1996; Dougherty and Hardy, 1996; Fahey and Prusak, 1998; Amabile, 1998	Bantel and Jackson, 1989; Bessant and Caffyn, 1997; Anderson and West, 1998; King and Anderson, 1990; West, 1990; West and Anderson, 1992; West and Anderson, 1996; Leonard and Sensiper, 1998	(Mohr, 1969; Norman, 1971; Baldridge and Burnham, 1975; Daft and Becker, 1978; Miller and Friesen, 1982; Damanpour, 1992; Bowen et al. 1994; Wolfe, 1994; Dougherty and Cohen, 1995; Dougherty and Hardy, 1996; Chiesa et al., 1996; Damanpour, 1996; Kessler and Chakrabarti, 1996; Subramanian, 1996; Subramanian and Nilakanta, 1996; Teece, 1998; Bommer and Jalajas, 1999; Avlonitis et al., 2001; Nonaka, 1990; Woodman et al., 1993; Scott and Bruce, 1994; Daghfous and White, 1994; Faulkner, 1994; von Hippel, 1994; Nonaka and Takeuchi, 1995; Nohria and Gulati, 1996; Quintas et al., 1997; Coombs and Hull, 1998; Goldenberg et al., 1999; Johannessen et al. 1999; Ruppel and Harrington, 2000	Powell, 1987; Pavitt, 1991; Ondøej, 1993; Joyce and Stivers, 1999; Lawson and Lorenz, 1999; Avermaete et al., 2003; Goes and Ho Park, 1997; Smith, 2000
Process	Boisot et al., 1996; Pitt and Clarke, 1999; McAdam, 1999	Cooper, 1990; King, 1992; Bowen et al., 1994; Agrell and Gustafson, 1994; Anderson and Larsson, 1998; Malach, 1998; Thomas, 1998; Barth, 1998; Fernández, 2001	Burns and Stalker, 1961; Milio, 1971; Zaltman et al., 1973; Warner, 1974; Ettlie, 1980; Kimberly and Evanisko, 1981; Rogers, 1962; Rogers and Shoemaker, 1971; Rogers, 1983; Pelz, 1983; Pelz, 1985; Van de Ven, 1986; Meyer and Goes, 1988; Angle and Van de Ven, 1989; Warren et al., 1989; Nonaka and Yamanouchi, 1989; Schroeder et al. 1989; Van de Ven and Poole, 1989; Kimberly et al., 1990; Stacey, 1993; Page, 1993; Cheng and Van de Ven, 1996; Sundbo, 1997; Koput, 1997; Veryzer, 1998; Noci and Verganti, 1999; Wilson et al., 1999; Poole et al., 2000; Damanpour and Gopalakrishnan, 2001; Feldman and Ronzio, 2001; Martins and Terblanche, 2003	Pouder and St John, 1996; Keeble and Wilkinson, 1999; Ahuja, 2000
Innovation type	Agarwal and Prasad, 1997; Coopey et al.,1998	Fliegel and Kivlin, 1966; Cardinal, 2001	Downs and Mohr, 1976; Holloway, 1977; Tornatzky and Klein, 1982; Heany, 1983; Dewar and Dutton, 1986; Cooper and Kleinschmidt, 1987b; Damanpour, 1988; Cooper, 1990; Henderson and Clark, 1990; Moore and Benbasat, 1991; Dearing and Meyer, 1994; Shenhar et al., 1995; Chesborough and Teece, 1996; Gallouj and Weinstein, 1997; Garcia and Calantone, 2002	Biswas, 2001
Outputs		Bantel and Jackson, 1989; Cooper and Kleinschmidt, 1995; de Brentani, 1991; de Brentani and Ragot, 1996; West and Anderson, 1996; Griffin, 1997a; de Brentani, 2001	Johne and Snelson, 1988b; Damanpour et al., 1989; Damanpour, 1990; Kleinschmidt and Cooper, 1991; Lengnick-Hall, 1992; Griffin and Page, 1993; Ali et al., 1995; Atuahene-Gima, 1995; Atuahene-Gima, 1996; Meyer et al., 1997; Griffin, 1997b; Lynn and Akgün, 2001; Tatikonda and Montoya-Weiss, 2001; Tidd, 2001; Gopalakrishnan and Bierly, 2001	(Rothwell, 1992; Bagchi-Sen, 2001)

Table 3-1: Dispersion of innovation research

3.3 Innovation Inputs

3.3.1 Introduction

Wolfe (1994) circumscribes the innovativeness stream of research with questions that seek to identify the antecedents and determinants of organisational innovation, which tends to be the dependent variable. The results of this work are commonly expressed in terms of either factors that predispose an organisation to innovate or, an assessment of the degree to which organisations are considered to be innovative. The bulk of the research has taken place at the level of the organisation.

A wide range of determinants has been identified. These can be categorised under the headings: structural, resource and people factors.

3.3.2 Structural factors

3.3.2.1 Size

The research history on the relationship between organisational size and innovation is both long and inconclusive. One reason given for the lack of clarity is the use of different measures of innovation and different sampling methods used in operationalised research (Avermaete et al., 2003).

There is considerable research evidence in support of a positive relationship between organisational size, measured by personnel indicators (e.g. number of employees), non personnel indicators (e.g. physical capacity, such as number of beds in a hospital), input/output indicators (e.g. student throughput) and financial resources (Damanpour, 1992) and organisational innovativeness. Damanpour (1992) postulated a curvilinear relationship between size and innovativeness. The evidence though, is inconsistent. Kimberly and Evanisko (1981) found that larger hospitals tended to be more innovative than smaller hospitals, Tether (1998) reported on findings that small firms introduce more innovations per thousand employees than do large firms.

Organisational size has its advantages: the larger the organisation the greater the potential resource available to invest in processes of innovation (Damanpour, 1991). Size facilitates financial slack, provides marketing skills, research capabilities and, experience and, large organisations are presumed to be more capable of tolerating losses than small ones (Kimberly and Evanisko, 1981).

Conversely, large size can hinder innovativeness: as organisations become over-formalised, there is a tendency to practice standardised managerial behaviour and, for lower commitment to innovating becoming evident (Figueroa and Conceiçâo, 2000). Small organisations are arguably more appropriate: they are more flexible, more readily adaptable, more willing to accept and implement change and, are better at enacting the coupling of parts that is required for innovation (Damanpour, 1996). The relationship between organisational size and innovation is mostly positive, though there is high variance. Alternatively, it might be that size is a surrogate measure of several factors that influence the innovativeness of organisations. As Mohr (1969) suggested, size could be expected to predict innovativeness only insofar as it implies the presence of motivation, obstacles or resources.

Pavitt (1991) noted that the average size of innovative firms is increasing but the average size of divisions within those firms is decreasing and that large, innovative organisations are creating flexibility and autonomy by founding smaller more specialised divisions. The implication of this is that, as organisations grow and age, they become more mechanistic and need to find alternative ways of sourcing innovation through delegation to groups or sub-units.

3.3.2.2 Complexity

Complexity, the amount of occupational specialisation and task differentiation within the organisation, is reported to have a positive influence on innovation. The creation of today's complex systems of products and services requires the merging of knowledge from diverse national, disciplinary, and personal skill based perspectives (Leonard and Sensiper, 1998). Greater complexity provides a diversity of specialists and more differentiated units from which collaborative relationships can emerge (Damanpour, 1991). It is well acknowledged that diversity in occupational backgrounds can bring a variety of sources of information to bear, which can facilitate awareness or knowledge of innovations (Amabile, 1998).

However, complexity is not of itself either an adequate or sufficient explicator of innovation. Wolfe (1994) commented that complexity could be a positive influence on initiation but a negative influence on implementation. Baldridge and Burnham (1975) indicated that large, complex organisations with heterogeneous environments are more likely to adopt innovations than small, simple organisations with relatively stable homogeneous environments.

3.3.2.3 Vertical differentiation

Vertical differentiation, measured by levels of hierarchy, has been shown to have a negative relationship to organisational innovativeness. Increased numbers of hierarchical levels increase links in communication channels making communication between the levels more difficult, thereby inhibiting the flow of innovative ideas (Damanpour, 1991). Flatter structures facilitate intra-organisational communication (Packendorff, 1995).

3.3.2.4 Functional differentiation

Functional differentiation, the extent to which an organisation is divided into different units, also known as horizontal differentiation, structural differentiation, departmentalisation, and measured by the number of units (not to be confused with hierarchy) under the chief executive level, has been shown to have a positive relationship with innovation (Damanpour, 1991). Innovation depends on the individual and collective expertise of employees (Leonard and Sensiper, 1998). They illustrate that varying perspectives bring creative abrasion that proves to be a powerful enabler.

The requirement of multifunctionality in complex innovative environments, variously called functional differentiation (Damanpour, 1991), and requisite variety (Nonaka and Takeuchi, 1995) demands a high degree of interaction within innovative groups. Communication, trust, sharing and redundancy make groups a holistic single entity engaged in a single process of expertise, rather than purely as a well-coordinated group of individual contributors (Madhavan and Grover, 1998). Innovation, conceptualised as the embodiment or articulation of new knowledge, acknowledges the primacy of the contribution of individual knowledge to the innovation process. The transfer of knowledge within the group is better seen as a process of socialisation (Pinch et al., 1996) which stresses the importance of social relationships to innovation.

3.3.2.5 Organisational type

The literature on the influence of organisational type on organisational innovation is not clear cut. There appears to be inconsistency in the use of terms and, there is a high degree of variance in results. Burns and Stalker (1961) differentiate between mechanistic and organic organisations. Similarly, Miller and Friesen (1982) propose and test 'entrepreneurial' and 'conservative' models of innovation, and Dougherty and Hardy (1996) investigate the relationship of mature bureaucratic organisations with innovation.

Mechanistic, mature, bureaucratic and conservative firms are found variously to have negative impacts on innovation or positive impacts on some types of innovation. Mechanistic organisations are best-suited to stable conditions and innovate incrementally (Burns and Stalker, 1961), the conservative model describes product innovation as something that takes place only when absolutely necessary (Miller and Friesen, 1982) and, bureaucratic control has a negative influence on innovation (Cooper, 1979a). Administrative intensity, however has been shown to have a positive influence on administrative innovations (Damanpour, 1991; Damanpour, 1996; Damanpour, 1996). According to Burns and Stalker (1961) organic organisations are well-adapted to changing, unstable conditions and are able to yield more radical innovations. The entrepreneurial model predicts innovation to be a continuous feature of the organisation.

3.3.2.6 Longevity

Research has indicated a curvilinear relationship between innovation and organisational age. Various dimensions of longevity have been identified at different levels of study: the age of the organisation, maturity of the innovating group and, the tenure of individual members of the group. As the group matures practices become more institutionalised, routinised and habitual, the boundaries of individual and group activity systems become narrowed, attention tends to revert to local issues rather than to the whole system, inter-relating becomes careless, collective mind gradually decreases and so does propensity to innovate (Leonard and Sensiper, 1998).

King and Anderson (1990) report that research scientists are more creative if *not* assigned to permanent groups and that relatively short-lived groups should be formed, at least, for creative processes to take place. Dougherty and Hardy (1996) observe barriers to sustained innovation in the structures and processes of mature organisations. Yet, conflicting influences are evident here. Organisational longevity contributes to organisational cohesiveness which, in turn, facilitates innovation because it allows for high psychological and participative safety (West, 1990). There are, too, incipient risks of 'group-think' (Janis, 1971) associated with the homogenising effects of maturity and cohesiveness when concurrence-seeking over-rides appraisals of alternative courses of action and becomes the dominant mode of thinking within the group.

3.3.2.7 Centralisation and formalisation

Centralisation, the concentration of decision making authority at the top of the organisational hierarchy and, formalisation, the degree of emphasis on following rules and procedures in role performance, have both been shown to have a negative impact on organisational innovation (Burns and Stalker, 1961; Damanpour, 1991).

High centralisation, measured by the degree of organisational members' participation in decision making or freedom to make their own decisions, inhibits the initiation of innovation. It restricts both channels of communication and information availability within the organisation (Burns and Stalker, 1961). Similarly, high formalisation prevents the initiation of innovative solutions. Damanpour (1991) found it also to hinder implementation of innovations, though other studies have demonstrated that it might enable implementation (Holbek, 1988). Rigid rules and procedures may prohibit organisational decision-makers from seeking new sources of information (Vyakarnam and Adams, 2001).

3.3.2.8 Routines

The concept of organisational routine is an interesting one. Levitt and March (1988) describe routines as involving established sequences of actions for undertaking tasks enshrined with a mixture of technologies, formal procedures or strategies, and informal conventions or habits. In this sense, routines reflect highly context-specific knowledge, embedded in organisational practice that has developed over time through experience and practice. Thus routines become the mechanisms that transmit the lessons of history, and are postulated to have an existence independent of particular personnel and are unique and difficult to imitate (Levitt and March, 1988). Therefore, organisations 'remember' through repeated actions and practices, which are socially embedded and communicated through personal contact between workers, rather than by exclusive reference to manuals and checklists.

Pentland and Rueter (1994) distinguish aspects of routines into 'effortful accomplishments', the more formal and codified aspects of organisational life, and 'automatic responses' the more uncodified or taken-as-given aspects. Tranfield and Smith (1998) postulate that routines have within them cognitive, behavioural and structural aspects which are constantly being adapted and interpreted such that formal policy may not always reflect the current nature of the routine.

Thus, shared-taken-for-granted routines are part of an organisation's culture. Routines have been demonstrated to both enable and hinder innovation. Routines enable in the sense that they provide recourse to patterns of taken-for-granted problem solving. They hinder in the sense that it may prove difficult to unlearn knowledge that is tacit and fully embedded into routine behaviour (Lawson and Lorenz, 1999), in which case they may become core rigidities (Leonard-Barton, 1992). Indeed, when knowledge is primarily tacit in nature and routines are deeply embedded it is difficult for individuals to think beyond the constraints inherent to routines (Jordan and Jones, 1997).

Routines, sets of regular and predictable patterns of organisational behaviour (Fitzgerald et al., 2002), can both enable and hinder innovation. Some groups follow algorithms and have routines imposed on them. Groups that have been socialised have stocks of tacit knowledge about how they previously combined tacit knowledge, and will work better together than teams that have not worked together before. Effective teams begin with a shared prior knowledge of how things ought to be, explicated, perhaps, by leadership and vision (West, 1990) or articulated by artefacts and symbols (Kreiner and Schultz, 1995), and from which learning will proceed (Levinthal and March, 1993).

3.3.2.9 Structural factors – conclusion

The brief review of structural factors has demonstrated that the relationships between structural factors and innovation are ambiguous and contingent. Underpinning each of these factors though, is the sense of a social environment in which they are utilised. Whilst size *qua* size might not be a determinant its presence or absence might indicate flexible autonomous environments, which, in turn, might be constrained by levels of vertical differentiation, formalisation and centralisation. Similarly, complexity privileges diversity and heterogeneity, studies of longevity suggest that the social dynamic becomes less effective as relationships mature beyond a certain point. Finally, it would appear that no organisational type is clearly more suited than others for innovation. Daft's (1978) dual-core model, Holbek's (1988) innovation design dilemma and Rabson and DeMarco's (1999) model of innovation systems (see Chapter ten) attest to this. Consequently, variance might be expected across different structural configurations.

So, whilst an important consideration in understanding innovation, structural factors are not the only story. Daft (1978) reports that the values of leaders toward change are better predictors of new programme adoption in health and welfare agencies than the structural characteristics of the agencies. In more recent years, therefore, the structural factors approach has given way to a focus on other factors, notably resource and social factors.

3.3.3 Resource factors

The Resource-Based View suggests that sustainable competitive advantage can be achieved through the expeditious exploitation of resources internal to the firm. The resource-based view explores the link between a firm's internal resources, which are defined as all assets capabilities, organisational processes, firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency (Barney, 1991), and performance. The resource-based view provides a useful theoretical framework in which to consider resources for innovation.

Grant (1996; 110) interprets the resource-based view as presenting the firm as a "*unique bundle of idiosyncratic resources*", that are optimally deployed. Barney's (1986) framework for exploring whether or not a particular resource might be a source for sustained advantage emphasises that, in order for them to contribute, resources must be unique, valuable, rare, imperfectly imitable, and capable of being operationalised by the firm. That is, they must be heterogeneous across organisations; exploit opportunities or nullify threats; be difficult to trade, to copy or, to imitate. Teece et al. (1997) describe the ability of an organisation to combine its competencies and resources advantageously as its 'dynamic capability'. This suggests a purposeful approach to innovation and is consistent with Tranfield and Smith's (1998) view of strategic advantage being driven from the 'inside-out'.

The following section reviews those resources that the literature proposes influence innovation: knowledge, technical knowledge, slack, functional differentiation, specialisation and, professionalism. Nonaka (1995) advocates a planned allocation of resources for innovation to take place and, that this allocation should be deliberate. Resources do not always flow smoothly to innovation, particularly where prevailing practice supports established activities (Dougherty and Hardy, 1996) and, where innovation falls outside the boundaries of this 'normality'.

3.3.3.1 Knowledge

Competitive pressure and the rapid and pervasive growth of information and communications technologies have forced companies to review the sources of their competitive advantage. This has resulted in a focus on both innovation and knowledge and, the concept of knowledge has received a deal of attention in recent years. The concept of knowledge has emerged as a strategically significant resource for the firm (Grant, 1996; Milio, 1971; Mintzberg et al., 1976) and has been asserted to play a significant role in the innovation process (Song and Montoya-Weiss, 1998). Indeed, the complexity of skills and processes needed in the development of today's products and services requires that managers attend to the processes of managing knowledge combination as the very basis of innovation (Leonard and Sensiper, 1998).

Mingers (1990) conceptualised innovation as both an exploration and synthesis involving a process of the combination and exchange of knowledge (Nahapiet and Ghoshal, 1998). Galunic and Rodan (1998) report that firms are encouraged to innovate by searching out new resources or finding new ways of using existing resources. Sometimes innovation consists of a recombination of knowledge and other resources that were previously in existence (Cooper, 1988b).

Grant (1996) suggests that organisations accumulate knowledge over time, learning from their members. Organisational knowledge is created through the interactions of individuals. Diverse and disparate individual knowledge is moulded, integrated and reconciled (Grant, 1996) with the collective whole through story-telling (Brown and Duguid, 1991), metaphor and analogy (Nonaka and Takeuchi, 1995) and, common cognitive schema (Weick and Roberts, 1993), which may or may not come to be captured in explicit form.

In the course of this review, three models have been identified that present the notion of knowledge as a fundamental component at the core of the innovation process. These develop contingent explanations of the management of the knowledge dynamic: the knowledge spiral (Nonaka and Takeuchi, 1995), and competing renditions of a social learning cycle (Boisot et al., 1996; Pitt and Clarke, 1999).

The knowledge spiral (Nonaka and Takeuchi, 1995) presents an abstracted view of the interaction between tacit and explicit knowledge in a continuous process of exchange, combination and new knowledge creation. Boisot (1995) describes a four-stage social learning cycle which, arguably, maps the movement of technical knowledge around a system and suggests a paradigm of a manageable knowledge creation process. Pitt and Clarke (1999), on the other hand, suggest a much less manageable process in which the diverse, idiosyncratic, experiential knowledge of individuals is diffused in social settings commonly, but not necessarily, on a face-to-face basis.

Pitt and Clarke's (1999; 305) is a "*master-apprentice model…wherein neither party may know explicitly what has been transmitted or gained from any particular encounter*". They make a powerful claim that, whilst the two models of social learning can exist concurrently, the directed learning of Boisot's model may be insufficient to cope with the challenges of radical new knowledge creation. In the Boisot model we recognise a routinisation of the innovation process exemplified by 'ghettos' of research and development. It is suggestive of a tendency to address problems through the application of fundamental, but constraining, R&D routines.

Pitt and Clarke's (1999) model illustrates a more distributed process of knowledge creation which, although less manageable, presents a fluid adaptive framework for the creation of new knowledge. The implication of their model for the role and management of knowledge in innovation is that, although the outcome of the innovation process cannot be predicted, it can be facilitated by creating environments that recognise the significance of social interaction as the lubricant of knowledge generation and dissemination.

3.3.3.2 Technical knowledge

Technical resources and technical knowledge, measured by the presence of a technical group or technical personnel, has been shown to have a positive impact on technical innovation. The greater the extant technical resources within the innovating system the more likely new technical innovations can be understood (Damanpour, 1991). The construct is similar to that of administrative intensity which posits a relationship between the ratio of managers to employees and administrative innovativeness. This is echoed by Daft's (1978) dual-core model of innovation that argues that administrative innovations emanate from the administrative core and technical innovations from the technical core (see Chapter ten).

3.3.3.3 Slack

Slack is defined as the "*pool of resources in an organisation that is in excess of the minimum necessary to produce a given level of organisational output*" (Nohria and Gulati, 1996; 1246). Evidence in its support as a positive resource for innovation is somewhat equivocal and a curvilinear relationship has been postulated (Damanpour, 1992). Slack resources, items of excess inputs such as redundant employees or unused capacity, are regarded by many as an important catalyst for innovation. Typically financial measures of slack are used (Damanpour, 1991), Miller and Friesen (1982) though, used both financial and human measures of slack. Slack allows innovations, derived exogenously, to be purchased; allows failures to be absorbed; provides the opportunity for diversification; frees up management attention where it is scarce, or focused principally on short-term performance; allows for a relaxation of controls; fosters a culture of experimentation; and, protects against the uncertainty of project failure (Leonard and Sensiper, 1998). Even though a positive relationship may be identified between slack and innovation, there is evidence though, suggesting a negative relationship: slack can become synonymous with waste; a reflection of self-interest, incompetence and sloth and, represents a cost that is unnecessary and should be eliminated.

3.3.3.4 Specialisation

As with functional differentiation, specialisation has been shown to have a positive relationship with innovation. Measured by the number of job titles, a greater variety of specialists provides a broader knowledge base (Kimberly and Evanisko, 1981) and increases opportunities for the cross-fertilisation of ideas (Damanpour, 1991).

3.3.3.5 Professionalism

The professional knowledge, measured in numbers or percentage of staff with specified educational backgrounds, of organisational employees has a positive relationship with innovation: it has been shown to be positively related to high levels of self-esteem, develop confidence and is associated with increased boundary spanning activities (Damanpour, 1991), which positively impact innovation.

3.3.3.6 Resource factors - conclusion

The literature review has shown that innovation is reliant on diverse resource inputs and, that social processes mediate knowledge creation and application. However, a tension exists between the need for enduring secure relationships for effective resource utilisation and the diverse heterogeneous relationships recommended by innovation theory. Consequently, it is argued that social factors are integral to understanding innovation.

Each of the resource factors examined here has been demonstrated, though occasionally under certain contingencies, to have a positive impact on innovation. There is some equivocation about the relationship of slack with innovation. Different approaches to the generation of new knowledge would appear to result in different types of innovation. For West and Anderson (1996) resource availability does not predict overall group innovation.

It is evident though, that knowledge, explicit or codified, and its exploitation in the innovation process is augmented through facilitating personal interaction and social relationships. Exchange of resources is a prerequisite for innovation to take place, occurring through social interaction and coactivity (Nahapiet and Ghoshal, 1998)

A wide and diverse range of skills and processes is needed for the development of today's product and service requirements (Nonaka and Yamanouchi, 1989; Leonard and Sensiper, 1998). This diversity is brought together through the combination and exchange of knowledge in highly interactive, mutually dependent social contexts.

3.3.4 People factors

The role of the individual in innovation receives little attention in the literature. There seem to be two reasons for this. First, innovation tends to be conceptualised as a social process with impact on a wider (though possible small and proximal) community and the contribution of the individual is often overlooked (King, 1990). Second, at the individual level, 'innovation' and 'creativity' tend to be terms used almost interchangeably and the two literatures overlap (Amabile, 1988; Marshall, 1993).

Indeed, the notion of individual innovation is partly dismissed by Dougherty and Hardy (1996) who suggest that primary reliance on individuals is inherently ineffective for sustained innovation. However, extant literature on the contribution of the individual to innovation divides into two categories: first of all demographic profiles of the individual – age, sex, education, cosmopolitanism, tenure etc. Secondly a description of an individual's propensity or disposition to innovate or be creative.

3.3.4.1 Demographic

Baldridge and Burnham (1975) indicated that individual demographic factors such as sex, age, cosmopolitanism and education did not account for differences in innovative behaviour between individuals. More recent research has though, challenged these findings and suggested that individual demographic factors do have a role to play.

Members with high levels of education and self-esteem increase the effectiveness of research and development project teams (Kessler and Chakrabarti, 1996). Bantel and Jackson (1989) noted that individuals of greater educational attainment with diverse backgrounds managed the more innovative teams. Whilst individual variables have a role, organisational level variables, argue Kimberly and Evanisko (1981), particularly, are better predictors of innovation. From a longitudinal study of 27 top management teams in the health sector, West and Anderson (1996) concluded that the quality of innovation may be determined by team composition and that the proportion of the team that is innovative predicts innovation radicalness.

A study of 199 banks by Bantel and Jackson (1989) showed a positive relationship between innovation/problem-solving and the characteristics of the top management team – age, tenure, educational background, function. The more innovative banks were managed by more educated teams that were diverse with respect to their functional areas of expertise. Intellectually heterogeneous groups are more innovative than homogenous ones (Leonard and Sensiper 1998).

However, putting a diverse collection of people on teams will not of itself deliver innovation. Too diverse a team creates too many diverse frames of reference and, a lack of balance amongst members' commitment and ability to contribute to the various activities of innovation (Kessler and Chakrabarti, 1996).

Group composition has been seen, therefore, to have a significant impact on innovation, and a curvilinear relationship between the two might be postulated to explain the interaction.

3.3.4.2 Disposition

Kirton's (1976) Adaption Innovation Theory argues that it is within the capacity of all individuals to be innovative, that which differentiates people is the extent to which they are prepared to consider solutions that exist outside the existing paradigm. He postulates a continuum of innovative personalities, polarised as 'adaptors' and 'innovators'. Adaptors characteristically produce a sufficiency of ideas, based closely on existing understandings of the problem and likely solutions. Innovators, on the other hand, tend to generate a large number of ideas, and, in seeking a solution, separate the problem from existing, customary models of thinking to emerge with much less expected, and invariably less acceptable, solutions.

However, the innovation literature reveals tensions. Creative people are argued to be self-motivated, risk orientated and expert in their relevant subject matter but averse to social conformity (Kirton, 1994). Finding a way for highly creative people to interact and share knowledge effectively with others within co-operative systems and collective activities may be one of the key challenges in the management of innovation (Angle, 1989).

Innovation can also be conceptualised as a problem-solving process (Bessant and Caffyn, 1997). Dougherty and Hardy's (1996) study of innovation in mature organisations argued that the key to effectiveness appeared to be the approach to problem-solving. They suggested two aspects of problem-solving are relevant to innovation: approach and cognitive style.

First, Dougherty and Hardy (1996) and, Jordan and Jones (1997) suggest individual style and procedural approach influence innovation outcome. Their dimensionalisation of the procedural approach to problem-solving dichotomised a trial-and-error approach against a heuristic approach. Problem solving in general has trial and error as a prominent feature (von Hippel, 1994). Where a large amount of knowledge is integrated in a process of problem solving or innovation, we would expect to see an iterative process of trial-and-error. Individuals may have preferred approaches and groups may have procedures thrust upon them. The heuristic approach will constrain freedom to explore alternatives beyond the scope permitted by the parameters of the algorithm. That is, where routines are embedded and rigid we would not expect to see similar levels of trial-and-error and thus a reduced level of innovative newness.

Second, cognitive style. Scott and Bruce (1994) describe a conceptualisation of problem-solving as two independent modes of thinking: associative and bisociative thinking. Associative thinking is based on habit, following a set of rules and routines and, the use of rationality and logic: systematic problem-solving working within established routines and boundaries. Kirton's (1976) adaptors are similar and prefer to try to do things better through improvement and amendment.

Bisociative thinking is characterised by overlapping several domains of thought simultaneously, with a lack of regard for existing rules and boundaries. They call this 'intuitive problem-solving style' and argue that it is more likely to generate novelty. This method of problem-solving is similar to that of Kirton's (1976) innovators who choose effectiveness over efficiency and break or ignore rules. The 'overlapping' style can exist as an individual cognitive style, as has been described, also at a group or organisational level. Nonaka and Takeuchi (1995) describe this as redundancy, i.e. information that exists beyond immediate operational requirements. It is "intentional overlapping" (Nonaka and Takeuchi, 1995).

3.3.4.3 People factors - conclusion
The review of people factors has emphasised the importance of collective activity in the pursuit of an innovation agenda, and also a cognitive approach that is able, depending on the extent to which it is able to challenge the orthodoxy, to generate innovations of various hue. Innovation may have roots in individual creativity and invention but it has been argued that this alone is insufficient for an enduring innovation strategy.

The contribution of the individual to innovation within a social context is moderated by: trust and time-served relationships (Coopey et al., 1998), levels of autonomy and supportive collaboration, feedback and recognition, organisational cultural and physical structure (King, 1990), reward systems (West and Anderson, 1996), individual discretion (Scott and Bruce, 1994), and encouragement of creativity, resource availability, pressure and organisational impediments (Amabile et al., 1996).

3.3.5 Inputs - summary

A wide range of input factors ordered under three category headings have been reviewed. The findings of structural research have tended to be ambiguous, or at least difficult to generalise widely. Similarly, resource factors, although held to be an important determinant of innovation across a variety of contexts, are best understood within the context of a social process, able optimally to exploit their latent potential. Finally, the role of dispositional and demographic characteristics were reviewed. Diversity, approach to problem solving and tenure leading to a comfort factor were held to be important. To understand innovation, therefore, this section concludes with the proposition that understanding social processes is an integral factor.

3.4 Innovation Process

3.4.1 Process Background

Process research addresses the nature of the innovation process, how and why innovations emerge and grow. Process has come to be conceived as a temporal, path-dependent phenomenon (Schroeder et al., 1989; King, 1992; Koput, 1997) that is a collection of tasks or activities which together transform inputs into outputs (Garvin, 1993).

Singular development activities or events are fitted into categories of stages or phases of a temporal innovation process[2]. The literature is broadly consistent in its view on constituent parts of process. First, that, at the macro-level, innovations are initiated and then implemented (Zaltman et al., 1973). Second, that these macro-level phases consist of sub-phases. The number of sub-phases varies across studies (see table 10-1, Chapter ten), though eight have been identified by Pelz (1983), and 13 by Cooper (1988a).

The nature of the process has been shown to be affected by a range of factors such as organisational structure (Burns and Stalker, 1961; Daft, 1978; Holbek, 1988), environmental factors (Tidd, 2001) and, innovation attributes (Pelz, 1983). Pelz's

[2] Avlonitis et al. (2001) provide a useful illustration of this event/activity listing and subsequent categorisation (pp. 339).

(1983) study of urban innovations found, for example, that the innovation process appeared to differ according to the radicalness of the innovation. That is, simple borrowed innovations were developed and implemented in a clearly identifiable sequence of phases, whereas for original complex innovations the 'sequence' was overlapping and disorderly.

Scholars continue to disagree as to the specific nature of these processes and, indeed, the extent to which the various events and activities that comprise the process are both necessary and sufficient in all cases of innovating and the nature of their pattern of occurrence.

At the level of the individual, research focus tends to be on creativity and the creation and diffusion of knowledge and the factors that inhibit or facilitate these processes (Boisot et al., 1996; Pitt and Clarke, 1999; McAdam and McClelland, 2002). At the group level two themes emerge. The first originates in the project management literature where the project is seen as a microcosm of the larger organisation and is its agent of change (Bowen et al., 1994). An over-riding objective of project management is to deliver projects on-time and on budget, and so the processes of change tend to be acutely managed to reduce time to market and improve utilisation of resources (Guellec and Pattinson, 2001). The characteristic view of project management is as a vehicle to create order and control through a determinant and closed process of following prescription and rules (Thomas, 1998). It is generally reckoned that the more ordered processes of innovating, where, perhaps, process is strongly prescribed, the opportunities for delivering radical innovation are constrained.

The second theme that the group/project literature addresses is that of the social environment in which innovation occurs. The factors said to affect group innovation include team size, group climate, heterogeneity, vision, leadership style and group cohesiveness (Agrell and Gustafson, 1994). The boundary between the group/process cell and group/input cell in table 3-1 is permeable, and a number of studies combine aspects of both innovativeness and process factors (King and Anderson, 1990; Meyer et al., 1999; West and Anderson, 1996).

At the organisational level, process research focuses principally on understanding the core activities in which innovators engage and the order in which they occur. Most recently chaos theory has provided a theoretical perspective for understanding process. A picture of innovation has emerged that is chaotic in its early stages, or as Kim and Wilemon (2002) call it the 'fuzzy front end', and is characterised by periodicity in the final stages (Cheng and Van de Ven, 1996). Prior to this view process was considered to be an ordered sequence of events (Zaltman et al., 1973; Rogers, 1983) or less orderly, characterised by feedback and feed forward loops (Schroeder et al., 1989; King, 1992).

Finally, research at the supra-organisational level relates network-ties to innovation output (Ahuja, 2000) and considers the environmental, socio and institutional factors that exist within geographic regions that create favourable conditions for the creation and exchange of knowledge. These studies echo, though at a macro-level, the results of studies at the organisational and sub-organisational level, emphasising the importance of social processes in the creation and exploitation of knowledge for innovation. Importantly, they add a dimension not seen at the other levels of innovation research (or at least it is made explicit) and that is importing essential technological and managerial expertise from outside the cluster (Keeble and Wilkinson, 1999).

3.4.2 Process – summary

Two clear themes are evident in process research to date: those that focus on core activities and those that focus on the surrounding enabling processes. Von Bertalanffy's (1962) description of organisational processes as collections of activities, involving many people, that unfold over time is particularly apposite and privileges the social in addition to the temporal and sequential. Pentland's (1995) view of processes, as sequences of actions that occur in the context of enabling and constraining structures, permits a wider conceptualisation of process as opposed to one framed simply by time and sequence of events and the innovation process can be construed as being facilitated by social processes that run concurrently within the context of innovators' relationships. These themes are returned to in Chapter ten.

3.5 Innovation Type

3.5.1 Type Background

The notion that there are different kinds of innovation, with different organisational, economic and competitive effects, has long been an important theme in the literature (Schumpeter, 1934; Cooper and Kleinschmidt, 1987b; Robb, 1989; Henderson and Clark, 1990; Burningham and West, 1995; Neely and Hii, 1998). Consequently, typologies of innovation play an important role in the whole genre of innovation research. 'Type', by which is meant the classification of innovations according to a specific scheme (of which there are several in the literature) of innovation has been used extensively as an independent variable in innovation research. Type has been shown variously to impact on adoption and diffusion of innovations (Rogers, 1962, 1983; Rogers and Shoemaker, 1971; Damanpour, 1988; Damanpour, 1990), organisational and innovation performance (Cooper and Kleinschmidt, 1987a; Cooper and Kleinschmidt, 1993; Danneels and Kleinschmidt, 2001) and innovation process (Pelz, 1983; King, 1992; Fernández, 2001).

Three different typographic approaches are most commonly used in innovation studies. Of these, approaches which categorise innovations according to their functionality or domain of application (hereafter 'area of focus') or according to degree of newness are the most frequently occurring. Examples of the former include administrative, technological, process, service and product innovations. Examples of the latter include simple dichotomisations between new to the world innovations and innovations involving only minor changes (variously known as radical/incremental, revolutionary/evolutionary, discontinuous/continuous etc). More sensitive conceptualisations of newness that dimensionalise the space between the polar extremes of radical and incremental exist. Garcia and Calantone (2002) identify typologies of degree of newness comprising ranges of from three to eight categories. The third approach is that which focuses on the attributes of an innovation.

It has been established that different types of innovation (based on any of the three typologies) impact differently on factors in the innovating process and the innovation output (Garcia and Calantone, 2002). It is the contention of this thesis that two of the approaches (area of focus and novelty) are inadequate and the third (innovation attributes) is under-developed for generalisable and comparative purposes. First, although it is widely agreed that no two innovations are the same, the area of focus approach tends to treat them as unitary phenomena – all process, for example, innovations are treated as the same or similar. Studies occasionally differentiate area of focus innovations by degree of newness (Damanpour, 1990) but these are rare. This debate is more fully explored in Chapters four and five.

This unidimensional style of research continues despite the observation, made through the history of innovation studies, that innovations differ one to another. One powerful and sensitive means of distinguishing between innovations is according to the developer's or user's perspective (Warner, 1974; Downs and Mohr, 1976; Rogers, 1962). Indeed, Zaltman et al. (1973) define innovations as entities perceived by the relevant unit of adoption. They argue that the distinguishing characteristic of innovation is that, instead of being an external object, it is by the perception of the social unit that it is recognised. Thus it can be, for example, that the same 'administrative' innovation can be perceived completely differently in different social units. In simple terms this might mean that Organisation A perceives the innovation to be radically new whilst Organisation B considers it only marginally new. Such divergence clearly has implications for the differential management of innovation in Organisations A and B.

However, according to West and Farr's (1990) definition that guides this research, innovation consists of more than simply newness, whether radical or incremental. Indeed, there is a growing body of studies that is re-evaluating the utility of continued researches based on more intricate and contextual measures of newness (Garcia and Calantone, 2002). For the moment though, there is little agreement on the specifications of a universal measure of newness.

Certainly newness is a fundamental and important aspect of innovation, but it is only one part. Innovations are complex, multidimensional phenomena and the literature is replete with evidence of a wide range of perceived attributes of innovations. These are reviewed in Chapter five.

3.5.2 Type – summary

Typologising in innovation studies, and in any of the scientific disciplines, helps to manage the diversity and reduce the complexities of multidimensional phenomena. However, the typologies operationalised in innovation research appear not to have a foundation of scientific derivation. Rather, it would seem that the most, apparently intuitive categorisations of innovation artefacts, area of focus and degree of newness, have, by convention, become the default independent variables for many innovation studies.

There is no universal agreement on which is the best justified of the typologies to operationalise in innovation research. In the absence of this, cumulative research is hampered (Calvert et al., 2002). The case for a classification of innovations based on their psychometric properties developed according to scientific principles begins to be made. Such an approach will further enhance our understanding of the complexity of the phenomenon and its associated processes and origins and is developed in the following chapters.

3.6 Innovation Output

3.6.1 Output Background

Intuitively, it is not difficult to recognise the contribution that innovation makes to competitive advantage (Tidd, 2001). This output has generally been construed in terms of financial, market or organisational performance. Measurement is undertaken principally at the level of the organisation or industry and includes factors such as: numbers of patents (Rogers, 1983), contribution to turnover (Figueroa and Conceiçâo, 2000), research and development expenditure (Goffin et al., 1997), market share and market growth (Tidd, 2001). Furthermore, few studies have focused on the performance of the process of innovating. For example Keller (1986) considered budget and cost performance, meeting the assigned schedule and value to the company.

There is a tendency in these studies to treat innovations as unitary phenomena, such that it becomes difficult to distinguish between the innovation and the performance. Consequently they are best suited to industry-wide benchmarking activities. At the level of the innovation though, the approach contributes little to theory or practice and tells us very little about the innovation itself. Short term financial indicators can undervalue innovation, for example where research and development expenditure is treated as a profit and loss item, as opposed to being capitalised, earnings per share are reduced (Tidd, 2001). Number of patents, measures of market growth and so forth do not tell the whole story. The measures might identify some organisations as innovative but they do not tell anything about how they do it, or from where the innovations come.

Furthermore, implicit in the approach is the assumption that outputs of the processes of innovating are directly related to the process: that is, the activities in which innovators engage and the mode of their engagement, influence the resultant outcome. However, this relationship is far from clearly established in the literature other than to suggest that some types of temporal/sequential activities are related to innovation novelty (King, 1992). The argument that output and process are related has theoretical and practical implications. Empirical work establishing that different outputs of innovation are related to different dynamical processes can be useful in developing our understanding of innovation, particularly if developed within a framework that will permit comparisons across future studies. Further, there is a practical application in helping organisational leaders understand the requirements of their innovating systems. The choice of systems cannot be made solely on what is most comfortable for the organisation Tidd (2001) but has to include, also, recognition and acceptance of the process characteristics needed to achieve the desired result (Rabson and DeMarco, 1999).

Finally, output performance research focuses intently on the role of novelty or newness as a factor of success. Research is principally reported in the New Product Development literature where the results are inconsistent. For example, Avlonitis et al. (2001) concluded an inverted U-type relationship between degree of novelty and financial success, on the other hand, Kleinschmidt and Cooper (1991) observed a U-type relationship between innovativeness and commercial success.

Consequently, it has been difficult to establish any strong empirical relationships between the inputs, processes and outputs of innovation where the relationship is based on an unmodified input-process-output model (Tidd, 2001; Goffin and Szwejczeski, 2001). Indeed, there is a multitude of other factors, beyond the control of the actors and the innovation, that can impinge upon performance, for example a recession (Howell and Shea, 2001). It is also conceivable that an innovation in one domain of an organisation might be in conflict with the objectives and mission of the whole organisation. In the UK NHS, for example, innovative methods for the diagnosis and treatment of illness, particularly those that divert significant resources and skills from other parts of the service, may detract from the mission of the NHS to provide a "*universal service for all based on clinical need, not the ability to pay*" (NHS, 2000; 3).

3.6.2 Innovation output - conclusion

Studies addressing financial and market performance measures suggest a preoccupation with efficiencies in the processes of innovation or with economic indicators. These contributions pay less attention to what it actually is, the artefact, that the process of innovation produces. Dubiety also exists about the extent to which the relationship between organisational performance and an individual innovation can be determined. Because of the difficulty of establishing empirically any strong relationships between degree of novelty and innovation performance/success, new perspectives are beginning to develop. An alternative perspective, therefore, that argues a role for the innovation artefact as the mediator, the middle ground, between process and performance, has recently gained currency in the literature.

3.7 Conclusion

Innovation has been introduced as a complex and multidimensional phenomenon. Coming to an understanding of the state of innovation research demands the tolerance of high levels of ambiguity. In this brief synopsis the objective has been to present an understanding of how researchers have tried to make sense of the diversity of the phenomenon of innovation and, several important themes have been highlighted.

Modifying Wolfe's (1994) conceptualisation, four streams of research have been identified (organisational innovativeness, innovation processes, innovation type and the output of innovation) in studies that take place across levels ranging from individual to supra-organisational. Furthermore, a wide range of factors have been indicated to influence and relate with each of these four streams at each level of research (see table 3-2).

Stage	Characterised by
Inputs	Variables predisposing organisations to innovate, some are quasi-controllable such as structure, resources and people. Others are not, such as environmental factors: world events, technology, demographic change, relationships etc.
Process	The sequence of events and individual activities taking the organisation from input to output. Also the interactions among group members; information exchange; patterns of participation in decision making; social support and sanctions for group related behaviour; and combination and exchange of knowledge that provides for a conducive climate.
Outputs	The innovation output, for example: number and kinds of innovation; rates of diffusion the products of the group's performance; and, the diffusion of the innovation.
Type	Categorisation according to area of focus, nature of newness or, attributes of an innovation.

Table 3-2: The input-process-output model of innovation

As the field of innovation research has developed the permeability of the boundaries between the levels and streams of research has increased. And, whilst on the one hand knowledge and understanding would appear to have moved forward. On the other though, research strategies and operationalisation of concepts have delivered an output characterised by its contingent qualities. The consequence is the generation of mid- to low-level theory.

Two perspectives on process were introduced. In addition to the core activities of innovating, there is strong theoretical and empirical support to the importance of facilitating social processes to optimise opportunities for successful innovation. Innovation takes place within the context of interpersonal interaction and social relationships the enaction of which influences the output of the process. It is a process that can be conceived of as taking place within a system characterised by intentionality, flexibility, social collaboration and, the combination and exchange of knowledge resources to produce beneficial outcomes.

The direct link between process and output, commonly construed in terms of organisational performance, in the input-process-output model, that underpins much innovation research, has been empirically difficult to establish. This latter approach tends not to differentiate between the innovation and organisational performance. However, the stream of research that has been identified as ‘innovation type’ would offer the opportunity to bridge the empirical gap between process and output. Several studies have linked process to artefact and artefact to output. This body of work motivates a re-drafting of the input-process-output model with the process-output relationship moderated by artefact.

Three approaches to operationalising innovation artefact research were subsequently identified. Anticipating the debate in Chapter five, two of these approaches are argued to be inadequate for generalisable, cumulative research. That which considers the area of focus of innovation treats 'types' as unitary phenomena and fails to take account of the fact that innovations differ one from another. The 'newness' approach was shown to be inconsistent in both its conceptualisation and application and not to be a sensitive enough measure of the innovation artefact. The third approach, innovation attributes, was felt to have potential but was in need of further development. A focus on an approach that privileges perceptions of innovations as the basis for classification challenges many of theses engrained approaches and has implications, at least for the re-evaluation of, extant theory that posits certain relations between processes of innovation and output. Previous classificatory approaches tend to be based on convention, analytic convenience and individual bias rather than on a scientific approach. Only in recent years, after a decade of calls (Wolfe, 1994; Calvert et al., 2002; Garcia and Calantone, 2002; McCarthy et al., 1997), have researchers begun to make concerted efforts at comprehensive approaches to classification.

In order to advance our knowledge of innovation, not only is a consistent typology an essential prerequisite but that typology must also be based on a meaningful conceptualisation of innovation – is novelty enough? The multidimensionality of innovation is too complex and varied to be understood within a narrow perspective. An approach that looks for distinguishable patterns and meaning among its many attributes is that which identifies composites of states that are labelled gestalts, archetypes and configurations (Miller and Mintzberg, 1983). The implications for innovation research of developing the configurational 'attribute' approach to conceptualising the innovation artefact are significant. Principally, a validated framework is required and subsequently relationship between configurations, process and output can then be empirically explored. This clearly identified research gap can be summarised by the question:

Based on a multidimensional conceptualisation of innovation artefact, construed in terms of attributes, do innovations configure into discrete, identifiable types?

This over-arching question triggers a set of sub-questions:

- **How do innovators perceive their innovations?** Little empirical evidence is evident in the literature, most frameworks having been derived from revisiting the framework initially developed in Rogers and Shoemaker (1971) and Rogers (1962; 1983).

- **How might a parsimonious, scientifically-developed framework of attributes of innovation appear?** There is no evidence that innovation research is based on universally agreed, formal, scientifically developed taxonomies of artefact.

- **Can different innovations be described in terms of different configurations of attributes?** Is a taxonomy based on attributes of innovations valid? Does it perform the function of classification in helping to manage and understand?

- **What are the distinguishing attributes of the different innovations?** Assuming the validity of the taxonomy, on what basis do the different taxa differ from each other?

- **Do innovations differentiated by attributes exhibit different processual origins?** Previous research (for example King, 1992) has suggested a relationship between innovation types and processual origins.

These questions drive this research over the following eight chapters, the first of which explores the role of classification in innovation studies.

4 A PHILOSOPHY AND PRACTICE OF CLASSIFICATION IN INNOVATION RESEARCH

4.1 Introduction

The previous chapter concluded by posing a series of questions relating to the classification of innovations according to different configurations of attributes. This chapter presents a review of classification in innovation studies. It opens, however, with a discussion of the ontology and epistemology of classification and traces a series of principles and guidelines to help in its practice. Subsequently, three approaches to the classification of innovation are described: classification according to newness, innovation area of focus and by attributes. The origin of each of these classificatory approaches and their roles as categories of classification are briefly explored. Finally, the limitations of the three approaches are discussed in the context of proposing an alternative approach. The chapter concludes that, in innovation studies, the reliance on time-served approaches to classification that lack a strong scientific basis has led to multiple idiosyncratic operationalisations of measures, which hampers comparative research.

4.2 A philosophy of classification

Sweet is the lore which nature brings;
Our meddling intellect
Mis-shapes the beauteous forms of things:
We murder to dissect.

The Tables Turned
William Wordsworth, 1798

Wordsworth's Romantic persuasions led him to be critical of science's clinical dissection and categorisation of nature's beauty, a phenomenon that he considered to be indivisible. Earlier in the century (1737) Carl von Linné had written

> "*All the real knowledge which we possess, depends on methods by which we distinguish the similar from the dissimilar. The greater the number of natural distinctions this method comprehends the clearer becomes our idea of things*" (quoted in Everitt et al., 2001; 2).

Wordsworth's view has not prevailed and individuals appear to make sense of and navigate their worlds by categorising their experiences into groups or classes on the basis of their similarity and, subsequently, appending theories to them. Through the ability to recognise different entities, organisms or individuals as belonging to different groups, generalisations and predictions may be made about the world (Everitt, 1995). Such grouping of objects, according to specified criteria, considered similar to each other has played a pivotal role in facilitating mankind's understanding of his universe and, it is argued (Meyer et al., 1993), is the basic orientation of human beings.

The practice of classification, of sorting items into categories has been central to research and sense-making in a multitude of disciplines (McCarthy et al., 2000). It is an important technique in the natural and social sciences, providing a method for organising large amounts of multivariate data. Different class labels can provide a parsimonious way of describing patterns of similarities and differences in the data (Everitt and Dunn, 2001). For Everitt et al. (2001) classification performs three functions:

- Management of data: Classification provides a means of dealing with large and complex volumes of non-classified data (McCarthy, 1995). Through the reduction of complexity, description of cases, comparison of similarities and differences amongst a diverse population of items, classification permits large amounts of data to be allocated into sets, be more easily managed and better understood (Bailey, 1994). Consequently, theorising can adhere more closely to the principle of parsimony.

  Meyer et al. (1993) call this 'codification' and suggest that it is widely used in the social sciences, particularly where phenomena are complex and multidimensional. The conceptual challenge that complexity and multidimensionality offers can be, at least partly, met by classification that allows the opportunity of sensemaking through configuration and/or pattern recognition (Ketchen and Shook, 1996).

- Prediction of events: Classification underpins predictive endeavours, for example making prognoses about different classes of disease or illness. Hypotheses can be developed and laws tested based on clearly demarcated, homogenous groupings of entities. That is, there is a key contribution to generalisability to be made from classifications generated from salient characteristics (McCarthy, 1995). Classification in innovation studies has been widely used in pursuit of this predictive goal, not least of all in attempts to understand and explain the determinants of innovation diffusion and adoption (Rogers, 1983; Damanpour, 1991; Moore and Benbasat, 1991; Dearing and Meyer, 1994).

- Explanation of phenomena: Classification helps frame studies exploring causation, provoking such questions as 'do different classes of object have different origins?'. Classifications provide conceptual frameworks that describe and aid understanding of complex phenomena and which may be useful in other areas of organisational research (McCarthy, 1995).

Others have identified similar purposes of classification, for example Bailey (1994) and Good (1965). Good (1965) offers: 1) for mental clarification and communication, 2) for discovering new fields of research, 3) for planning an organisational structure or machine, 4) as a check list, 5) for fun, as the purposes of classification, and most authors appear to be broadly in agreement with these.

The origins of classificatory science would appear to lie in the Aristotelian and Platonic discourses on animal and plant classification that sought to establish the complex differentiae and genera central to definitions of living things. Differentiae are those properties by which entities (or species, items, objects etc) within the same genus are distinguished from one another (for example distinguishing between human, horse and cat within the animal kingdom), which Plato calls 'the collection and division of kinds'. The list of properties that distinguish kinds, once identified, form (in the Aristotelian/Platonic paradigm) the fixed essence of that entity or species, which came to be known as 'natural kinds' or 'natural types' (Audi, 1999).

This 'Classical' approach was based on the premise that nature designates and demarcates categories into which entities fit, and remain: so-called 'natural types'. These pre-Darwinian biological classifications of species were held to be immutable, part of the unchanging make-up of the universe. Darwin's idea, which is now more commonly held, was that species are not eternal, that they change over time and that consequently boundaries between them are not sharp (Dennett, 1996). Previous classificatory approaches were shown to be highly persuasive but little more than pre-scientific intuitive judgements based on comparative similarities (Audi, 1999).

One consequence of Darwin's thinking, at least in the biological sciences, is that the target or subject of classification is considered to be moving. Species are argued to evolve. That is they change gradually over time and so do not display the formerly requisite characteristics of species (categories): eternality, immutability and discreteness - 'natural kinds'. Part of Darwin's contribution was to challenge the established classifications of the day and permit the development of classificatory approaches based on criteria of data management, predictive capacity and causal explanation. That is not to say though, that the debate regarding the ontological basis of classifications or the fixedness of boundaries between categories is any closer to being resolved.

The biological sciences are possibly the most practised of all the sciences in the techniques and philosophy of classification but have yet to recover from Darwin's challenge. The debate as to whether or not species (in the sense of categories of entities with fixed properties) actually exist still engages biologists and has become known as the 'species problem' (Hey, 2001). Hey (2001) discusses the ontological status of categories through recourse to his evening meal. It is evident that the fish on his plate (he recounts), that he will have for tea tonight, is real. In what real sense though, can the category (species) FISH be said to exist other than as a convenient lexical tool for managing a diversity of animal forms that share, at a certain point in time, certain characteristics that are deemed to be significant to a greater or lesser extent (Hey, 2001)?

The debate about the ontological status of natural types continues to be played out amongst philosophers of classification. Nominalists would argue that natural types do not, in any real sense exist rather they are lexical and conceptual constructions by dint of which we are able to organise the constitutive ideas we attach to items of our experiences. Realists might argue that natural kinds are more than merely ideas invented to help us compartmentalise the world and that they have ontological status.

That is not to suggest though, that the Realist position asserts the immutability of these types.

So, for Nominalists classifications are abstract constructions that do not exist and, not being observable, are meaningless (Blaikie, 1993), though the individual entities that populate them do exist. So, to classify is a human sense-making impulse in which classifications are an artefact of mind and not a reflection of reality. Realists, on the other hand, recognise classifications and categories as a device for managing the complexities of human experience and affirm them as useful means on which to base predictions about the future and explanations of the past. This debate is partly diversionary. Both positions recognise the instrumentality of classification though they disagree in the degree to which they affirm an ontological status to resultant categories. This research adopts the instrumentality of classification and aligns itself with Everitt and Dunn's (2001) pragmatic observation that the ultimate test of any classification is its usefulness.

Invariably, a population of objects may be classified in a variety of different ways, human beings, for instance, by age, sex, occupation, education, ethnicity and so forth, and the contents of classes will differ across the different classifications. Each classification system can be justified in terms of the extent to which it helps in solving or understanding different issues. Bonner (1964) argues that if using a term such as "cluster" or "group" produces an answer of value to the investigator, then that is sufficient justification for its use, whether or not that group is a natural kind (has ontological status).

Everitt and Dunn's (2001) mandate of usefulness has already been noted and it is endorsed by Punj and Stewart (1983) for whom the ultimate test of what they call archetypes or classifications is their usefulness in aiding understanding the phenomena under investigation. Classifications, then, may be judged by their usefulness, and are not like scientific theories whose merit endures only so long as they are held to be true (Popper, 1991). The distinction is important because it emphasises the point that in undertaking a classification exercise the variables that are chosen to describe classes must vary according to the research problems and the predictive or exploratory tasks at hand (Miller and Friesen, 1984).

Classification is, therefore, concerned with the investigation of a set of objects and their characteristics in order to establish whether or not they fall into groups (natural or artificial) of objects. A group has the property that the objects within it are similar to one another and different from objects in other groups. The issue of analysis therefore becomes a multivariate data-solving problem: given a sample of N objects, each of which is measured on each of p variables, devise a classification scheme for grouping the objects into g classes (Everitt, 1974). Classification, therefore, is descriptive and exploratory. Classification is not explanatory. It may, however, form the foundations for explanation (Gordon, 1996).

In the widest sense of its use, 'systematics' is the label given to the scientific study of the kinds and diversity of organisms or entities and of any and all relationships among them. By this, systematics attempts to understand the evolutionary interrelationships amongst organisms and the way in which life has diversified over time. Systematics' concern is not only with the arrangement of organisms into taxa and with the naming of those taxa, but also with the causes and origins of these arrangements (Bailey, 1994). One output of systematics, with its holistic approach to the study of phenomena or entities, is the arrangement of types of entity into a meaningful order (Sneath and Sokal, 1973; Bailey, 1994).

The routes by which the principles and techniques of biological classification were introduced into the management sciences are not distinct. Much is owed to the work of Sneath and Sokal (1973) who identify practitioners in psychology, social anthropology, social science and computer studies, disciplines whose boundaries occasionally merge with those of the management sciences (Easterby-Smith et al., 1994). It is not really until the late 1960s and 1970s that the scientific approach to classification in the management sciences begins to establish itself. In the vanguard of this movement were organisational scholars such as Pugh et al. (1968) and McKelvey (1975; 1978).

Of course classification occurred in management disciplines prior to the scientific method of systematics. Perhaps the most familiar conceptual classification scheme in the social sciences has been Weber's *ideal* or *pure type(s)* (Pugh and Hickson, 1996), which Bailey (1994) calls an extreme or heightened representation of all dimensions in the typology. Weber's classification is interesting from the point of view of epistemology of classification because the debate that surrounds it reflects, in miniature, some of the epistemological debate on classification. The basis for Weber's classification was organisational authority structures according to which he proposed three pure organisational types: rational-legal, charismatic and traditional (Pugh and Hickson, 1996). Evincing the conceptual purity of the models Weber asserted these ideal types could not be found empirically anywhere in reality. Side-stepping a large proportion of the debate that Bailey (1994) expertly recounts we are left to consider the merit of classification schemes that specify 'types' that do not exist in reality.

This philosophical dilemma is partly resolved in the two different approaches to classification that exist. These are classification by typology and classification by taxonomy, key features of which are illustrated in table 4-1.

Approach	Method	Role of theory	Application	Output
Typology	Deductive	*A priori* theory as a basis for categorising phenomena.	Hypothesis testing based on existing theory.	Theoretically-based classification scheme. These may offer a heuristic framework in the form of certain assumptions and constraints to guide further inductive enquiry (Ketchen and Shook, 1996; 1307).
Taxonomy	Inductive	Absence of *a priori* theory.	Exploratory – use of configurations generated from empirical observation as basis for comparison and classification.	Empirically based classification of actual objects. Classifications are empirically-based multivariate classifications may be monothetic or polythetic.

Table 4-1: Comparison of taxonomic and typological approaches to classification

Typologies are *a priori* classifications, theoretically or conceptually grounded approaches to classification of objects based on the grouping of one or more characteristics. Doty and Glick (1994; 232) define typologies as "*conceptually derived interrelated sets of ideal types each of which represents a unique combination of the attributes that are believed to define the phenomenon*". So, typologies are categorisations of phenomena grouped into mutually exclusive and exhaustive sets through following a series of discrete decision rules, but which do not attempt to group *actual* observations. Taxonomies are the grouping of *actual* observations, empirically derived multivariate classificatory schemes based on one or more characteristics (Pinder and Moore, 1979). For example Hull et al.'s (2000) taxonomy enumerated five main groups of knowledge management practices for innovation according to their relation to dimensions of research and development activity, management and relationships.

The differentiation between taxonomy and typology is useful in helping identify the theoretical or empirical origins and nature of the classificatory systems being used. It also provides the conceptual space for classifications such as Weber's ideal types to exist alongside those based on empirical observation. In reality, however, the boundaries between the two often are blurred. Typologies, at some point, have been grounded in empirical experience and taxonomies, at some point, have at least some (tacit) theoretical underpinning. Indeed, because of this blurring, Meyer et al. (1993) regard the debate about the relative merits of taxonomy versus typology as diversionary, and in effect many classification systems combine, to a greater or lesser extent, elements of the two. The distinction though, does help to locate the orientation of any particular scheme and roughly equates with Bailey's (1994) three levels of classificatory analysis:

- Conceptual classifications: in which only concepts are classified.
- Empirical classifications: in which only empirical entities are classified.
- Conceptual/empirical classifications: also known as operational or indicator level classifications in which both are combined. A conceptual classification is first devised and then empirical examples of some or all of the categories are identified.

Notwithstanding the final point, in developing a comprehensive parsimonious classification system decisions must be made with regard to choice of the 'right' characteristics and, sufficient of these in order to obtain a stable classification. Unfortunately, we do not have answers to questions about 'right' or 'sufficiency' though several authors have provided guidelines. Sneath and Sokal (1973; 108), for instance, recommend that investigators should "*employ at the very least as many characters as will give the confidence limits the investigator wishes*".

Sneath and Sokal (1973) alert us against over-reliance on conceptual studies as the basis for empirical classification. The danger is that historical weight, in effect conventionalism, leads to inordinate favour being attributed to conceptual characters. This largely accords with McKelvey (1975) who suggests 10 guidelines to keep the researcher free from the influence of previous taxonomies and typologies (see table 4-2). The guidelines make no concessions to the invariable limitations of empirical investigation (lack of resources, problems with access and so forth), but are a useful common-sense guide to helping to try to maintain objectivity.

Guideline 1: Define the broadest possible population of entities.
Guideline 2: Use a probability sampling plan without stratification for selecting a sample of entities in order to ensure that all members of the population have an equal probability of being selected.
Guideline 3: Define as inclusive a population of characters as possible.
Guideline 4: Use a probability sampling plan for selecting a sample of characters if there is the possibility of volume leading to unmanageability.
Guideline 5: Define the population of observers of characters to be as inclusive as possible.
Guideline 6: Use a stratified probability sampling plan for selecting observers.
Guideline 7: The sample of characters must be no larger than the input capacity of the multivariate analysis program.
Guideline 8: Each character must not be over-represented in the input stream of the multivariate programme and must be independently measured. Each character must have equal potential as a classificatory concept, and it must *also be assumed that each attribute* [character] *concept is a theoretical entity independent of all others in definition and capable of being operationally measured in a way that does not compromise its independence, and leaves it equally represented in the input stream as a potential classificatory concept* (pp. 518).
Guideline 9: Criteria guiding unavoidable decisions in using multivariate analysis must be publicly described and consistently applied.
Guideline 10: Classificatory breaks in ordering type concepts should come at points optimising parsimony and intraclass homogeneity.

Table 4-2: Guidelines for classification exercises (Source: McKelvey, 1975; 512-522)

All classifications are based upon the comparison of sets of characters and the evaluation of the similarities and differences between them (Sneath and Sokal, 1973). Consequently, the identification of characters on which to base the classification and, the expression and implementation of the concepts of similarity/dissimilarity and/or resemblance are of central importance in the epistemology of classification. It is on the basis of similarities and differences between characteristics that categories are formed, and so will ultimately influence the final results of any analysis (Fernandez and McCarthy, 2002).

Bailey (1994; 2) argues that the one

> "*…basic secret to successful classification…is the ability to ascertain the key or fundamental characteristics on which the classification is based…It is crucial that the fundamental or defining characteristics of the phenomenon be identified*".

Yet, in spite of its importance selecting characteristics can be a subjective task, and whilst there is no specific formula for identifying key characteristics, there are certain types of character whose nature disqualifies them from consideration (Sneath and Sokal, 1973). These can be grouped under 5 headings:

- Meaningless characters: attributes that are not a reflection of the inherent nature of the item itself.
- Logically correlated characters: any property that is a logical consequence of another must be excluded.
- Partial logical correlations: where the dependence of one character upon another is not total but partial.
- Invariant characters: any characters that are invariant over the whole population should be excluded, including them does not afford extra insight.
- Empirical correlations: this problem is one of the absence of logical correlation but the presence of empirical correlation between factors.

On the issue of empirical correlation there remains room for subjectivity. Sokal and Sneath (1973) concede that even where there is evidence of empirical correlation between characteristics at least some independent sources of variation should be assumed. The corollary of this is that the classification framework may contain levels of redundancy. Redundancy is acceptable, they argue, because it would be counterbalanced by the likelihood of obtaining new information.

Given that classification is the process of ordering entities into groups or sets on the basis of their relationships then the concept of similarity or resemblance is, too, of central importance to processes of classification. It is on the basis of 'sharedness' of properties of characters that similarity between entities is judged. In order to be able to state that entity A is more similar or closely related to entity B than it is to entity C a clear definition of what it means to be 'more similar' or 'closely related' must be given. By what criteria can similarity or relatedness be measured?

Sneath and Sokal (1973) make the distinction between similarity based on evolutionary relatedness (phyletic or phylogenetic relationships) or resemblance as judged by the characters of the entity without any implication as to their relationship by ancestry (phenetic relationships). Phenetic relationships are determined by contemporary characteristics not by ancestry, and in this sense are cross-sectional as opposed to the longitudinal phyletic relationships. This distinction clearly has implications for the way in which similarity may be determined.

An evolutionary perspective has often been utilised to help understand processes of innovation and organisational change e.g. (Aldrich, 1999; Poole et al., 2000). In particular, concepts have been borrowed from evolutionary theory to help explain the origins and nature of stimuli for change such as punctuated equilibrium and natural selection (O'Shea, 2002). However, in that part of the innovation literature where the innovation is taken as the unit of analysis, the longitudinal, evolutionary perspective of ancestral relationships is uncommon. That being the case, the similarity basis for the classification of innovations in this study is the phenetic relationship.

Numerical taxonomy is the label given to "*the grouping by numerical methods of taxonomic units into taxa on the basis of their character states*" (Sneath and Sokal, 1973; 4). There are a variety of statistical approaches to phenetic and phyletic classification. Of interest here are those techniques suited to phenetic classification. Cluster analysis is a generic term for a collection of statistical techniques for dealing with multivariate data pertaining to individual entities. Chapter eight details the cluster analysis approach and, in the light of the previous debate, specifies a design for the analysis of multivariate data pertaining to a sample of innovations.

In brief, clustering techniques use measures of distance (dissimilarity) or resemblance (similarity) between objects, which can be either individual entities or the emergent groupings. Two cases are identical where they share the same scores on the range of variables (characters): absence of correspondence of variables can be construed as distance or dissimilarity. These distances can be based on a single dimension or multiple dimensions. Sneath and Sokal (1973; 5) outline seven principles to guide the operation of a classification exercise:

- The greater the content of information in the taxa of a classification and the more characters on which it is based, the better a given classification will be.
- *A priori* every character is of equal weight in creating natural taxa.
- Overall similarity between any two entities is a function of their individual similarities in each of the many characters in which they are being compared.
- Distinct taxa can be recognised because correlations of characters differ in the groups of organisms under study.
- Phylogenetic inferences can be made from the taxonomic structures of a group and from character correlations, given certain assumptions about evolutionary pathways and mechanisms.
- Taxonomy is viewed and practised as an empirical science.

Cluster analysis permits the identification of categories of entities based on the use of multiple variables (characters) in permutations or configurations of similarity or resemblance as the defining quality of the categories. When we speak of configurations, note Miller and Friesen (1984; 4),

> "*…we are concerned with complex clusters of elements or variables...we are speaking of different constellations of conceptually distinct variables or elements that commonly cluster together to characterise many aspects of organisational...*[phenomenon of interest]."

The configurational approach in which phenomena are described according to the extent to which they share, or otherwise, common profiles based on degrees of difference or conformity along conceptually discrete variables, is a key means by which humans make sense of their world. Multidimensional configurational studies have been popular in some domains of the management sciences for example Mintzberg's (Pugh and Hickson, 1996) five types of organisational structure or Bailey and Johnson's (1995) six types of strategy development process. They have not, however, proved so popular in the innovation literature.

It is argued that there are many phenomena that can be construed of as being multidimensional with the implication of potentially infinite combinations of characters (where variance is independent and continuous)

"*…but for theorists taking a configurational perspective, this potential variety is limited by the attributes' tendency to fall into coherent patterns...The upshot is that just a fraction of the theoretically conceivable configurations are viable and apt to be observed empirically*" (Meyer et al., 1993; 1176).

Innovation research has long used a classificatory approach, but predominantly based on narrow dimensions. Indeed, the use of multiple variables to define groups requires the use of new research techniques in innovation studies – because research based on multiple variables has not been done in this way before. This has implications for the methodology of this research (see Chapter six).

Classifying innovations poses interesting ontological and epistemological challenges. Ontologically the field is divided between those theorists who conceive innovations positivistically, as objective properties (Damanpour, 1988; Veryzer, 1998; Garcia and Calantone, 2002) and the constuctivist perspective that conceives of innovations as perceptual artefacts arising from the interaction between the innovator/adopter and the innovation (Rogers, 1962, 1983; Rogers and Shoemaker, 1971; Dearing and Meyer, 1994).

There is a wide array of classifications of innovation in the literature, these are fully reviewed in the following chapter. Of the classifications many share dimensions that show such high levels of congruence that these classifications can themselves be categorised as being one of three different kinds: innovation newness, innovation area of focus, and perceived characteristics of the innovation. It is, however, reasonable to assume that innovation diversity might be patterned into countable configurations of greater or lesser clarity. It is proposed that a suitable conceptualisation of innovation is polymorphic, that is innovations have or occur in several distinct forms and these forms are best circumscribed by an holistic conceptualisation based on the perceptions of those who develop and implement the innovation.

Underlying every classificatory system is a drive for better understanding and, the different paths of innovation research are hedged around by competing and complementary classificatory approaches. Innovation studies appear to have concentrated on using classifications to predict and explain, but have not provided the scientific basis for the management of classifications in the form in which they are manifested. In the following sections of this chapter those approaches are reviewed. A number of these classifications are narrowly specified and many researchers have relied on estimates and measures of only one or two parameters. It is a limitation of conceptualisations of innovation that the complexity of the phenomenon is defined across narrow sets of variables. The chapter concludes that groups established on the basis of single characters are of low or limited exploratory value and argues that a classification of innovation based on user/innovator perceptions would offer a rich and original approach to innovation classification that addresses limitations of existing approaches.

4.3 Classification in innovation research

The origins of the three classificatory approaches, described in Chapter three (see also table 4-3), in innovation research are somewhat obscure. The newness approach likely has its origins in Schumpeter's (1934) early circumscription of innovation and would appear to be legitimised by intuition, common-sense and convention. The distinction between administrative, product and technological innovations, the 'area of focus' approach, has its roots in a more general distinction between social structures and technology and also represents changes made in a wide range of activities within an organisation (Damanpour, 1988). Finally, the attribute approach, this would appear to be predicated on the sociological dictum that perceptions reify situations (Rogers, 1983). The most significant event in this latter approach was the introduction of a five-factor framework of innovation attributes, initially by Rogers (1962) and then refined by Rogers and Shoemaker (1971) and then, again, by Rogers (1983). This framework is further examined in Chapter five but, it presents five conceptually distinct but empirically interrelated attributes of innovation (see section 5.3.2 Multi-attribute empirical studies) based on meta-analysis of over 300 innovations in 12 separate studies that, it is argued, are as mutually exclusive and universally relevant as possible. Henceforward this framework is referred to as Rogers' (1983) framework.

Innovation newness	**Innovation area of focus**	**Innovation attributes**
Novelty (narrow)	Administrative	Narrow (uni- or bi-dimensional)
Novelty (broad)	Technological and process	Broad (multidimensional)
Familiarity	Product	Conceptual

Table 4-3: Classification schemes in innovation studies

In spite of the longevity of interest in innovation classification, and despite a number of attempts, there is no single universally adopted classification. Further, innovation theorists fail to agree on how to distinguish and enumerate diversity in innovation. Recent attempts have been made to synthesise the diversity of approaches and present refreshed perspectives on classifications (Garcia and Calantone, 2002).

The following three sections briefly review three approaches to the classification of innovations: by newness, by area of focus and by innovation attributes.

4.4 <u>Newness</u>

Conceptualisations of newness have been fundamental to the study of innovation since Schumpeter (1934) used one as the basis for explaining economic cycles. It has become a taken-for-granted convention that innovation is about newness. It is undeniable that, to at least some extent, innovations introduce newness into social contexts (West and Farr, 1990). Appendix one identifies 38 'newness' studies. Whilst the list is not exhaustive it presents an illustrative purview of the construct, its role and the nature of debate surrounding its use in innovation research.

From the list several things become apparent. First, there are numerous and competing conceptualisations and operationalisations of newness. It is an area that has attracted a large amount of theoretical and empirical debate (Schumpeter, 1934; Burns and

Stalker, 1961; Heany, 1983; Roberts and Berry, 1985; Subramanian, 1996; Garcia and Calantone, 2002). Second, newness has been demonstrated to be an important determinant of innovation and organisational success and performance (Booz-Allen and Hamilton, 1982; Johne and Snelson, 1988b; Kleinschmidt and Cooper, 1991). Third, multiple factors determine the newness of an innovation (Tushman and Nadler, 1986; de Brentani, 2001; Cardinal, 2001; Lynn and Akgün, 2001). Finally, the degree of newness has a significant impact upon the nature of the innovation process (King, 1992; Cheng and Van de Ven, 1996; Rice et al., 1998; Veryzer, 1998; Fernández, 2001). At this point in the thesis the principal interest is in the debate regarding the construct of newness and its stability, or lack of it, in innovation research, as opposed to its role as a variable.

It is argued that the distinction between innovations on the basis of degree of newness is an important one because radical and incremental innovations have dissimilar dynamics. Radical innovations produce fundamental changes in the activities of the organisation and represent a large departure from existing practices, whereas incremental innovations result in a lesser degree of departure from existing practices (Damanpour, 1996).

It is difficult to identify a commonly held, universally agreed definition or measure of newness. Avlonitis et al. (2001) identified what they described as 10 key typologies, and their dimensions, of product and service innovativeness each presenting a conceptualisation in terms of degree of newness. In a review and synthesis of 21 empirical studies Garcia and Calantone (2002) identify 15 constructs and 51 scale items to measure newness. Newness, as reported in these two studies, is generally determined along a continuum with contrasting polar extremes. Various labels are used to identify these polar points, such as radical, revolutionary, discontinuous, new-to-the-world and so forth at one end and, incremental, evolutionary, repositioning of existing products, minor modifications, style changes and so forth at the other. Whilst anchoring at the poles would appear to be stable, gradations of newness along the continua vary. Between the poles newness is dimensionalised into between two and eight different categories (Garcia and Calantone (2002), see Appendix one). Both studies correctly identify the plethora of definitions and conceptualisations of innovation newness in the literature. They both ponder whether or not there is any difference between the various constructs, whether or not having such a range adds anything meaningful to innovation research, or it simply serves to obfuscate?

Certainly the results of studies are inconsistent with regard to newness. For example, Avlonitis et al. (2001) concluded that an inverted U-type relationship existed between degree of novelty and financial success. Similarly, Goldenberg et al. (1999) suggest that successful products tend to be those that are moderately new to the market but not the firm. On the other hand, Kleinschmidt and Cooper (1991) observed a U-type relationship between innovativeness[3] and commercial success, where highly or only marginally innovative products were more successful than moderately innovative products. Atuahene-Gima (1995) notes that radical innovations appeared to be more

[3] The term 'innovativeness' is potentially confusing. It has meanings ranging from degree of newness to capacity of an organisation to innovate (see section 7.5.1.2 Operationalising novelty).

dependent on more market research and investigation activities (that is devoting more time and resources to structures and processes that engender understanding of customers) than was the case for incremental ones. Conversely, Veryzer (1998) suggested that exploratory, less customer-driven was the route to discontinuous innovation.

Much of the inconsistency in the results can be attributed to differences in the conceptualisation and operationalisation of variables. This results in different and competing conceptualisations of newness and this leads to accusations of inconsistency in the innovation literature (Downs and Mohr, 1976; Wolfe, 1994; Garcia and Calantone, 2002; Wolfe, 1994; Garcia and Calantone, 2002; Garcia and Calantone, 2002).

Other studies have taken broader views of newness, conceiving it in terms wider than simply only the single radical/incremental type continuum. Although Damanpour (1996) does not operationalise a broad conceptualisation of newness, his observation that radical innovations represent a large departure from existing practices and incremental innovations a lesser degree of departure usefully illustrates the second perspective on newness observed in the literature. This second perspective argues that there are some inherent qualities that are indivisible from newness and so a broader approach is required. Chief amongst these qualities is the departure or discontinuity that an innovation can generate at a macro (e.g. a global paradigm shift) or micro (e.g. adopting unit's processes) level (Damanpour, 1996; Garcia and Calantone, 2002). These qualities are further discussed in Chapter seven.

Roberts and Berry (1985) take a third view on conceptualising newness with what they call the 'Familiarity Matrix'. In this approach innovations are allocated to a category generated from the orthogonalisation of two of four domains of activity wherein the innovation is implemented. The predominant view is familiarity to the firm, but also applied is familiarity to the market (Atuahene-Gima, 1995), familiarity to the project group (Lynn and Akgün, 2001) and familiarity of the technology (Johne and Snelson, 1988b). It has been utilised principally in what might be considered strategic innovation studies. Booz et al. (1982) use it as a basis for selecting 'successful' innovation strategies, Roberts and Berry (1985) to select strategic response for new business opportunities and, de Brentani (2001) for better understanding different new service development scenarios.

There are two weaknesses of the approach. First, innovations are categorised on the basis of only two dimensions, but arguably, many more than two dimensions define an innovation. Second, the approach assumes that innovations within each of the resultant categories are homogenous. These assumptions would appear to be at odds with the widely acknowledged view that innovations differ one from the other.

The requirement for new solutions to new or even recurrent problems would explain the widespread acceptance of 'newness' as a significant construct in innovation research. However, a diversity of approaches to newness is evident. Broadly, three categories of approach to newness have been identified. The first is a narrow perspective predicated on the view that newness is the degree of change from a previous state. Research in this field has generated inconsistent and contradictory results. Inconsistency of the research results in this field becomes a problem at the level of generalisability and hampers comparative research and theoretical development. The second perspective broadens the view and introduces the idea that additional factors can be associated with newness, such as departure and discontinuity. The third approach assesses familiarity, the extent to which aspects of the innovation (e.g. technology) are familiar to innovators, the firm or the market. This was argued to be valuable but, again, difficult to generalise.

Earlier in this chapter it was suggested that one criterion by which a classification system may be judged is its 'usefulness'. What, therefore, has been the utility of 'newness' as an approach to classification and, to what extent does it remain useful? Clearly investigation and discussion of the approach has occupied a portion of the academic community for some years. However, as yet there is no consensus on the meaning of newness, in either its broad or narrow forms, and so results tend to be inconsistent, contextual, difficult to compare and sometimes contradictory. Barclay's (1992) observation that innovation research had proved to be of little value to practitioners was, a critique aimed at the whole body of innovation research. But, if after four decades and more of research, that part which concerns itself with newness shows little evidence of advancement it cannot be immune from Barclay's criticism. This strongly suggests that a narrow conceptualisation of newness, on its own is not adequate or sufficiently sensitive to capture the complex and dynamic nature of an innovation.

Interestingly, in the same issue of the Journal of Product Innovation Management in which Garcia and Calantone's (2002) synthesis appears, a short editorial provides reflective commentary on product innovations that had their origins in past years' wars. In helping the reader to understand something of the innovations the editor uses the word 'new' (or similes) four times. More attention, however, is given over to describing, and therefore in helping the reader to come to some understanding, the innovations in terms other than newness. The utility of submarines is, demonstrated, and of the catamaran whose twin hulls shielded a central paddle wheel, and the list further includes ship camouflaging schemes, radar, microwave and many other innovations. The language that is used in order to help the reader come to know and understand each of these innovations describes them in use, their application and some of the benefit they bring. Thus it is that the helicopter "*was used in WWII*", they have "*been used in all sorts of humanitarian…*", it started life "*as an instrument*"(Griffin, 2002; 108) and so on.

It is an interesting juxtaposition of articles. Garcia and Calantone (2002) argue the criticality of the variable newness to our understanding of innovation whilst the editorial helps us to understand something about a series of innovations by supplementing the construct newness with further factors. It seems that by its language the editorial implicitly recognises that a fuller understanding of innovations rests on factors in addition to newness.

Perhaps part of the reason for the sustained focus on 'newness' as the attribute of choice in conceptual models of innovation is the complexity of defining different types of innovation. Indeed, the diversity of possible outcomes is testament to the multidimensionality of the ways in which innovations can be perceived and so deciding on the basis for their classification can become a complicated issue to handle (Leonard, 1998).

There is evidence of renewed vigour in innovation research to try and make some sense of the extant literature. Garcia and Calantone's (2002) synthesis is one good example. However, newness has been argued to be too narrow a conceptualisation of innovation. This suggests that future conceptualisations of innovation need to include operationalisations of a wider number of dimensions that capture the ideas of degree of newness and impact of benefit. This idea is further explored in Chapter seven.

4.5 Innovation area of focus

Gopalkrishnan and Damanpour (1994; 103) call product, process, administrative and technological innovations collectively the "*area of focus of an innovation*". These are developed and defined in table 4-4.

Administrative innovations
Administrative innovations occur in the administrative or productive components of the organisation and affect its social system. The social system of an organisation consists of the organisational members and the relationships among them: it includes those rules, roles, procedures and structures that are related to the communication and exchange between organisational members. These innovations do not provide a new product or service, but can directly influence the introduction of new products or services or the process of producing them. As such, they are only indirectly related to the basic work activity of the organisation and are more immediately related to its management, personnel, allocation of resources, and the structuring of tasks, authority and rewards (Damanpour, 1990; Subramanian and Nilakanta, 1996).

Technological and process innovation
Organisational theories define the concept of technology broadly to include not only hardware but also the skills and knowledge utilised by field participants to transform inputs into desired outputs (Hatch, 1997). Technological innovations are those that bring change to an organisation, product or service by introducing changes in the technology that is used to transform raw materials, information, equipment or methods into products or services (Zaltman et al., 1973). Changes determined to have been educed by changes in technology are considered to be technological innovations. Technological or technical innovations directly relate to the primary work activity of the organisation (Damanpour and Evan, 1984). They occur in the operating component of an organisation and affect its technical system where technology is usually regarded in an instrumental sense by which individuals and organisations transform raw materials or information into products or services (Subramanian and Nilakanta, 1996). Included in this sub-category, because of the notion of instrumentality, are process innovations such as might involve the introduction of new elements in the organisation's production or service operations such as: input materials, task specifications, work and information flow (Utterback and Abernathy, 1975). Consequently, technological innovations consist of products, services, processes and technology used to produce products or render services directly related to the basic work activity purpose of the organisation. It is worth noting that some typologies, such as the Oslo Manual guidelines (OECD, 1996), treat technological and process innovations separately.

Product / service innovation
The introduction of new or amended products or services to meet a user or market need (Utterback and Abernathy, 1975), in effect this is what the customer sees.

Table 4-4: Classification by innovation area of focus

Classification by area of focus is less commonly used in the innovation literature than classifications based on newness but still underpins a large proportion of innovation research (Appendix two details 13 studies). The classification is used principally in two domains of innovation research. First, in process research, particularly with regard to the adoption and diffusion of innovations (Daft, 1978; Kimberly and Evanisko, 1981; Damanpour, 1990; Chesborough and Teece, 1996; Sirilli and Evangelista, 1998; Damanpour and Gopalakrishnan, 2001) in which adoption processes reportedly differ according to area of focus and organisational factors.

The second field of use has been in that which considers the determinants of organisational change and performance (Burns and Stalker, 1961; Damanpour, 1990; Subramanian, 1996). Results of this second element of research have been inconsistent and contradictory at a macro level, clarity only seemingly able to be established at a micro level (Subramanian and Nilakanta, 1996).

Categorising according to area of focus would intuitively seem to make sense within the context of the phenomenon. Simultaneously the approach generates a manageable typology. However, the approach assumes discreteness between the categories of area of focus and also their immutability. There is, in the approach, the implicit assumption that all innovations that belong to any category are homogenous. That is, for example, all 'technological' innovations are equally 'technological'. This is a limitation of the approach and, researchers who contend that the boundaries between categories of area of focus are in fact blurred, increasingly challenge these assumptions (Bhoovaraghavan et al., 1996; Osborne, 1998).

The notion that innovations are rarely, if ever, the same in different contexts supports the assertions of blurring. Apparently identical innovations initiated and implemented separately in organisations A and B could, quite feasibly, differ markedly from each other in terms of their newness and area of focus characteristics. For example, the introduction of an information technology innovation into organisation A might be considered a low degree of change from the preceding condition and be considered a technological innovation. In organisation B, however, the same innovation could conceivably be construed as a high degree of change from the previous state and concurrently an administrative innovation. This begs the question, 'to what extent could these innovations be considered the same?'.

This is an enduring problem with the area of focus approach. It is most apparent when trying to distinguish between technological and non–technological innovations but also, increasingly, the boundary between product and process innovations is becoming blurred. It may be the case that organisational, structural or managerial innovation follows from or is an inextricable part of technological change or, that product and process innovations are not independent phenomena. They may represent different ends of a continuum, thereby implying that at a point around the centre it is difficult to discriminate between the two (Bhoovaraghavan et al., 1996).

Warner (1974) attempts to tackle this problem of innovation classification. He argues that the physical or artefactual entity does not suffice as a descriptive definition of the innovation, and further dimensions are required to more fully describe it. He proposes 'use' and 'value' perspectives to help define and discriminate between innovations. However, although an advance in terms of framework sensitivity, these perspectives are confounded by problems of applying the constructs across multiple markets and the problems of measurability.

Wilson et al. (1999) point out that innovations differ one from another because they do not share the same attributes, are not similarly affected by organisational factors nor, indeed, do they share similar processes of initiation or implementation. This suggests that categories of area of focus can be unstable across studies, possibly even within studies. Given the important role of innovation classifications (as either dependent or independent variable) in process, organisational change and performance research this observation poses a challenge to the validity of the area of focus approach.

4.6 Innovation attributes

The observation that innovations differ one from another, and that they are rarely the same thing in two organisations, is not new (Downs and Mohr, 1976). As has been shown already efforts have been made to distinguish between innovations on the basis of classification by newness and area of focus. The third area uncovered in this review is that of innovation attributes, characteristics, or psychometric properties (Adams et al., 1992). An attribute is a descriptive property, quality or feature belonging to an entity (McCarthy, 1995) similarly, attributes are those qualities that individuals assign to innovations (Adams et al., 1992).

Of the three approaches to classification identified in this review, classification by attribute or attributes is possibly the approach that is the least commonly utilised and has been subject to least scrutiny and conceptual development. In 1971 Rogers and Shoemaker noted that, compared to other aspects of innovation, relatively few empirical studies had directly addressed questions regarding the attributes of innovations, this continues to be the case, but it is not clear why this is so. Avlonitis et al. (2001) averred the suggestion that it might be due to the difficulties intrinsic within a diverse and multidimensional phenomenon.

Nevertheless, classification by attributes has made an important contribution to innovation research. Tushman and Nadler (1986) argue that frequently innovations may not be reflected in tangible characteristics. Indeed, as products and services increasingly co-exist as part of a single offer, innovations may not exhibit any tangible qualities at all, rather the innovation is reflected in developer and user perceptions. Rogers (1983; 211) noted that perceptions have an important role in the study of innovation, "*the crucial importance of perceptions in explaining human behaviour was emphasised by an early sociological dictum: 'If men perceive situations as real, they are real in their consequences'*". For West and Anderson (1996; 681) the important thing is that which has actually been implemented, "[*W*]*e believe that group* *innovation should…be judged in terms of the content of the innovations implemented within the organization*". The value of understanding perceptions is in being able to elaborate a robust language and framework to talk at an abstract and comparative level about innovation.

Two clear streams of attribute-centric research are evident in the literature: process research (Mohr, 1969; Zaltman et al., 1973; Rogers, 1983; Pelz, 1985; Meyer and Goes, 1988; Agarwal and Prasad, 1997; Meyer et al.,1997; Mukherjee and Hoyer, 2001; Danneels and Kleinschmidt, 2001) and conceptual development. (Warner, 1974; Downs and Mohr, 1976; Tornatzky and Klein, 1982; West, 1990; Moore and Benbasat, 1991; Wolfe, 1994; Shenhar et al., 1995). 19 illustrative attribute-centric studies are presented in Appendix three.

In process research innovation attributes tend to take the part of the independent variable. The usefulness of research on the attributes of innovation has been mainly to explain and attempt to predict future rates of innovation adoption and diffusion. In this stream of research the adoption and diffusion of innovations can be understood and explained by the way in which the adopting unit perceives the innovation. Researchers place different emphasis on the particular attributes that are thought to be significant in different contexts. So it is that Rogers (1983) proposed five attributes as determinants of adoption, Meyer and Goes (1988) four, Moore and Benbasat (1991) eight, Agarwal and Prasad (1997) eight and Meyer and Johnson (1997) seven attributes[4]. Other researchers have been more selective (or less inclusive in terms of a multidimensional approach). Mohr (1969) assessed levels of slack and prestige associated with innovation adoption, Pelz (1985) considered innovation complexity and originality in relation to adoption, Adams et al. (1992) ease of use and usefulness, and Mukherjee and Hoyer (2001) novelty and complexity.

Arguably 'newness' can be treated as a psychometric property of an innovation. However, in this review it has been treated as both a psychometric property and as a separate approach to classification, for two reasons: first, because it is so widely used in innovation research it warranted separate treatment merely by dint of its volume. Second, attribute-centric research adopts a subjectivist position which privileges the perceptions of individuals. This is in contrast to some nova-centric research which attempts to establish objective measures of newness. There is, of course, a body of research that treats newness as an attribute of an innovation (West, 1990; West and Anderson, 1996; Mukherjee and Hoyer, 2001; Danneels and Kleinschmidt, 2001) and these studies are included in this section of the review.

Classically, empirical studies have tended to adopt a uni- or bi-dimensional approach as the means of distinguishing between innovations based on their attributes, for example Mohr (1969) slack and prestige; Adams et al. (1992) perceived ease of use and perceived usefulness; Shenhar et al. (1995) technological uncertainty; and Mukherjee & Hoyer (2001) novelty and complexity. As innovation has become increasingly important to organisational growth and survival, this dichotomised uni- or

[4] These are further explored in Chapter five.

bi-dimensional categorisation is argued to be insufficient to capture the diversity inherent in individual innovations (Shenhar et al., 1995).

A substantial proportion of empirical studies tend to be unidimensional, treating the innovation as a 'dis-aggregated' phenomenon (Tornatzky and Klein, 1982). It is against the tendency of these studies to produce unstable results that some conceptual studies rail and argue for holistic and constant frameworks in order to contribute to encouraging the generalisability of findings (Warner, 1974; Downs and Mohr, 1976; Tornatzky and Klein, 1982; Wolfe, 1994). There is a long history of calls in the literature for more substantial, sensitive and integrated frameworks of innovation characteristics. There has been some small response to these calls but evidence of integrative (by which is meant incorporating three or a greater number of attributes), operationalised measures of innovation attributes are hard to find. Of the literature reviewed, only seven published studies were identified that had operationalised and applied a multidimensional framework of innovation attributes: Fliegel and Kivlin (1966), Pelz (1985), Meyer and Goes (1988), Moore and Benbasat (1991), West and Anderson (1996), Agarwal and Prasad (1997) and Meyer et al. (1997), see table 5-5.

This observation leads to the identification of the second stream of attribute-centric literature, that of conceptual and theoretical development as a response to instability and inconstancy in innovation research. Rogers and Shoemaker (1971) produced what appears to be the first aggregated conceptualisation to the study of attributes in innovation research. Prior to that the approach appears to have been utilised erratically. Early investigations appear to have been restricted to sector-specific studies on the adoption and diffusion of educational and agricultural innovation utilising context specific attributes. For example, Fliegel and Kivlin (1966) used the attribute 'association with dairying' in their study.

In terms of theory development, the use of attributes in innovation research stagnated for a period (Fiol, 1996) and, notwithstanding some studies (Rogers (1983), Meyer & Goes (1998), Moore and Benbasat (1991), Agarwal and Prasad (1997) and Meyer and Johnson (1997)), the dis-aggregative tendency of selective study of selected attributes prevailed. Dis-aggregation of innovations into manageable units of analysis has, without doubt, eased the processes of research, but the approach is becoming increasingly redundant. Selective studies preclude both wide generalisation and comparisons across studies. Furthermore, theoretical development is necessarily restricted to a level governed by the exigency of the context in which research has been undertaken. The development of a context-independent, comprehensive classification scheme would directly confront these weaknesses.

This problem has been recognised for some time. Downs and Mohr (1976) appealed for constancy within studies for, if innovations are under-specified or their attributes inconsistently applied then, there can be no confidence in the generalisability of results. Indeed, it is this threat to generalisability that Wolfe (1994) confronts and argues that a framework with a clear specification of attributes is necessary. Without such clarity our understanding of innovation will not advance substantially. As a consequence of inconstancy and inconsistency researchers' ability to compare findings across studies has been hampered.

This review has indicated the importance of the role of different attributes in empirical work. Studies that focus on only a small number of attributes under-specify the innovation and render an incomplete picture of understanding. Research designs that consider innovations in terms of configurations of multiple attributes offer the opportunity to reach a finer-grained and more generalisable understanding of innovation.

Having a standard classification scheme for describing the attributes of innovations in universal terms consequently becomes an important goal of innovation research. Multidimensional frameworks based on these perceptions offers the opportunity for polythetic, that is more sensitive, classifications of innovation. In such a case the interesting question might be, to what extent do perceptions of innovations cluster into groups where within groups, although innovations are different (process, product, technology and so forth), they are perceived as being similar? And, if innovations can be identified in terms of similarity, based on configurations of attributes, what are the implications of that for other classification systems?

Individual perceptions of innovations differ one to another and a plethora of attributes of innovations can be identified in the literature, Tornatzky and Klein (1982) identify 30 and Wolfe (1994) identifies 18 (excluding synonyms). These are more fully explored in Chapter five. There is a real need, if attributes are to form the basis of any meaningful study of innovation, for these lists to be synthesised and for redundant or overlapping attributes to be removed. In studies, these elements have rarely been taken together. The basic premise of this research is that there are potentially different combinations of these elements which, as a more sensitive measure of innovation will provide us with a device to help better understand relations in the process outcome performance chain.

4.7 Discussion

Innovations have been shown to differ one from another. They are not affected in similar ways by different organisational variables (Damanpour, 1996), they do not share the same processual origins (Pelz, 1983; Pelz, 1985; King, 1992), nor do they impact equally on organisational performance (Damanpour and Evan, 1984; Damanpour et al., 1989; Kleinschmidt and Cooper, 1995) or new product success (Booz-Allen and Hamilton, 1982; Cooper and Kleinschmidt, 1993; Lynn and Akgün, 2001). The concept of innovation is multidimensional and complex consisting of diverse but inter-related elements. Many attempts have been made in the literature to manage this complexity through the reduction of the diversity into manageable groups that distinguish between innovations. Three approaches to classification have been identified and these have been reviewed in terms of their origins, application and usefulness.

In this review classification systems have been differentiated into three types: innovation newness, innovation area of focus, and innovation attributes. Occasionally studies cross the boundaries and integrate two of the classification systems. In such studies innovations tend to be categorised according to a perspective on newness in conjunction with an attribute, for example complexity (Pelz, 1985). Other studies investigate newness in conjunction with innovation area of focus, for example product or process innovations (Tushman and Nadler, 1986). However, these studies are the exception.

Underlying each of the classification systems is a drive for better understanding of the phenomenon innovation. The need for classificatory approaches is premised on the basis of a belief in the existence of different types of innovations, that these are the product of different processes and which have different impacts and implications on innovation adoption and diffusion and organisational performance.

Each of the classificatory approaches described in this chapter share in common the objective of making sense of the phenomenon of innovation and managing large volumes of potentially unwieldy data. Nevertheless, limitations of each of the approaches have been identified. Existing classifications can over-simplify and fail to reflect the complexity and multidimensionality of innovations. Some of these limitations are summarised in table 4-5.

	Approach		
	Newness	**Area of focus**	**Attribute**
Origins	Conventionalism	Intuitive	Empirical
Classification output	Monothetic	Monothetic	Monothetic & Polythetic
Conceptualisation	Narrow to mid	Narrow	Narrow to broad
Theoretical contribution	Limited by range of conceptualisation	Limited by range of conceptualisation	Potentially wide

Table 4-5: Limitations of approaches to innovation classification

Classificatory approaches based on innovation newness, innovation area of focus and innovation attributes have been identified and reviewed. In their operationalisation these approaches have been demonstrated to be principally monothetic in nature. That is, innovations are allocated to a category according to their value on a single variable. Consequently, categories contain cases which are identical on all dimensions being measured. This tends to be the rule in approaches to classification that privilege newness and area of focus. Clearly there are exceptions to this, not least of all the meta-analytical work of Damanpour (1988) and Damanpour and Szabat (1989).

The advantage of monothetic classifications is that they are simple to understand and relatively easy to determine. However, given that they allocate membership according to the presence, absence or degree of a single criterion they risk ignoring salient and defining information and may even be misleading if the wrong criterion is chosen as the basis for classification.

It has been argued that classification according to newness tends to be narrowly conceived and rather arbitrarily applied. Innovation area of focus, whilst intuitively attractive is too rigid an approach. By assuming that entities within a category are identical on all dimensions of the variables that define that category the inference is that these entities share the same relationships with other variables (Miller and Friesen, 1984). A significant critique of the newness and area of focus approaches is their tendency to produce monothetic classifications, which fail to take account of the mutability of innovations.

If the merit of any classification scheme is to be judged largely by its usefulness (Everitt and Dunn, 2001), the Downs and Mohr (1976), Wolfe (1994) and other (Tornatzky and Klein, 1982; Barclay, 1992) critiques of newness and area of focus approaches suggest, there is limited utility in them and they suffer from being under-specified, coarse and unsatisfactory.

The recognition that, whilst unidimensional studies of innovation attributes has been a valuable basis on which to distinguish them, it is increasingly recognised that as multidimensional phenomena they are better studied as such. Recent classifications include (Shenhar et al., 1995; Veryzer, 1998; Garcia and Calantone, 2002; Gopalakrishnan and Bierly, 2001; Danneels and Kleinschmidt, 2001; Avlonitis et al., 2001). These classifications tend, however, to be typological, that is they are grounded in theories of innovation that can be traced back to some of the earliest characteristics studies. The original premises and assumptions underpinning these researches have remained undeveloped over the decades.

It is part of the critique of this chapter that there has been a tendency toward conventionalism in innovation research. Conventionalism is manifested in an implicit assumption that extant bases for classification, perhaps due to their provenance or longevity, can be applied in studies without regard to the requisite demands of justification. None of the classificatory approaches identified appears to have its origins in a scientific approach to classification and this must further call into question their validity.

However, the attribute approach is found to have the potential to offer a solution to the problems of narrow specification and mutability through a focus on developer and user perceptions. The approach though, is still relatively underdeveloped empirically. As has been noted, upward of 30 seemingly discrete attributes of innovation have been identified in the literature (Tornatzky and Klein, 1982). In studies, these attributes have rarely been taken together and yet it may be possible to combine these elements to provide a more sensitive measure of innovation.

It is not suggested that as criteria newness or area of focus are wrong or inappropriate. Indeed their application in innovation research has made a substantial contribution. Rather, the suggestion is that, in order to move innovation research forward a more sensitive classification based on multiple criteria, or a polythetic approach, is needed. It is argued that a classification based on innovation attributes fits this requirement.

Monothetic classifications are argued to be restrictive whilst a polythetic approach promises the opportunity for a more sensitive rendering of the phenomenon of interest and wider ranging comparative studies. Regardless of being monothetic or polythetic, each of these classifications is, however, united by the shared characteristic that there appears to be no scientific basis for its selection or generation. Early in this chapter it was argued that classifications should be based on scientific discovery and that rules and guidelines, now well established and practised in biological taxonomy and also in some of the disciplines of the management sciences, might be adopted in order to provide such a scientific classification.

There is clearly a need for a classification system that can accommodate this complexity. Such a system, providing a more sensitive measure of innovation, may use multiple variables to define and describe innovations. But, given the implicit difficulties associated with the study of phenomena characterised by a multiplicity of attributes, how might a comprehensive but parsimonious framework of innovation attribute, whose utility would be in facilitating comparative research, look?

Any valid framework of innovation must be capable of capturing the complexity and multidimensionality of an innovation's content and be applicable across cases. Innovation attributes form a reasonable basis on which to develop a valid framework for describing innovations. The objective would be to discover if innovators perceive in their innovations what Reger and Huff (1993) call 'differentiating commonalities'. This would suggest a configurational approach to the study of innovation attributes. Configurations are collections into groups or clusters of the phenomenon of interest wherein the groups are bound together by commonality or similarity of specified, relevant characteristics (or attributes). At the heart of configuration analysis is the assumption that by identifying internally consistent and externally distinct groupings of the phenomena that hold across all instances of the phenomenon, better understanding can be achieved. The configurational approach is especially relevant to the study of multidimensional phenomena where the challenge is to manage multiple discrete data combinations along dimensions that provide a richer understanding or description of the phenomenon of interest (Ketchen et al., 1993).

Multidimensional configurational studies have not been as widely utilised in innovation research as they have in other domains of the management sciences. The approach asks 'What does the innovation look like?', 'What generates the configurations and what causes them to cluster?'. It is a perspective that requires the researcher to consider a whole different set of metrics and allows for the innovation to be assessed along a series of dimensions. The configurational approach will generate polythetic classifications, that is where membership of a class or group is based on entities sharing similarities across a large number of attributes. This contrasts with the monothetic classifications (where membership is determined by the presence or absence of a single characteristic) which the newness and area of focus approaches have been argued to generate.

Innovation research has long used a classificatory approach, but classifications have been predominantly based on narrow conceptualisations. Existing classifications of innovation are argued to be unsatisfactory, not because important attributes and dimensions are ignored, but because they fail to be either comprehensive and/or lack any scientific basis or justification. It is proposed that a reasonable conceptualisation of innovation is polymorphic, that is innovations have or occur in several distinct forms and these forms are best circumscribed by an holistic conceptualisation based on the perceptions of those who develop and implement the innovation. The configurational perspective is holistic and asserts that innovations, their processes, determinants and impact can be better understood as a whole rather than in component parts.

If the basis for changing the manner in which innovations are classified (i.e. by establishing the validity of an approach based on an holistic attribute perspective as opposed to the narrow 'nova-centric' or area of focus approaches), then there is an imperative to revisit questions about the relationship between process and innovation type. Already, a number of researchers have turned their attention to alternative methods of exploring the relationship between process and output (the latter construed in terms of performance). For example Harmsen, et al. (2000) and West and Anderson (1992; 1996). Each of these argue that the characteristics of the innovation mediates the relationship between process and performance. A study based on a conceptualisation of innovation more sensitive to its multidimensionality will augment these existing studies.

By empirically deriving a descriptive framework of innovations based on user-perceived attributes and, applying it to a wide range of innovations, it may be possible to identify discrete configurations. Assuming that such discrete configurations do exist and can be identified, it should be possible to determine whether or not these are underpinned by common characteristics of the innovation process. The following chapter begins to address how this might be accomplished.

5 THE NOTION OF ATTRIBUTES

5.1 Introduction

Previous chapters have shown that approaches to innovation classification have been characterised as being one of three types: according to newness, area of focus and attributes. Newness and area of focus studies attempt to minimise subjectivity whilst the attributional approach recognises subjectivity as an important discriminating factor in innovation classification. These might be described as objective and perceptual approaches. The former is typified by the work of Damanpour (1988; 1990; 1991; 1992). The latter group argues that innovations possess attributes projected by and consequently measurable from the point of view of the innovator or potential user (Rogers, 1962; Fliegel and Kivlin, 1966; Rogers and Shoemaker, 1971; Rogers, 1983; Moore and Benbasat, 1991; Agarwal and Prasad, 1997).

It has been argued that a classification of innovation based on configurations of innovations' attributes has the potential to generate new insights and offer theory building opportunities. This research proposes exploring the extent to which such configurations can usefully be found to exist within a population of innovations. New insights into the relationship between innovations and processes can be developed if the concept of innovation is less narrowly conceived (Subramanian, 1996). The previous chapter closed with a reflective question on how such a classification might look.

This chapter has two objectives. First it reviews previous studies in which innovation attributes have been operationalised. Two types of study are identified: those that operationalise uni- or bi-dimensional investigations and, multi-attribute studies in which three or more attributes are operationalised concurrently in more holistic frameworks. Empirical studies of the latter type are infrequently found. Second, it has the objective of gathering data to be the raw material for developing a framework of innovation based on attributes. As such it is an inductive study in its own right.

The methodology is further developed in Chapter six, but it is important to note the ways in which this chapter differs from those that comprise the literature review. One objective of preceding chapters has been to map the world of innovation studies in order to identify a gap and locate this research within that wider context. Whilst one objective of this chapter is to map the domain of attribute research within the field of innovation the second is to undertake a rigorous and comprehensive thematic analysis. Consequently, this chapter reports on an inductive study of the literature looking for attributes in the original authors' own language. These 'first level codes' (Miles and Huberman, 1994) will later (see Chapter seven) be subject to second level coding guided by the four key elements of the West and Farr (1990) definition of innovation that guides this research.

This chapter is organised as follows. First, the significance of attributes in innovation research is briefly examined. Next follows a discussion of attributes found in the literature. The resultant analysis provides a basis for mapping the literature and unearthing gaps, importantly it also generates a resource of theoretically-derived attributes which, later in this study, are used to populate a formal framework of innovation attributes. Finally, attributes are discussed in the context of the current research agenda and some methodological issues highlighted.

5.2 Attributes in innovation research

The importance of attribute studies in innovation research has long been recognised but 40 years after Fliegel and Kivlin's (1966) study there are still relatively few empirical studies, perhaps due to "*the considerable complexity of the research task*" (Fliegel and Kivlin, 1966; 236).

There are several reasons why the perceptions of innovators and adopters continues to deserve attention. It is something of a convention in social psychology that an individual's circumstances effect his subjective perceptions of objects and ideas. Rogers and Shoemaker (1971; 137) observe, "*[I]t is the attributes of a new product, not as seen by experts <u>but as perceived by the potential adopters</u>, that really matters*" (original emphasis). Amabile et al. (1996; 1180) confirm this in the context of creativity, suggesting that the "*perceived work environment does make a difference in the level of creativity in organisations*".

Furthermore, the concept (innovation attribute) is a recurring theme in innovation adoption and diffusion models. The usefulness of research on the attributes of innovation has mainly been to predict the future rate of innovation adoption. Attribute studies tend to be premised on the notion that attributes are a key independent variable in research into the adoption and diffusion of innovations. Empirical and theoretical scholarship would appear to support this assumption (Rogers and Shoemaker, 1971; Rogers, 1983; Moore and Benbasat, 1991; Agarwal and Prasad, 1997; Meyer et al., 1997).

In spite of this, the field requires theoretical refinement due, in some part, to the limited empirical investigations to date and the existence of competing models of significant attributes. Finally, from a pragmatic management perspective, perceptions can be managed. An understanding of which perceptions are relevant or pertain during the innovation process would allow management attention to be focused on improving the conditions that govern those specific perceptions or the climate in which they become manifest (Agarwal and Prasad, 1997).

Rogers (1983) adds another reason for why developing an understanding of the differences in innovations according to their attributes is important in being able to elaborate a robust language and framework to talk at an abstract and comparative level about innovation. Studies based on the attributes of innovation, specified in a more universal and parsimonious model, could offer a route to cumulative research and subsequent theory development by facilitating cross case comparisons. The importance of having a standard classification scheme for describing the attributes of innovations in universal terms is stressed.

Curiously, compared to other aspects of innovation such as actors, context, organisation and communication, the innovation artefact itself is infrequently taken as the unit of analysis. In the absence of a sufficient body of research on innovations themselves, it is difficult to adequately characterise or describe innovations in terms of their differences and similarities and this limits our ability to generalise from one innovation to others. Fliegel and Kivlin's (1966; 236) observation that there is a need to put innovations on a "*common footing, and thus generalise across innovations*" still holds today. The inadequacy stems from a paucity of empirical multi-attribute studies.

In spite of its demonstrated importance innovation theory lacks an empirically-grounded, general, formal framework that can describe a range of innovations in terms of attributes. A *formal* framework is constituted of categories generated at a higher level of generality and involves concepts that can be applied to a number of substantive areas. This contrasts with *substantive* frameworks which are generated for a specific or contextual area of social enquiry (Blaikie, 1993). Studies have variously researched the influence of single attributes on adoption and diffusion or process or, presented different 'bundles' of attributes to explain and predict adoptive behaviour. Multi-attribute studies of 'bundles' of attributes tend to be operationalised in substantive as opposed to formal research.

Different researchers emphasise the role of different attributes across studies. Downs and Mohr (1976) describe two generic categories of attribute: primary and secondary attributes. Primary attributes, they argue are invariant, unchanging across cases. They are constant, regardless of context, an inherent part of an innovation, for which there would be "*essentially no variation among the organizations studied in categorizing the innovation on that attribute*" (Downs and Mohr, 1976; 703). They suggest *cost* or *size* as examples.

Results of studies operationalising primary characteristics of innovation have been inconsistent because behaviour is predicated on perceptions, not inherent characteristics (Downs and Mohr, 1976). Tornatzky and Klein (1982) challenged the distinction between primary and secondary attributes as inappropriate because all attributes, they argue, vary perceptually. For example, Downs and Mohr (1976) suggest that the cost or price of an innovation should be regarded as a fixed intrinsic feature of the innovation. The impact of cost may, however, be differentially reified according to individuals' perceptions in different contexts. That is, it might be construed as expensive in one context and inexpensive for another.

So, it is argued, perceptual items that are relative to the innovator or adopter have a greater effect as determinants of innovation than do primary attributes. It is not the intrinsic properties of the primary attributes that are important but the way in which they are perceived that is the basis for action and behaviour: behaviour and sensemaking is predicated on perceptions (Reger and Huff, 1993). Downs and Mohr (1976) call those attributes that are determined by individual perceptions and subjectivity, secondary attributes.

Tornatzky and Klein (1982) suggest Downs and Mohr underestimated the importance of perceived attributes. Downs and Mohr (1976; 703) though, do acknowledge that "*most if not all characteristics upon which one might consider basing a typology turn out to be secondary attributes of innovations*". Because researchers place different emphasis on the particular attributes that are thought to be significant, there is a lack of clarity about selection and operationalisation of attributes at a universal level. Although Rogers and Shoemaker (1971; 137) argued the need for a "*standard classification scheme for describing the perceived attributes of innovation in universal terms*", arguably, no such scheme yet exists.

This research has identified seven empirical multi-dimensional studies of innovation attributes published since 1966 (see table 5-5). Each study is underpinned, to a greater or lesser extent, by Rogers' (1983) five factor framework. Notwithstanding its obvious merits (see below) there are two problems with Rogers' general framework. The first is that the scheme was developed from a meta-analysis of previous studies grounded principally in rural sociology, and so runs the risk of context specificity. The second, and more significant weakness is, as Rogers and Shoemaker admit (Rogers and Shoemaker, 1971; 171), that the postulation of five attributess is logical but empirically indefensible.

Future studies should, therefore, be cautious about operationalising studies based on the unthinking adoption of extant frameworks. The remainder of this chapter is dedicated to a review of attributes identified in the literature and serves two purposes. First, it provides a review and critique of attribute-centric studies. Second it is an inductive investigative study in its own right. One objective of the current research is to generate a formal framework of innovation. The constructs that populate the framework may be theoretically- and/or empirically-derived. One output of this review is an extensive list detailing attributes that have been operationalised in innovation research. These may be considered a resource to populate a formal framework. This process begins with a review of singular attributes used in studies, this is then followed by a review of multi-attribute studies.

5.3 Theoretically-derived attributes

5.3.1 Singular items

Table 5-1 itemises 55 attributes of innovations identified from the literature. It is evident that many of them are virtual synonyms and there is clearly a lack of conformity in the labelling and definition of attributes. Garcia and Calantone (2002) suggest that such a state of affairs may be attributable to the fact that innovations are researched in a variety of disciplines and language develops differentially within the confines of each.

Attribute	Observations	Indicative literature
Adaptability	The degree to which an innovation can be modified to fit local needs. Similar to flexible, mutual adaptation.	Holloway, 1977; Wolfe, 1994; Meyer et al., 1997; Leonard-Barton and Sinha, 1993
Applicability	The degree to which an innovation is communicated as having more than one use in more than one context.	Dearing and Meyer, 1994
Architectural	Architectural vs. modular or component: architectural innovation is that which changes the way the components of a product are linked together whilst leaving the core design concept untouched. It destroys architectural knowledge but leaves intact component knowledge. Once a dominant design is accepted within the industry architectural knowledge becomes stable, encoded and implicit. Incremental innovation occurs within the context of stable architectural knowledge.	Henderson and Clark, 1990
Association with dairying	Relatedness to the core activity of the adopter.	Fliegel and Kivlin, 1966
Autonomous	Autonomous innovations can be pursued independently from other innovations. Similar to component innovation (part of the system can be redesigned without necessity of redesigning the whole, see also Architectural). Goodman (1981) counterpoises autonomous with systemic innovations. The benefits of a systemic innovation can only be realised in conjunction with related, complementary innovations for example, Polaroid camera and film (Chesborough and Teece, 1996). Autonomous innovations directly replace an existing product or process whereas a systemic innovation requires other products or processes to adapt significantly in order for the subject innovation to be effective. Similar to individual and instrumental innovation..	Goodman, 1981; Chesborough and Teece, 1996
Centrality	Central vs. peripheral: the degree to which innovation concerns the major day to day work of the organisation and involves activities critical to organisational performance.	Nord and Tucker, 1987; Wolfe, 1994
Communicability	The degree to which aspects of an innovation may be conveyed to others, positively related to rate of adoption.	Zaltman et al., 1973; Tornatzky and Klein, 1982; Rogers, 1983; Dearing and Meyer, 1994; Meyer et al., 1997; Zaltman et al. 1973; Tornatzky and Klein, 1982; Meyer et al., 1997
Commutuality	The degree to which an innovation is communicated as exhibiting a complementary relationship with other innovations.	Dearing and Meyer, 1994
Compatibility	The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. The degree of difference from previous ways of doing the job. The degree to which an innovation is communicated as being consistent with past experiences, existing practices and the needs of potential adopters. The degree to which an innovation is perceived as consistent with the existing values of the receivers, and is positively related to rates of adoption. Frequently used in studies but mostly inferred rather than measured. Positively related to adoption.	Rogers, 1962; Zaltman et al., 1973; Fliegel and Kivlin, 1966; Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982; Moore and Benbasat, 1991; Dearing and Meyer, 1994; Agarwal and Prasad, 1997; Meyer et al., 1997
Complexity	Embraces multiple concepts but mostly derived from techno-centric view of innovations, the idea origins of the innovation and organisational complexity. Relates to the ease of understanding and use; the degree to which an innovation is communicated as being relatively difficult to use; the degree to which an innovation is perceived to be difficult to understand and use, and is negatively related to rates of adoption.	Rogers, 1962; Fliegel and Kivlin, 1966; Rogers and Shoemaker, 1971; Tornatzky and Klein, 1982; Rogers, 1983; Pelz, 1985; Gopalkrishnan and Damanpour, 1994; Dearing and Meyer, 1994; Meyer et al., 1997

Continuous improvement	Can be understood in several ways: to improve; as a core value for organisational renewal; as a process for incremental change. The objective is the attainment of advantage either through efficiency or, improvements.	Bessant and Caffyn, 1997
Cost	Various perspectives on cost, but principally financial: how much, running costs, initial cost, continuing cost, rate of cost recovery, negatively associated with adoption, relatively easy to measure. Social cost, affecting power and status is the principal non-financial perspective.	Fliegel and Kivlin, 1966; Zaltman et al., 1973; Tornatzky and Klein, 1982
Discontinuous	Fundamental changes in the organisation and a large departure from existing practice.	Lambe and Spekman, 1997; Rice et al., 1998; O'Connor, 1998
Divisibility	The extent to which an innovation can be tried on a small scale prior to adoption, research results inconsistent; the degree to which an innovation is communicated as allowing incremental implementation of its components. The degree to which the innovation is a tight package of inter-linked parts as opposed to being a loose composite of independent parts that could be adopted separately. Similar to status quo ante and reversibility.	Rogers, 1962; Zaltman et al., 1973; Tornatzky and Klein, 1982; Dearing and Meyer, 1994; Wolfe, 1994
Ease of operation	Similar to complexity in that it articulates users' views on the ease or difficulty in making use of the innovation.	Tornatzky and Klein, 1982; Moore and Benbasat, 1991; Adams et al., 1992; Agarwal and Prasad, 1997
Economic advantage	The innovation is more cost effective than that which it supersedes. Similar to relative advantage.	Zaltman et al., 1973; Dearing and Meyer, 1994
Effectiveness	The degree to which an innovation is communicated as being relatively more capable of achieving an ideal end-state. Relates to the extent to which the innovation addresses the problem for which it was initiated. Perceived effectiveness of innovations influence rates of adoption and contribute to the organisation's ability to fulfil its mission and achieve its objectives.	Pelz, 1985; West and Farr, 1990; West, 1990; Dearing and Meyer, 1994; West and Anderson, 1996
Flexible	The ability to modify an innovation according to needs of the implementor. Similar to adaptability, reversibility, mutual adaptation.	Tornatzky and Klein, 1982; Wolfe, 1994
Image	Innovation motivated by prestige and social status. Enhanced social status of user through adoption. Had been subsumed within relative advantage by Rogers (1983).	Mohr, 1969; Rogers, 1983; Moore and Benbasat, 1991; Agarwal and Prasad, 1997
Incremental	Those that result in a low degree of departure from existing practices. Similar to continuous improvement.	Damanpour, 1996
Individual	Individual vs. synergistic: individual innovations affect only a single functional area and do not affect other functions or cause wider change. A synergistic innovation is one that requires that many functions are affected.	Goodman, 1981
Instrumental	Instrumental vs. ultimate: ultimate innovations are ends in themselves, instrumental innovations are necessary to facilitate the introduction of the ultimate.	Zaltman et al., 1973; Wolfe, 1994
Interpersonal relationships	The potential of innovations to have consequences for individuals and their relationships. Zaltman et al. (1973) describe a disruptive-integrative continuum along which to conceptualise impact.	Zaltman et al., 1973
Magnitude	The degree of displacement of existing organisational states that the innovation implies – structural, personnel, financial etc. Operationalised by West and Anderson (1996) as the perceived consequence of the change in comparison to other changes.	Wolfe, 1994; West and Anderson, 1996

Mechanical attraction	Personal interest in the technology.	Fliegel and Kivlin, 1966; Tornatzky and Klein, 1982
Mutual adaptation	The degree to which users refine a system to fit their particular need. Similar to adaptability, flexible, reversibility.	Leonard-Barton and Sinha, 1993
Newness and novelty	Principally perceived from one of two perspectives. Newness to the context of application (firm, market etc) or according to component parts (e.g. technology). Dimensionalised along continua typically ranging from new to the world to style changes.	Heany, 1983; West, 1990; Leonard, 1998; Tatikonda and Rosenthal, 2000; Avlonitis et al., 2001; Danneels and Kleinschmidt, 2001; West, 1990; Krippendorff, 1997; Leonard, 1998; Tatikonda and Rosenthal, 2000; Avlonitis et al., 2001; Danneels and Kleinschmidt, 2001
Observability	The degree to which the results of an innovation are visible to others, and is positively related to rates of adoption; it is not clear whether or not observability per se is being assessed or the observability of different attributes; the degree to which the results of an innovation are communicated as being visible to others. Similar to visibility.	Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982; Meyer and Goes, 1988; Dearing and Meyer, 1994; Meyer et al., 1997
Originality	Different levels of originality exist : 'originated' (developed entirely in-house and are wholly original); 'borrowed' (copied from outside with no modification); 'adapted, (prior solutions identified and modified to fit the local context).	Pelz, 1983; Pelz, 1985; Amabile et al., 1996
Payoff	Financial return from adoption.	Fliegel and Kivlin, 1966; Tornatzky and Klein, 1982
Pervasiveness	The proportion of total behaviours occurring within an organisation that are expected to be affected by the innovation. Pervasiveness is a function of how many organisational members are expected to change their behaviours due to the innovation and for how much time those involved will be behaving in new ways. Does it lead to other change or practice.	Fliegel and Kivlin, 1966; Becker and Whisler, 1973; Beyer and Trice, 1978; Tornatzky and Klein, 1982; Wolfe, 1994
Point of origin	Origins of the innovation - endogenously developed or exogenously derived.	Zaltman et al., 1973; Pelz, 1983; Pelz, 1985
Profitability	The level of profit gained from adoption of the innovation, may not be appropriate for all innovations.	Tornatzky and Klein, 1982
Quality	Consists of magnitude, radicalness and novelty.	West and Anderson, 1996
Radical	The degree to which an innovation is communicated as being different from existing innovations. Radical vs. incremental: radical innovation, a new paradigm, the 'next killer application' all point to the same thing – fundamental change in the activities of the organisation and a large departure from existing practices. Lambe and Spekman (1997) called it discontinuous technological change (DTC) and suggested that it poses a significant challenge for the companies operating in the affected industry. The concept tends to have been applied to technological innovation. Operationalised by West and Anderson (1996) as the perceived changes in the status quo resulting from adoption.	Numerous, including: Zaltman et al., 1973; Tornatzky and Klein, 1982; Dearing and Meyer, 1994; West and Anderson, 1996; Lambe and Spekman, 1997; Wilson et al., 1999
Relative advantage	The degree to which an innovation is perceived as being better than the idea it supersedes or, is better than alternative solutions and is positively related to rate of adoption. Tornatzky and Klein (1982) were critical of the vagueness of the construct, indeed some studies have disaggregated it into sub-attributes, but it is, nevertheless, a frequently used attribute.	Rogers, 1962; Zaltman et al. 1973; Rogers and Shoemaker, 1971; Tornatzky and Klein, 1982; Rogers, 1983; Moore and Benbasat, 1991; Adams et al., 1992; Agarwal and Prasad, 1997; Meyer et al. 1997; Wilson et al., 1999
Reliability	The degree to which an innovation is communicated as being consistent in its results.	Tornatzky and Klein, 1982; Dearing and Meyer, 1994

Result demonstrability	The tangibility of the results of using an innovation.	Moore and Benbasat, 1991; Agarwal and Prasad, 1997
Returns to investment	Varies across organisations and sectors depending on resource availability and policy on investment return. Difficult to determine in non-profit organisations.	Zaltman et al., 1973
Reversibility	The degree to which an innovation can be reversed. Similar to status quo ante and divisibility.	Zaltman et al., 1973
Revolutionary	Evolutionary vs. revolutionary: continuous improvement or paradigm/system changing. Similar to radical.	Rabson and DeMarco, 1999
Risk	Often associated with uncertainty, varies across organisational contexts and perceived in different ways. E.G. the degree to which the medical profession accepted the equipment as safe and efficacious; the level of risk liability to which an adopting organisation is exposed; the degree to which organisational members perceive the new interventions to be risky. The greater the uncertainty of the outcome the greater the degree of perceived risk. Risk can be at its least where market, product and process repercussions are non-existent or minimised. Operationalised risk by pooling the judgements of a panel of experts.	Zaltman et al., 1973; Heany, 1983; Bommer and Jalajas, 1999; Taggart and Blaxter, 1992; Tornatzky and Klein, 1982; Meyer and Goes, 1988; Meyer et al., 1997
Saving discomfort	Discomfort prevented following adoption.	Fliegel and Kivlin, 1966; Tornatzky and Klein, 1982
Saving time	Time saved following adoption.	Fliegel and Kivlin, 1966; Tornatzky and Klein, 1982
Scientific status	Reliability, validity, generality and internal consistency important as a knowledge component of innovation. Similar to uncertainty.	Zaltman et al., 1973
Scope	Linkage between innovation and its environment. That is, to what extent can the innovation stand-alone and be pursued independently or, does its introduction require changes elsewhere in the system? Similar to autonomous and architectural.	Goodman, 1981; Henderson and Clark, 1990; Chesborough and Teece, 1996
Skill	The extent of specialised expertise or training needed for a typical specialist to begin using the equipment.	Meyer and Goes, 1988
Social approval	A non-financial aspect of reward emanating from association with the innovation. Status gained in one's reference group. Are people likely to look up to the farmer because he uses it (Fliegel and Kivlin, 1966)? Similar to image.	Fliegel and Kivlin, 1966; Tornatzky and Klein, 1982
Status	The extent to which an innovation is adopted in the quest of prestige rather than organisational profit or effectiveness.	Mohr, 1969; Wolfe, 1994
Status quo ante	The degree to which and the ease with which the status quo ante can be restored, positively related to adoption. Similar to reversibility.	Zaltman et al., 1973
Susceptibility to successive modification	Degree to which the innovation can be modified in response to technological change or other requirements. Similar to adaptability.	Zaltman et al., 1973
Terminality	A point in time beyond which adoption would appear to be less rewarding. Number and spacing of terminal points may have significant impact on adoption.	Zaltman et al., 1973
Trialability	Various conceptualisations: ease of trial ; the degree to which an innovation may be experimented with on a limited basis; the degree to which an innovation is communicated to allow experimentation on a limited basis; the degree to which an innovation may be experimented with on a limited basis. Those that can be trialed will be adopted more quickly, though results are ambiguous, as trial reduces uncertainty.	Fliegel and Kivlin, 1966; Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982; Moore and Benbasat, 1991; Dearing and Meyer, 1994; Agarwal and Prasad, 1997; Meyer et al., 1997

Uncertainty	Knowledge concerning the link between the innovation's inputs, processes, and outcomes.	Zaltman et al. 1973; Souder and Moenaert, 1992; Wolfe, 1994; Deyle, 1994; Shane, 1995; Brouwer, 2000
Visibility	The extent to which potential adopters see the innovation as being visible in the adoption context. Similar to observability.	Tornatzky and Klein, 1982; Moore and Benbasat, 1991; Agarwal and Prasad, 1997

Table 5-1: Innovation attributes, singular items (after Wolfe, 1994)

Because of labelling, issues of similarity of attributes and, cognisant of the guidelines for classification outlined in the previous chapter, it is considered inadvisable to operationalise the list of attributes from table 5-1 in this study. Similarly the numbers involved would make such a study impractical within the constraints of this research. However, the list constitutes a valuable resource for a descriptive framework of innovations based on their attributes. The inclusion of any attributes in a framework must be justifiable and, the basis on which attributes are incorporated into or rejected from the framework developed in the current research is described in Chapter seven.

The following section reviews multi-attribute studies.

5.3.2 Multi-attribute empirical studies

As was noted earlier in the chapter, seven empirical multi-attribute studies have been identified and these draw heavily on the influence of Rogers' (1983) five factor framework. Rogers' work is not empirical but is a synthesis of previous studies. However, because his studies are central to any discussion of research utilising attributes of innovation a discussion of Rogers' framework opens this section.

Rogers' (1983) view of innovation is as an innovation-decision process that commences at the convergence of awareness of a problem or issue with first knowledge of the existence of a potential innovation solution. His process begins with the knowledge of "*when an individual is exposed to the innovation's existence*" (Rogers, 1983; 164). The view appears to privilege exogenously derived innovations. This perhaps best explains his assertion of the importance of perceptions to adoption and diffusion.

Rogers (1962; 1983) and Rogers and Shoemaker (1971) drew heavily on innovation studies in agriculture and, to some extent education, to develop a five-factor framework of innovation attributes said to influence rates of adoption. In the first study Rogers (1962) categorised the attributes as relative advantage, divisibility, complexity, compatibility and, communicability. In subsequent publications, modifications to divisibility (becoming trialability) and communicability (becoming observability) reflected a concern for descriptive precision. These factors are detailed in table 5-2.

Rogers' (1962; 1983) and Rogers and Shoemaker's (1971) objective was to present five conceptually distinct but empirically interrelated attributes of innovation that were as mutually exclusive and universally relevant as possible. They argue that their five

Attribute	Description
Relative Advantage	The degree to which an innovation is perceived as being better than the idea it supersedes. Advantage can take several forms, particularly economic and social factors. Because of the economic factor, diffusion researchers are not surprised to find relative advantage a good predictor of adoption.
Compatibility	The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters. Change agents find it difficult in promoting innovations that run counter to strongly held values. The more compatible the more likely to be accepted but 100% compatibility implies that the degree of change would be marginal.
Complexity	The degree to which an innovation is perceived as being difficult to understand and use, classified on a complexity-simplicity continuum.
Observability:	The degree to which the results of an innovation are observable to others, the more observable the more likely adoption.
Trialability:	The degree to which an innovation may be experimented with on a limited basis before adoption. Those that can be trialed will be adopted more quickly as trial reduces uncertainty.

Table 5-2: Rogers' (1983) framework

factors are the most important attributes as most other attributes can be subsumed within their meanings. In subsequent studies this has led to some difficulties as researchers have tried to extract from Rogers' attributes further characteristics that appear to be subsumed within the meaning but appear to differentially explain rates of adoption and diffusion (Tornatzky and Klein, 1982; Meyer et al., 1997). Indeed, some studies have shown that the five attributes may only partially account for varying rates of diffusion (Tornatzky and Klein, 1982).

Although studies that specifically focus on attributes of innovation are comparatively infrequent in the great corpus of innovation studies, a large number of attributes can be identified. In most cases these attributes are studied as determinants of an adoption or rejection decision and, Rogers (1983) argues, can generally be subsumed under the five attributes he proposes as a general framework. Rogers noted, from early sociological studies of innovation in agricultural and educational contexts, that similar attributes may be important for predicting rates of adoption in both contexts. Citing these earlier empirical studies, Rogers finds some support for the general framework that he proposes, particularly for relative advantage, compatibility and complexity, but less so for trialability and observability, though each of the attributes features to a greater or lesser extent. It is evident, then, that in multi-attribute frameworks different innovations are reflected in different configurations of attributes according to the presence, absence or degree of that attribute.

Evidence of the strength of the influence of Rogers' (1983) work is amply demonstrated in table 5-3. In total Rogers' (1962; 1983) and Rogers and Shoemaker's (1971) works have generated 299 citations. The next best total is 31, shared between Agarwal and Prasad (1997) and Wilson et al. (1999). Clearly, it is to their (i.e. Rogers and Shoemaker) advantage, in terms of numbers of citations, that their books have been available for up to 40 years and, in terms of subject matter, cover a wide range of innovation topics and are not just restricted to the notion of attributes.

Study	Number of citations
Rogers (various)	299 (1962, 72; 1971, 2; 1983, 225)
Agarwal and Prasad, 1997	31
Wilson et al. 1999	31
West and Anderson, 1996	19
Pelz, 1985	10
Dearing and Meyer, 1994	6
Fliegel and Kivlin, 1966	0
Meyer and Goes, 1988	0
Moore and Benbasat, 1991	0

Table 5-3: Citations of multi-attribute innovation studies (Source: Web of Science, March 2003)

Rogers and Shoemaker (1971) recognise some of the limitations of their work and suggest areas for future research, these are illustrated in table 5-4. Of the five areas indicated this research attempts to contribute in two. First, to the improved measurement of attributes, many past studies' ratings have been made on the basis of answers to single item surveys and so there is a need for a scale composed of numerous items. Second, to the study of innovation bundles.

Issue	Addressed by
Measuring perceived attributes at the time of the innovation decision not in retrospect.	King (1992), but not a multi-attribute study
Differential perceptions by different adopter groups	
Improved measurement of perceived attributes, past studies ratings have been made on basis of answers to a single question – need a scale composed of numerous questions	Moore and Benbasat, 1991; Dearing and Meyer, 1994; Dearing et al. 1994; Meyer et al., 1997 This research
Factor analysis of perceived attributes – how many and which ones are significant?	Moore and Benbasat, 1991; Dearing and Meyer, 1994; Meyer et al., 1997
Studying innovation bundles – most previous studies have been limited in the number of innovations that they study	This research

Table 5-4: Needed research on innovation attributes (source, Rogers and Shoemaker, 1971; 168-172)

Other empirical research, following on from the work of Rogers (1962; 1983) and Rogers and Shoemaker (1971), have also, addressed some of these areas, and it is to these that this review now turns. The studies reviewed are synopsised in table 5-5. The five factors are seen to be influential however, they do not overly constrain subsequent research, yet, there is no single, stable, consistent categorisation of attributes that can easily and parsimoniously capture the multidimensional complexity of innovation.

Study	Focus	Unit of analysis	Attributes operationalised	Nature of study
Fliegel and Kivlin, 1966	Process of innovation diffusion.	Innovation. 33 farm innovative practices from a list of 59 drawn up by 229 dairy operators.	Initial cost, continuing cost, rate of cost recovery, payoff, social approval, saving of time, saving of discomfort, regularity of reward, divisibility for trial, complexity, clarity of results, compatibility, association with dairying, mechanical attraction, pervasiveness. 4 point scale to reflect degree of possession of the attribute (infers range of character states).	Selected "*those attributes of innovations which have been suggested or shown to have some bearing on the diffusion process*" (pp237). Some were general others specific to the context. Rate of adoption of 33 farm practices. Most readily accepted innovations are characterised by being perceived to be least risky and most rewarding. Respondents were interviewed.
Holloway, 1977 (unpublished PhD thesis)	Degree to which adopters' and potential adopters' perceptions of an innovation related to adoption decision.	Innovation. Specified educational innovation.	Relative advantage (cost) 4 items, relative advantage (status) 4 items, compatibility 5 items, observability 4 items, simplicity (or complexity) 3 items, trialability 2 items.	Extends Rogers (1962) with addition of items relating to status and prestige included under the rubric of relative advantage. 22 Likert items to investigate adoption of specified educational innovation. Early adopters are different from late adopters.
Pelz, 1985	Investigation of stages model of innovation process and relation with organisational and innovation attributes.	Respondents interrogated on adoption of one of three kinds of technically-based innovation.	Technical complexity, organisational complexity, originality (borrowed, adapted, original).	Researchers ranked innovations on dimensions of attributes following unstructured interviews.
Meyer and Goes, 1988	Assimilation of innovations into organisations.	12 Medical innovations (significant departure from previous techniques for diagnosis, treatment or prevention). Expert panel.	Investigate attributes of innovations and, environment, organisational leaders and decision processes. Innovation attributes: risk, skill, observability.	Risk & skill by pooled opinion of expert judges on 7 point Likert scale. Observability by impact on patient flows. Assimilation is a 9-step process. 25 hospitals and 12 innovations over 6 year period.
Moore and Benbasat, 1991	Develop and validate an instrument to measure individual perceptions of information technology innovation.	Information technology innovation.	Voluntariness 4 items, relative advantage 9 items, compatibility 4 items, image 5 items, ease of use 8 items, result demonstrability 4 items, visibility 5 items, trialability 5 items. (also propose a shorter 25 item scale).	Adopts view of secondary attributes (after Downs and Mohr, 1976). Extends Rogers (1962) with other attributes that were "*deemed necessary*" (pp. 195). Synthesis of existing measures and new measures. 3 stages of instrument development: item creation; scale development; instrument testing.
Dearing and Meyer, 1994	Develop attribute-based prediction tool for adoption of innovation.	Innovation. Hazardous waste clean-up technology and process innovations, n=9.	Economic advantage, effectiveness, observability, trialability, complexity, compatibility, reliability, divisibility, applicability, commutuality, radicalness.	Attribute selection justified in terms of prior empirical work (Dearing, Meyer and Kazmierczak, 1994). Responses on 7 point Likert scale.

Study	Focus	Unit of analysis	Attributes operationalised	Nature of study
West and Anderson, 1996	Investigation of top management teams and innovation.	Innovation. 205 innovations in 27 hospitals.	Magnitude, radicalness, novelty, benefit to administrative efficiency, benefit to patient care, benefit to staff well-being (1 item for each factor).	Innovations rated on dimensions of attributes by domain-relevant experts. Rating on a 1-5 scale.
Agarwal and Prasad, 1997	Adoption of an innovation: initial use and intended continued use of the World Wide Web. Are the perceptions that predict initial use the same as those that predict continued use?	Innovation, use of the World Wide Web.	Relative advantage 5 items, ease of use 4 items, compatibility 3 items, image, 3 items, result demonstrability 4 items, visibility 2 items, trialability 2 items.	User perceptions demonstrated to be instrumental in explaining a substantial proportion of the variance in both current use and future intentions: particularly, compatibility, trialability and visibility. Operationalisation of slightly modified Moore and Benbasat (1991) instrument. 7 point Likert scale anchored with strongly agree/disagree.
Meyer et al., 1997	Implementation of multiple innovations into a new organisational form.	Innovation, three contrasting health service innovations.	Relative advantage 5 items, compatibility 2 items, observability 3 items, complexity 4 items, trialability 5 items, adaptability 5 items, riskiness 4 items.	Construct identification through a theory-driven process. Self reported questionnaire amongst key decision makers (n=89).

Table 5-5: Empirical multi-attribute studies of innovation

It was noted earlier that Fliegel and Kivlin (1966) attributed the shortage of multi-attribute studies of innovation to the complexity of the task. They operationalised 15 attributes on the basis that they "*have been suggested or shown to have some bearing on the diffusion process*" (Fliegel and Kivlin, 1966; 237). The selected attributes include those that are highly context specific (e.g. association with dairying) those that are economically-oriented (e.g. cost and profitability) and those that are somewhat general in nature (complexity, compatibility, trialability), the latter 'bundle' betraying the influence of Rogers (1962).

The Fliegel and Kivlin (1966) study was limited to only 33 innovative farm practices. They described this as a manageable number but observed that "*the prospects for including substantially larger numbers of innovations in a meaningful research design are not bright until some progress is made toward establishing comparability among these innovations*" (Fliegel and Kivlin, 1966; 239).

Dearing and Meyer (1994) developed interesting tools to enable the comparison of innovations. They develop and describe the 'attribute matrix' and the 'innovation profile'. The former is a representation of both innovator perceptions and those of potential adopters about the attributes of an innovation selected *a priori* by the researchers. It was generated from the innovator's and potential adopter's responses to a questionnaire relating to each of the 11 operationalised attributes scored on a seven-point Likert scale. The two sets of scores were then ranked alongside each other and the differences (or similarities) investigated in terms of the evaluative communications (positive or negative) about the innovation made by the innovator.

The innovation profile is a composite description of innovators' perceptions and communications about their innovations. It is an instrument that assigns a value to potential adopter's perceptions about an innovation by summing an innovator's score for each attribute and calculating the mean. Innovation profiles for nine functionally similar innovations, described as 'high-risk', were developed.

To develop the innovation profiles, the study operationalised 11 attributes, in terms of how information about the innovation is communicated, in the form of a questionnaire. Six of the attributes were drawn from the Rogers (1983) framework (relative advantage having been disaggregated into economic advantage and effectiveness). The remaining five attributes (reliability, divisibility, applicability, commutuality and radicalness) were included on the basis of the researchers' expectation that these factors would be significant to adopters in thinking about high-risk innovations. It is not clear though, why a factor 'risk' was not included, although, arguably, 'risk' might be subsumed within the factor 'reliability'. The study concludes that diffusion is dependent on the perceptions of both innovator and adopter moderated by the 'evaluative communication' sent by the innovator.

Meyer et al. (1997; 123), describe the innovation profile as "… *a promising tool to assess organisational members' perceptions of innovation attributes*". They extend the work on multi-attribute measures of innovation in a study of three health service innovations. In their selection of salient attributes Meyer et al. (1997) were influenced by both Rogers' (1983) Dearing and Meyer (1994) and Dearing, Meyer and Kazmierczak (1994). However, they introduce two further attributes alongside modified conceptualisations of Rogers' original five: risk and adaptability. The study though is limited by its failure adequately to justify the selection of attributes on which its case is built. Also, the study sample of three innovations is small and context specific to an emergent organisational form (a network of contractors providing services for a federal government agency), thereby limiting the generalisability of results.

The research employed diffusion of innovations theory to contrast three different preventive health interventions by their innovation attributes. In doing so it continues empirically to develop the field opened up[5] by Dearing and Meyer (1994) of instrument development for the comparison of innovations. However, the results of the study are limited by the size of sample and single organisational context. Nevertheless, they report two interesting (for this research) findings. First, the three innovations were rated differentially, and so are discrete from each other, according to degrees of difference in attributes. For example "*...project 3 had significantly higher levels of relative advantage than project 2. Project 2 was rated more highly than project 1 or project 3 in terms of risk…*" (Dearing and Meyer, 1994;124), and so on. Meyer and Goes (1988), too, noted different configurations of attributes resulting from their study. Innovations that were highly observable, carried low risks and required relatively little skill to use were more readily assimilated than were other innovations. This lends support to one of the assumptions underpinning this research that attributes configure differently for different innovations, thereby distinguishing innovations from each other. It is proposed that these configurations could lead to the development of a novel taxonomy of innovation developed from a large sample of innovations.

The second interesting finding is the support, or not, that the research uncovered for the operationalised attributes. Support was found for riskiness, adaptability and effectiveness however, observability and trialability did not appear to affect innovation acceptance. On the other hand, Agarwal and Prasad's (1997) study of initial use and intended continued use of the World Wide Web found support for each of the seven attributes they operationalised. However, support differed according to initial use or intended continued use.

In fact, Agarwal and Prasad (1997) operationalised an eighth attribute, 'perceived voluntariness', the extent to which potential adopters perceive the adoption decision to be non-mandated. In the context of this research, however, this item was considered not to be an attribute of the innovation but reflected organisational climatic conditions, and is thus discounted from this review.

Agarwal and Prasad (1997) operationalised a slightly modified version of Moore and Benbasat's (1991) instrument to measure the perceptions of adopting an information technology innovation. Moore and Benbasat's (1991) work appears to have been motivated by their observation that most existing instruments lack reliability and

[5] Moore and Benbasat (1991) pre-date Dearing and Meyer, but they did not apply the framework that they had developed other than in rounds of validation.

validity and that no comprehensive instrument to measure the variety of perceptions of innovations had been found to exist.

The instrument they develop is wholly theoretically-derived. They rely on four unpublished PhD theses, one personal communication, one conference paper and one (empirical) journal paper, as well as drawing on Rogers (1983), to provide the attributes that comprise their instrument. The extent to which they trawled outside the mainstream journal sources for evidence from empirical studies lends support to their assertion that no valid or reliable instrumentation for the operationalisation of Rogers' model existed. Ultimately they rely on attributes identified in Rogers (1983) and by the meta-analysis of Tornatzky and Klein (1982) to populate their instrument. As has been seen in the other studies reviewed here they chose to disaggregate the attribute relative advantage, extracting from it the attribute 'image'.

Their instrument, whilst comprehensive within the frame of reference they set themselves, is limited in two ways. First, the study appears restrictive, limited, principally, to a small number of published studies, one of which describes its framework as empirically indefensible (Rogers and Shoemaker, 1971; 171). Second, instrument development is restricted by both context (limited to information technology innovation) and by stage of innovation process (adoption based on perceptions of individual users).

Tornatzky and Klein (1982) undertook a review and meta-analysis of 75 studies concerned with innovation attributes and their relation to innovation adoption and diffusion. Many of the studies they review form the basis of Rogers' (1962, 1983) framework, and so are not included in this review. They describe the measurement of potential adopters' perceptions of innovation as a classic issue in the innovation literature (pp. 28). The assertion of this study, that the majority of studies in this area operationalise relatively few attributes, is supported by Tornatzky and Klein's (1982) observation that less than one-third of the studies they analysed had investigated four or more attributes. Their study concluded with the identification of the 10 most frequently referred to attributes, these were: cost, communicability, divisibility, profitability, social approval, observability, trialability, compatibility, relative advantage and complexity. Of these, compatibility, relative advantage and complexity had the most consistent significant relationships with innovation adoption.

Pelz (1985) and West and Anderson (1996) take slightly different perspectives from the studies reviewed thus far. The former, Pelz (1985), considers the relation between attributes and innovation process, the latter (West and Anderson, 1996) the relationship between innovation quality and team composition and social processes. In both of these studies the influence of Rogers' framework is, once again, evident.

Pelz (1985) operationalised three attributes (technical complexity, organisational complexity and origination) and West and Anderson (1996) four (magnitude, radicalness, novelty and benefit). Pelz (1985) concludes that for those innovations that are 'originated' (originates within the organisation as opposed to being exogenously derived) the sequence of events in the process overlaps in time, is muddled and disorderly. For simple innovations that are 'borrowed', a moderately clear succession of stages may appear. The answer to the question "are there innovating stages?" is contingent. That is the resolution of the edges between one stage and another depends on the complexity and/or originality of the innovation. That is not to say though that, a muddled or disorderly process will culminate in an original or complex innovation nor, indeed, that an orderly process in which the stages are relatively clear cannot culminate in an original innovation. The research is inconclusive as regards normative statements about what sort of configuration of attributes is related to any particular process patterns: "*apparently, an effective innovation could occur in either an orderly or muddled fashion, and so could an ineffective one*" (Pelz, 1985; 66).

West and Anderson's (1996) longitudinal study of the functioning of top management teams in 27 hospitals concluded that the degree of radicalness might be predicted by group processes that encourage or discourage members to propose new ways of doing things. However, they draw no conclusions regarding innovations conceptualised in terms of configurations of the attributes they operationalise.

5.4 Discussion

Innovation research is, in some quarters, characterised by the use of attributes and this review has demonstrated the importance of their role in contributing to understanding key aspects of innovation theory. Empirical and theoretical studies in this domain regard individuals' perceptions of innovations as important in understanding, explaining and predicting adoption and diffusion patterns. They lend support to the theoretical relationships between innovation attributes and adoption and diffusion behaviour (Dearing and Meyer, 1994; Meyer et al., 1997), initial use and routinisation of innovations (Agarwal and Prasad, 1997), innovation processes (Pelz, 1985) and, team social processes (West and Anderson, 1996).

Several multi-attribute studies have noted that innovations differ one from another according to different configurations of bundles of attributes. Furthermore, they note that these innovations exhibit different characteristics in terms of their rate of adoption (Meyer et al., 1997) and relation with process (Pelz, 1985; Schroeder et al., 1989; King, 1992). However, in spite of the large debt that the field of attribute studies owes to Rogers' (1983) framework, a widely accepted, valid, robust formal framework appears not to exist. In order to offer a more holistic view of the innovation a synthesis is needed.

In spite of its putative empirical indefensibility, Rogers' (1962; 1983) framework appears to have developed the status of *sine qua non* of attribute research. However, in empirical studies, support for all attributes is not constant and innovation research is still some distance from a universally applicable framework. Some attributes have been shown to be study specific, sector specific, or context specific. This inconsistency makes it difficult to envisage how any extant framework might usefully be operationalised as a general formal framework applicable across cases.

A large majority of studies tend only to operationalise a small number of attributes. Kimberly and Evanisko (Kimberly and Evanisko, 1981) are critical of research that focuses on a single innovation or a single class of innovation as this hampers opportunities for generalisation. The consequence is that little is known about the influence of variability of type (where type is construed in terms of attributes) of innovation on adoption and process. Also they note that sample sizes tend to be small in innovation research, and there is evidence of this in the studies of multi-attribute research reviewed above, thus precluding the opportunity of employing multivariate analytical techniques. That is, there is an absence of systematic quantitative comparative analysis of the characteristics of different innovations within an organisational context.

In terms of attributional studies of innovations, Rogers' (1983) framework provides a useful conceptual scheme of factors. Subsequent empirical and theoretical work has applied, tested, modified and continued to suggest alternative schema, but none of these appear to have taken the notion to its logical conclusion. That is, if innovations can be conceptualised in forms determined by their attributes then, to what extent does this reconceptualisation of the form of innovations support or challenge existing theories about the process origins of innovations that are differentiated according to different schema? Without a shared set of definitions, topics and concepts there can be no cumulative tradition and any cumulative tradition has to be based on "*well-defined constructs...based on theory, and the operationalisation of these constructs through measures with high degrees of validity and reliability*" (Moore and Benbasat, 1991; 193).

Whilst a large number of attributes can be identified in the literature, many are synonyms and are not conceptually distinct and others may be study-specific (for example Fliegel & Kivlin's (1966) 'association with dairying'). A logical approach can produce a synthesis of these attributes refining a long list into a, relatively speaking, parsimonious and generalised list. But given this difficulty and the multiplicity of attributes theorised and operationalised in the literature, what would a comprehensive but parsimonious framework of innovation outcome, whose utility would be in facilitating comparative research, look like?

In the light of this review the literature that focuses on multi-attribute studies of innovation can therefore be considered to be deficient in the following areas: dimensionality, constancy, scope and operationalisation (see table 5-6).

Dimensionality: Tendency to apply constructs in a seemingly *ad hoc* fashion and singly. The consequence has been the development of multiple contextual theories of innovation and the confounding of attempts at cumulative research.
Constancy: There is evident overlap between many of the attributes identified in the literature but apparently little effort has been made to present clear, constant and consistent definitions of attributes within and across studies. Efforts at cumulative research confounded.
Scope: Majority of attributes are found principally in one domain of innovation literature, organisational innovativeness (adoption, implementation and diffusion) and technological innovations. Suggestive of incompleteness and that any framework developed from these may be under-specified. It might be postulated that existing literature overlooks some practitioner views.
Operationalisation: Evidence of few empirically-applied, multidimensional frameworks in the literature.

Table 5-6: Problematising attribute-centric studies

5.5 Conclusion

Despite an extensive body of research that theorises and operationalises attributes of innovation, the literature is characterised by inconsistent and conflicting findings. Arguably, this problem stems from the lack of a generally accepted measure of innovation attributes. This research proposes a formal framework of innovation attributes that is theoretically derived and empirically developed.

So the question at the end of this review is, in terms of a study of attributes of innovation in the NHS, in order to compare across a wide body of innovations which attributes should be included in the framework? There is no shortage of attributes from which to choose and, there is even a short history of operationalised multi-attribute studies. It is, however, difficult to make a choice, from either the long list of individual attributes or, from those operationalised frameworks, that can be justified in terms of the guidelines for classificatory studies outlined in the previous chapter.

Whilst not producing an infinite number, the 55 attributes identified in table 5-1 could conceivably be arranged into 55! (factorial) different combinations each presenting a profile of a different type of innovation – even more if attributes are considered in terms of degree (e.g. high, medium, low) in addition to presence or absence. So many configurations could, arguably, not lead to synthesis or higher level theory but would contribute to increased diversity in innovation research. However

> "*this potential variety is limited by the attributes' tendency to fall into coherent patterns...The upshot is that just a fraction of the theoretically conceivable configurations are viable and apt to be observed empirically*" (Meyer et al., 1993; 1176).

On the assumption, then, that it is an inherent quality of attributes to configure into manageable and coherent patterns, this research can continue in its objective of developing a formal framework to be applied to a sample of innovations to discern if discrete types can be identified.

Tornatzky and Klein (1982; 39) note that an "*ideal innovation characteristics study*" should include the following:

- It must consider more than one innovation attribute so as to fully describe the innovation and also allow for comparison to other attributes.
- It should utilise replicable measures of innovation attributes, and data gathered from participants in the process. Simply inferring the level of certain innovation attributes is not adequate.
- It should study more than one innovation. Single innovation studies are not sufficiently robust to permit generalisation to a population of innovations.

This review has provided a valuable resource that can contribute partially to satisfying their recommendations. The issue becomes one of deciding which attributes, on what basis and how should they populate the framework. The previous chapter has provided some guidelines these and other methodological issues are addressed in the following chapter.

6 METHODOLOGY AND RESEARCH DESIGN

6.1 Introduction

Previous chapters have asserted both the multidimensionality of innovation, which makes its study both interesting and challenging, and the need for a synthesised framework of innovation attributes. A synthesised framework of innovation attributes would offer a new conceptual approach to the study of innovation and has the potential to offer the opportunity to generate new insights into the relationships between innovation types and other domains of innovation study (for example process and performance).

The principal focus of this research is, therefore, to develop a synthesised, formal framework of innovation based on users' and innovators' perceptions, and to consider its utility in the context of innovation process. The perceptual approach requires careful consideration of ontological and epistemological issues. This chapter focuses on these issues and charts a course that locates the research in the realist tradition as described by Bhaskar (1978). Subsequently, research design issues are discussed.

This chapter has three objectives. First, it reviews philosophical perspectives and their implications in the context of the aims of the current research. Second, it builds a research design consistent with the adopted philosophical approach and overall research aim. Third, three phases of empirical research, data collection and analysis are briefly outlined. The organisation of the chapter broadly follows this order of objectives, and begins with a brief review of ontology and epistemology in management research.

6.2 Ontology and epistemology in management research

Tuchman (1994; 306) reminds us that methodology means, not the application of a specific data collection method such as survey or interview but, "*the study of the epistemological assumptions implicit in specific methods*". Arguably, there is no solid enough foundation from which we can begin any consideration of our knowledge of knowledge (Johnson and Duberley, 2000). We have no 'neutral' ground on which to stand to evaluate the relative merits of different ontological and epistemological perspectives (Blaikie, 1993) because they are all human constructions. Popper (1991; 111) noted that the "*empirical basis of science has nothing 'absolute' about it. Science does not rest upon solid bedrock*". Consequently, different philosophical assumptions compete for primacy in the way in which we engage with social enquiry. So-called 'warranted knowledge' is framed by the researcher's ontological and epistemological persuasions and, consequently, it is incumbent on the researcher to articulate his own position regarding of what it is that reality consists (ontology) and how he believes he may come to know that reality (epistemology).

Explorations of competing philosophical perspectives tend to begin with a review of positivism. Positivism was, for centuries, the single and then dominant (in that challengers were few and minor) method of scientific enquiry, derived from the study of natural sciences, and whose tenets remain embedded in the western psyche. The ontological position of positivism is that reality is 'out there', it is single, objective and can be accessed by the researcher who can remain independent and neutral. The objective of positivism is to seek and understand causal relationships in natural phenomena and to explain and predict events. Similarly, in the fields of organisational and management enquiry, the objective of positivism is the discovery of fundamental laws which govern the ways in which organisations operate (Johnson and Duberley, 2000).

Temporal primacy (in that it was first) and longevity (in that it has demonstrated enduring utility), appear to have affirmed the place of the positivistic scientific method as the 'superior' process for generating high quality, warranted knowledge (i.e. in meeting the objectives of understanding, explanation and prediction). Thus positivism has earned the status of referent against which other positions must be judged. Positivism often becomes the 'default' position for which justification for considering alternatives must be given. However, the pre-eminence of the positivist approach in the social sciences should not be confused with any overarching legitimacy as a way of discovering truths. Other, legitimate, competing perspectives have emerged each of which reject, to a greater or lesser extent, some or all of the tenets of positivism. These perspectives are classically represented along a continuum extending from positivism at one end to constructivism at the other.

Constructivism exists at the other end of the continuum from positivism. It conceives of a world that is socially constructed in which meanings are produced by people:

> "*It takes…the meanings and interpretations, the motives and intentions, which people use in their everyday lives, and which direct their behaviour – and elevates them to the central place in social theory and research*" (Blaikie, 1993; 176).

For constructivists, reality is a product of social interactions, and consequently there is no single but multiple realities constructed in multiple contexts. That is, there is no objective reality that can be discovered by researchers. The view is a radical departure from the detached positivist perspective. It privileges subjectivity as the observer/researcher is concerned with how social objects are made meaningful by actors in the 'life world' (Holstein and Gubrium, 1994).

Between the poles of positivism and constructivism, perspectives that do not wholly reject all tenets of either can be identified. These perspectives attack positivism's adherence to the view that reality is objective and external arguing, instead, that reality is socially constructed and given meaning by people (Easterby-Smith et al. 1994; Guba and Lincoln, 1994; Denzin and Lincoln, 1994). Concurrently, they challenge the interpretivist notion of only a socially-constructed reality (Johnson and Duberley, 2000). Table 6-1 illustrates the extremes of this continuum and suggests implications for management research.

Having thus circumscribed the philosophical field, delimited by positivism and social constructivism, it is necessary to outline wherein the current research is located.

	Characteristics of positivism	Characteristics social constructivism
Ontological position: the nature of reality	• External and independent of the observer • Objective and ordered • Single reality • Belief in laws, uniformity and generalisability of knowledge • Reductionist and deterministic	• Reality is socially constructed and apprehendable in multiple forms • Interpretive: socially and experientially based • Changing realities • A product of human minds and has no independent status of its own, reality is determined by meanings individuals give to experience
Epistemological position: acquiring knowledge of reality	• Value free acquisition of sense data accessible by the scientific process which is the only reliable foundation for knowledge • Neutrality • Dualism: researcher remains objective and exterior to the subject. • Reduction of the natural world • Nomothetic (law giving) generalisations • Direct experience • Sense data • Empirical verification	• There is no neutral ground for knowledge since all observation is value laden • Observer becomes part of what is observed • Getting close to the subject • Adopting a holistic view of social phenomena • View social phenomena in their natural environments • Idiographic (relating to individuals) generalisations
Aim of the research	• Suited to the study of "It" beings to generate causal and fundamental laws of human behaviour • Explanation, prediction, control	• Suited to the study of human beings • Those metaphysical things that positivism discounts or cannot access through empirical facts, such as values • Understanding, exploration, emancipation
Attitude of the researcher	• Detached, independent, impartial	• Involved, interacts with the subject in order to gain understanding of the phenomenon
Methods	• Natural sciences methods • Measuring operationalised concepts • Use of large samples • Manipulation and control of isolated variables for the measurement of their relationships with others • Uniformity and generalisability of knowledge	• Multiple methods to establish different views of the same phenomena • Small samples investigated in depth over time • Social constructions can be elicited and refined through interaction between the researcher and the respondent

Table 6-1: Continuum extremes of competing philosophical perspectives and implications for management research (adapted from: Blaikie, 1993; Denzin and Lincoln, 1994; Easterby-Smith et al. 1994; Johnson and Duberley, 2001)

Blaikie (1993) proposes that choice of research perspective can be legitimised in several ways: matching perspective to research project in a pragmatic fashion; driven by a particular worldview, for example deontological or relativist; the consequence of personality factors that determine a preference for 'insider' or 'outsider' status; or, the social context of the researcher and the researched. The perspective adopted for this research is justified in terms of pragmatism, a rationale for which is developed in the following section.

6.2.1 Realism

Empirical observation is central to the traditional scientific, and therefore also positivist, method. Positivism asserts that direct experience, accumulated in the form of data through the observer's senses, is the only reliable and legitimate basis for knowledge. However, social research frequently encounters phenomena that are not easily observed, and are consequently discounted from the positivist epistemology (Johnson and Duberley, 2000), for example 'values' or 'trust' or 'culture'. Similarly, innovation is not easily observed, and a conceptualisation of innovation rooted in the experiences and perceptions of third parties disqualifies itself from embracing a wholly positivist approach.

It has been suggested in previous chapters that one limitation of innovation studies is the difficulty of generalising and undertaking comparative analysis due to inconsistencies in the application of characteristics of innovations. Research, in both its method (small sample narrative studies) and results (innovation is contingent and context dependent), up until the last years of the twentieth century, has been characterised by a predilection for the idiographic over the nomothetic (Poole et al., 2000). A developing momentum for more generalisable research results has though, been traced in the literature (Wolfe, 1994; Garcia and Calantone, 2002). Generalisability is one preoccupation of the positivist position and so this might be interpreted as a move toward a positivistic approach to innovation research.

However, the case has been made that innovation research, grounded in the perceptions of individuals, is unlikely comfortably to fit in a wholly positivist tradition. It is a seemingly contradictory position: a research framework constructed on the positivist preoccupations of representative samples and generalisability (with concomitant implications for replicability and validity[6]), but rooted in a (largely) interpretivist tradition and with a conceptualisation of innovation that privileges innovator and user perceptions.

A complete swing to positivism would invoke unmanageable tensions in this research: it would suggest a single, uniform, concrete innovation reality that denies the socially constructed meanings assigned by individuals and would be in conflict with the definition of innovation guiding this research. Yet Bhaskar (1978) and others describe (Trigg, 1980) and argue (Margolis, 1986; Blaikie, 1993) that the existence of an independent reality is not necessarily inconsistent with the notion of individual conceptions of it. This, so-called, realist perspective is underpinned by the ontological position that the world and the universe exist without any human awareness of this

[6] Issues of reliability and validity are addressed in each of the chapters reporting empirical work.

existence being necessary (Connelly, 2000), but that real phenomena may exist that cannot be measured by our senses. Bhaskar (1978) calls those phenomena which are independent of identification by human enquiry ‘intransitive objects’. Conversely, ‘transitive objects’ are those that are socially constructed and allow us to make sense of the social world.

Realism has been depicted as a middle ground between the philosophical polar extremes of positivism and social constructivism in that it rejects subjectivist ontologies by asserting the existence of a single concrete reality and rejects positivism in that, concurrently, reality is a social construction. Bhaskar (1978) resolves this apparent ontological paradox through an explication of the principles that the social and natural sciences hold in common whilst recognising the potential divergence in methods that necessarily results from differences in phenomena of interest. This explication is made manifest in the notion of three overlapping domains of reality: the empirical, the actual and the real (see table 6-2).

Domain of reality	**Explication**	**Consisting of**
Empirical	Events which are directly experienced by the observer	Experiences
Actual	Events whose existence is granted regardless of whether or not they are observed	Experiences Events
Real	The processes that generate the events, the underlying generative mechanisms	Experiences Events Mechanisms

Table 6-2: Bhaskar’s overlapping domains of reality (adapted from Bhaskar, 1978; Blaikie, 1993; 60)

In the Realist perspective, reality is underpinned by generative mechanisms (labelled the ‘real’), which produce events (the ‘actual’) which may, or may not, be experienced (the ‘empirical’). Further,

> “*... the first stage in the process of Realist science is to produce critical descriptions of non-random patterns by ‘exploration’- to extend what is known by common observation – and by ‘experiment’ to check critically the authenticity of what is thought to be known. In carrying out exploration, a scientist may have some idea about the direction in which to go but no very clear idea of what to expect. This critical descriptive phase is referred to as empirical studies and is followed by theoretical studies which are concerned with producing a rational explanation of the non-random patterns found in empirical studies*” (Blaikie, 1993; 60 original emphases).

Realism shares the same underlying ontology of positivism in that it accepts the notion of reality existing independently of the observer, yet it attempts to transcend positivism's thesis that positivistic methods are the only legitimate ways of coming to know something of reality. The methods themselves are not rejected, only the absolutism that comes with positivism (Johnson and Duberley, 2000).

The aim of the Realist approach is to 'dig deeper' to improve understanding of mechanisms that underlie phenomena through processes of critical exploration. This objective may be realised through the application of a strategy of retroduction, one objective of which

> "*…is to generate a set of categories based on theory and then refine and adjust them as they are applied to data. This permits the theoretically driven scheme to grow and to adapt in response to the exigencies of the data"* (Poole et al., 2000; 143).

The logic of retroduction is one in which new insights relating to the observed phenomenon can be sought through a process of model building and testing, a process of description, explanation and redescription (Blaikie, 1993). In this instance, the retroductive strategy commences with a description of the phenomenon in terms of attributes and moves to a description of innovations in terms of the relation of processes to types of innovations predicated on configurations of attributes. That is, a preliminary descriptive and exploratory stage based on empirical data forms the basis for a scheme that, it is postulated, firstly describes and taxonomises innovations and has the potential to offer new insights into underlying processes. The Realist approach and retroductive strategy are felt to be consistent with the objectives of this research.

6.2.2 Philosophical perspective

The basis and overarching aims of this research are:

- To develop a conceptualisation of innovation types based on innovators' perceptions; and,
- To explore the utility of such a conceptualisation in the relationship between emergent types and the processes that underpin them

Ultimately, realism aims to explain and predict, however this research holds back from these objectives and is restricted to exploration with a view to informing future explanatory studies. Exploration, then, is the first step in a process leading to explanation and prediction and implies a study in the domain of the empirical in which events and phenomena are investigated based on the recollections of those who have experience of them.

So, in Blaikie's (1993) terms, the realist approach adopted for this research is legitimised by the pragmatic matching of project and philosophy. It is pragmatic, also, in a sense suggested by Johnson and Duberley (2000; 174). It is intended that resultant knowledge should be "*evaluated in the context of how successfully it may guide action towards the realisation of particular objectives which express particular interests: that is in terms of what it does for, and to, various groups of human actors*".

6.3 Research design

6.3.1 Introduction

Any research design adopted should reflect, and be appropriate to, the research question being addressed (Yin, 1994). The overarching aim of this research is exploratory and so, an approach suited to exploration is required. Both qualitative and quantitative research methods offer opportunities for exploration. It is difficult to define concisely the terms quantitative and qualitative as each has long traditions associated with them (Schwandt, 1997). The two approaches may be simply differentiated by the former's emphasis on numeric data and the latter's on non-numeric data in the form of words. Denzin and Lincoln (1994) develop this and suggest that quantitative studies emphasise the measurement and analysis of causal relationships between variables. On the other hand, qualitative research stresses the socially constructed nature of reality.

Qualitative methods may be used to study, in-depth, settings that are inaccessible to other research methods, in areas that are sensitive to enquiry or those where the intention is to reach perceptions that might be expected to be difficult to articulate. Qualitative analysis provides local groundedness, its focus on naturally occurring ordinary events in natural settings generates rich, 'thick descriptions'. Qualitative studies also emphasise the lived experience and this suits them for exploratory studies that precede the generation of hypotheses. They do, however, tend to be limited in the conclusions and inferences that can be drawn from typically small samples but are, useful for supplementing, validating, explaining or illuminating quantitative data (Miles and Huberman, 1994).

Quantitative studies, on the other hand, offer greater opportunity for generalisation as the research tends to involve a larger number of individuals (items, entities, instances of the phenomena and so on), drawn from a wider, or even the whole, population. Quantitative methods can be fast and economical, provide wide coverage of the range of situations, and can be of considerable relevance to policy makers when statistics are aggregated. But they can be inflexible and artificial, and may not be very effective in understanding the processes or the meanings that people attach to events or incidents (Easterby-Smith et al., 1994).

Each of the approaches has different strengths and weaknesses. Indeed, almost all methodological tools are in some way flawed. However, a mixed-method approach prevents the research becoming method-bound and allows the strengths and weaknesses of methods to be counterbalanced (Easterby-Smith et al., 1994). This research combines qualitative and quantitative methods. Easterby-Smith et al. (1994) also caution against the combined use of the techniques in that they have the potential to give different results. However, because the qualitative and quantitative approaches are adopted in separate phases in this study the *caveat* is not held to apply. The three phases are outlined in table 6-3.

	Phase I	**Phase II**	**Phase III**
Date and duration	May-September 2001	May-November 2002	February-April 2003
Data collection method	Inductive content analysis of literature* Semi-structured interviews, repertory grid technique and documentary analysis	Postal questionnaire	Semi-structured interview
Sample	4 case studies of successful innovation in NHS. (23 interviewees)	310 innovations in the NHS	9 interviews with respondents identified from Phase II
Data analysis	Content analysis facilitated by NVivo® software and triangulation	Cluster analysis facilitated by SPSS® software	Content analysis and comparative method
*Ongoing from June 2000, rigorous thematic analysis			

Table 6-3: Three exploratory phases of empirical research

Previous chapters have argued that the state of our knowledge regarding different types of innovation artefact, specified by multiple attributes, is low. Under these circumstances an inductive/retroductive qualitative strategy was adopted for the first empirical phase. The output of the first phase is a multi-item descriptive framework of innovations (see Chapter seven). The framework is subsequently operationalised into a 56-item questionnaire. In the second phase of empirical research the questionnaire is applied to 310 NHS innovations and data subject to quantitative statistical analysis to determine the existence of identifiable clusters of discrete innovation types (see Chapters eight and nine). The final phase of empirical research was an inductive study whereby exemplar cases identified from phase two were qualitatively analysed (see Chapter ten). The following three sub-sections debate the selection of methods for each phase of the research.

6.3.2 Phase I: How do innovators perceive innovations?

A satisfactory, justifiable framework of innovation attributes could not be identified from an initial literature review. It was imprudent to operationalise individual attributes that emerged from the review, there were several reasons for this. First, as has been demonstrated, the few multi-dimensional models that exist are strongly grounded in the original work of Rogers (1962) which is later described as empirically indefensible (Rogers and Shoemaker, 1971). Second, there would appear not to be any overall guiding principles to justify the operationalisation of items selected from the list of singular items. Indeed, selected attributes selectively studied is a characteristic of the dis-aggregative tendency in innovation research already noted (Adams and Tranfield, 2002). Finally, Sneath and Sokal (1973) alert against over-reliance on conceptual studies as the basis for empirical classification because of the danger of inordinately favouring conceptual characters. This view is largely in accord with that of McKelvey (1975) whose guidelines for classification (see Chapter four) include the recommendation to define as inclusive a population of characters as possible. This would imply the usefulness of a round of empirical verification and development.

In order to resolve the framework 'selection' dilemma, two options were available. The first was to derive one from a synthesis of theoretically derived attributes based on the four key dimensions of innovation (novelty, benefit, application and ideas) in the definition that guides this research. This option was discounted on the basis of McKelvey's (1975) advice (above) and also on the basis of several informal, unstructured exploratory conversations. These conversations suggested that the list of items generated from the literature may not be complete. That is, practitioners may perceive their innovations in ways that were not reflected in the literature. Consequently, the second option for developing a justifiable framework was to undertake an empirical exploration of the way practitioners thought about their innovations. In a sense such a study would test the exhaustiveness of the theoretically-derived items and, if there were gaps, suggest new areas for conceptual development.

Yin (1994) argues for *a priori* theory development as a starting point in order to frame research. Eisenhardt (1989) advocates adopting a 'theory-neutral' state in research where the objective is to find new variables and explanations. Such a posture though, can be difficult to maintain when the research is underpinned by *a prior*i awareness of theory – as was the case in this instance, and, clearly, complete objectivity is impossible. In phase one, therefore, the role of theory was to provide a loose frame for the study in the process of developing the descriptive framework, cycling between theory and empirical data in a process of discovery, refinement, verification, rediscovery and validation.

An inductive/retroductive approach utilising mixed methods was felt to be consistent with these objectives. Inductive reasoning entails making general inferences about a phenomenon through the observation of particular instances of the phenomenon (Johnson and Duberley, 2000). The inductive approach allows the researcher to avoid being predisposed to *a priori* patterning of the data. Rather, the data is left 'to speak' to the researcher with patterns emerging (or possibly not), but not being imposed (Miles and Huberman, 1994), see figure 6-1.

Four case studies are used as an exploratory device in phase one. Casework has been criticised in past innovation studies for being superficial (in terms of analysis) and founded on convenience sampling (Poole et al., 2000). However, case studies are well suited to the task of unearthing a wealth of detail and richness of story on both process and outcome and, where the purpose is exploratory and descriptive, a case study approach is recommended (Yin, 1994). The core of the case studies was to tap multiple sources of evidence to investigate a contemporary phenomenon consisting of multiple dimensions, in its real-life context informed, but not steered, by a theoretically derived framework.

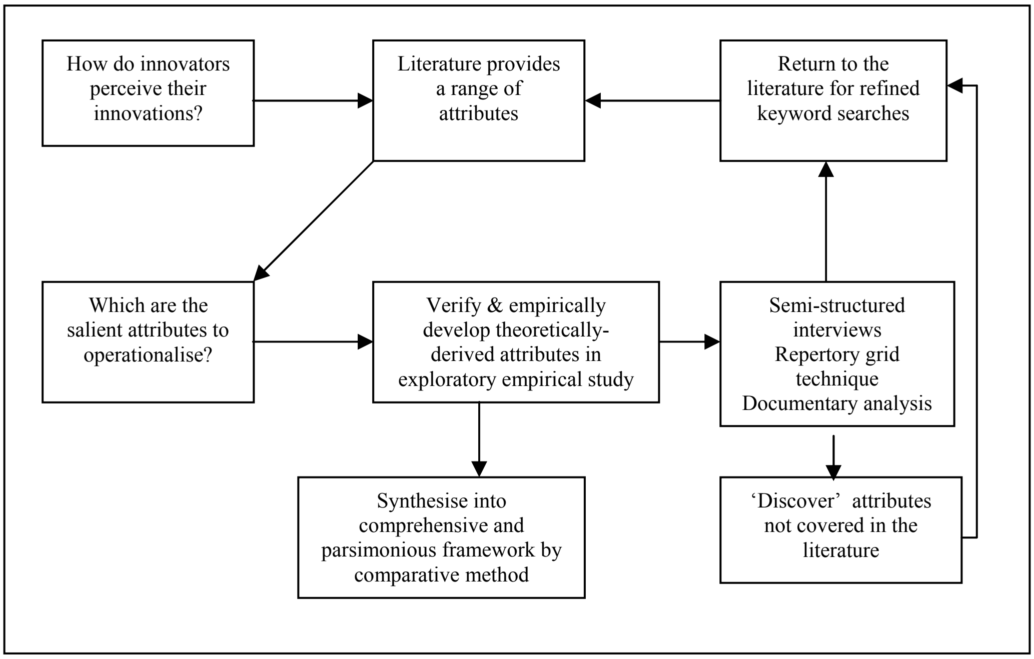

Figure 6-2: Inductive/retroductive research approach

6.3.2.1 Sample

Miles and Huberman (1994) detail a range of purposive sampling techniques for qualitative research. The technique favoured in this research is that which they call extreme or deviant case sampling, the purpose of which is to enable learning from highly unusual manifestations of the phenomenon. It is evident though, that judgements about success are likely to be conditional on who is doing the assessment and when the judgements are made (Pettigrew et al., 2001). Each of the teams sampled in phase one is a winner or runner-up in recent (in the year 2000) independent awards for teamworked innovation and problem solving[7]. Sample selection based on the assessment of domain relevant experts is well precedented in the research literature (West and Anderson, 1996; Neely and Hii, 1998). Arguably though, each of the applicants for the award considered themselves a success in their own right, it would be the logic behind their application. The advantage of this sample of face valid exemplars is that the selection process has been taken out of the hands of the researcher and the possibility of researcher bias, at least in this domain, is averted.

The difficulties of drawing generalisations from single or small numbers of case studies are well documented in the management literature. However, the approach has been argued to provide an appropriate vehicle in support of exploratory and indicative studies (Yin, 1994), particularly in situations where cases can be justified in terms of

[7] Awarding bodies were the British Association for Medical Management and the European Forum for Teamwork. The sample consisted of winners of both awards and the two runners-up from the British Association for Medical Management award.

outlier status as having exemplary or unusual characteristics which might provide insight to both academics and practitioner audiences.

However, Pettigrew et al. (2001) highlight a weakness of small sample studies of exemplars. Citing what they call the rise and fall of credibility of Peters and Waterman's (1982) 'In Search of Excellence', they highlight the vulnerability of generalisations based on narrow samples. Consequently, they advise one of two strategies to avoid that weakness: first, carry out large sample studies over time. Second, carry out associated sets of longitudinal comparative case studies of matched pairs with high/low performance, success/failure etc. Neither of these strategies is felt to be appropriate in this instance because the study has been an exercise in exploration and verification. Further, Eisenhardt (1989) commends the selection of extreme cases when the phenomenon of interest is transparently observable and notes that the selection of a sample from a single, consistent context is useful in reducing extraneous variation.

6.3.2.2 Data collection

The range of choice of data collection method was delimited both by the historical element of the study and the requirement to elicit perceptions and understandings from informants. The historical element indicated that a longitudinal study was infeasible. Observation and survey were discounted as methods as both are inappropriate for accessing deeper or normally unarticulated understandings. The range of alternative methods from which to choose includes analysis of archival and documentary data and, interviewing. Both methods were used in combination, a technique, strongly recommended by Yin (1994) for case study designs, that permits triangulation of data sources. Interviewing took two forms: semi-structured and the application of repertory grid technique.

Interviews range in type from those that are highly formalised and structured to those that are unstructured, free ranging and conversation-like. The latter will tend to be adopted where the primary purpose

> "*is to understand the meanings interviewees attach to issues and situations in contexts that are not structured in advance by the researcher's assumptions*" (Easterby-Smith et al., 1994; 73).

Consistent, then, with the objectives of phase one of the research, with the objective of probing deeply to uncover new clues, insights and dimensions of the ways in which innovations were perceived a less formal approach to the interview was demanded (Lofland and Lofland, 1995), (see Appendix four for interview protocol).

Repertory grid technique, as a device for collecting and analysing open-ended interview data, has been widely used in a variety of fields such as: educational research (Baxter et al., 1998), leadership in palliative care units (Barker, 2000), decision making in health care (Baker, 1996), counselling and psychotherapy (Neimeyer, 1989), systems design and artificial intelligence (Batty and Kamel, 1995; Latta and Swigger, 1992; Gronstedt and Thorson, 1996) and for market research for the identification of product attributes (Goffin, 1994; Marsden and Littler, 2000). It seems however, to be infrequently used in the management sciences in spite of its value in uncovering the difficult to articulate views of respondents.

Repertory grid technique is predicated on Kelly's (1955) theory of personal constructs which suggests that sense is made of the world through the constant formation and testing of hypotheses about it. It is based on the assumption that individuals act on their perceptions of an objective world filtered through their own construct systems (Reger and Huff, 1993). The repertory grid is a technique for eliciting knowledge about these personal world-views that gets beyond the words (Fransella and Reed, 1998), it confronts the informant directly with the phenomenon of interest and asks them to specify how they construe it (Langan-Fox and Tan, 1997).

The power of the repertory grid is in its stimulation of many possible levels of exploration and learning. At its most simple, it is a conversational device that helps respondents access and articulate views on complex topics. In its full application, rich qualitative interview data and matrices of quantitative data are conjointly developed (Goffin, 2002). The former provide detail about the world through the eyes of the informant. The latter permit the application of

> "*…numbers to the relationships between psychological views, perceptions, feelings and so forth…[to]…yield information about the degree to which some of the personal constructs (views, perceptions) relate closely together and have similar meaning and are, thereby, different from other ways of viewing the same event*" (Fransella and Reed, 1998; pages not numbered).

Repertory grid technique was selected as a data gathering and analytic method because of the perceived benefits it brought to investigating and making sense of the complexity inherent in the multi-dimensionality of innovations whilst, at the same time, seeking to avoid the dangers of introducing researcher bias from a pre-existing theoretical framework. The flexible, comprehensive, and highly individualised nature of repertory grid technique makes it possible for the interviewer to enter more readily and rapidly into the informant's frame of reference. Rapidity of access to difficult to articulate conceptualisations of the informants' world-views is clearly also a benefit in time-limited interviews. Repertory grid technique also offered the potential to triangulate against other data sources. Finally the analysis, using the construing of those who perceive the innovation (as creators and users), provides a useful basis for designing questions for surveys (Hutchinson, 1998). The empirical component of Phase I, analysis of data and development of the framework are more fully explored in Chapter seven.

6.3.3 Phase II: Applying the framework, an exploratory survey

Phase two is concerned with the question 'do attributes cluster into discrete configurations whereby different types of innovation can be identified?' The question remains exploratory as in Phase I; however, the question takes on a slightly different character and reflects a distinction that Yin (1994) develops. The question in Phase I explores the diversity of ways in which the phenomenon may be perceived. From this, a generalised framework for describing the phenomenon is refined. The question in phase II is a form of that which Yin (1994; 7) calls '*prevalence*', and asks about specific instances of that phenomenon to be described within the new framework.

The second phase of the research develops and then applies an operationalised version of the framework in the form of a 56-item survey instrument. The development of the survey instrument, item-generation and so forth, is described in Chapter seven. This section focuses, instead, on a justification of a postal survey instrument as the adopted method of administration.

In the early stages of research and, where the objective is to become more familiar with a topic, exploratory and descriptive surveys can help to identify concepts that need to be better understood and measured (Malhotra and Grover, 1998). This view accords with that of Yin (1994) who commends a survey approach to the asking of exploratory questions. With the objective of identifying and isolating distinct configurations or types of innovation the framework is subsequently applied in the form of a survey instrument to a second, wider, sample of innovating teams within the NHS.

Further, McKelvey's (1975) guidelines (see Chapter four) advocate that in classification studies as wide a range of entities (instances of the phenomenon of interest) as possible be investigated. Survey research, particularly postal surveys, allow access to the widest potential sample of entities (de Vaus, 1996). Finally, survey questionnaires are commonly used when the items can be clearly defined (de Vaus, 1996) for example departmental customer relationship performance in accordance with pre-specified criteria (Vyakarnam and Adams, 2001).

A survey approach is therefore identified as the most appropriate method for the second stage of the research. Kerlinger and Lee (1999) posit two major types of survey research – exploratory and explanatory – this research is clearly identified as exploratory and descriptive in which the resulting data is used to explore the possibility of attributes configuring to generate a taxonomy of innovation.

Surveys are distinguished from other methods of social research not so much by a particular technique of data collection but by the structured, systematic data set generated. de Vaus (1996; 3) calls this output a "*variable by case data matrix*". Survey research is characterised by its, usually, quantitative method that requires data to be collected by asking questions of people in a standardised or structured format in order to define or describe variables. Further, information is gathered via a sample, a fraction of the population, from which conclusions can sometimes be generalised to the whole population (Malhotra and Grover, 1998).

Various survey techniques are available. Widely used are questionnaires, which may be administered by mail, over the telephone or face-to-face in interviews of varying degrees of structure. For the design and administration of a survey de Vaus (1996) draws our attention to five important considerations:

1) response rates;
2) ability to produce representative samples;

3) limitations on questionnaire design;
4) quality of responses, and;
5) implementation problems.

It has been argued that because exploratory surveys are generally used to formulate propositions which can be tested in further research, sample representativeness is less important than in explanatory surveys (Malhotra and Grover, 1998). Similarly, low response rates are not considered to be critical to exploratory research (Oke, 1999). Indeed, the potential for low response rates may be counteracted where the topic under investigation is of particular relevance to the target group and, the response rates for mailed surveys can be as good as for any other technique (de Vaus, 1996). Administrative decisions, for this exploratory research are therefore be justified in terms of items 3, 4 and 5 (above). These are more fully explored in table 6-4.

Consideration	Face-to-face interview	Telephone interview	Mail survey	Preferred technique
Limitations on questionnaire design	Provides greatest flexibility of question design and for dealing with complex research topics. Can last longer than other techniques.	As with face-to-face but less well able to deal with complexity and possibly of shorter duration.	Performs poorly in handling long, complex, and open-ended questions.	1. Face-to-face 2. Telephone 3. Mail survey
Quality of responses	Performs least well in obtaining accurate answers due to dangers of: social desirability bias: influence of observable characteristics of interviewer, and: interviewer contamination.	Better than face-to-face in that there is less opportunity for interviewer contamination.	Best performer in obtaining accurate answers. Remoteness of interviewer avoids undue influence. Allows respondent time and space to answer.	1. Mail survey 2. Telephone 3. Face-to-face
Implementation problems	Difficulties in obtaining suitable staff can lead to implementation problems. Can be costly and slow to mobilise.	Prone to same difficulties as face-to-face, but less markedly so.	Least onerous implementation method in terms of staffing, speed and cost.	1. Mail survey 2. Telephone 3. Face-to-face

Table 6-4: Comparison of approaches to questionnaire administration (after de Vaus, 1996; Oke, 1999)

Mail surveys are recognised to perform best in terms of quality of response and overcoming problems in implementation. The performance of mail surveys in handling open-ended and complex questions is not considered to be a problem as the ‘questions’ (or more accurately, statements) developed in Chapter seven, are neither complex nor open-ended. In fact the questionnaire consists of a series of statements with which respondents are requested to indicate the extent to which they agree/disagree. Logistical issues such as the potential for wide geographic dispersion of the sample and the potentially large number of respondents also commend a mail survey as the most appropriate technique.

Having selected a mailed questionnaire as the most appropriate administrative method one other important question needs to considered, specifically 'To whom will the questionnaire be addressed?'. This necessitates consideration of two things: the sample frame and the qualifications of respondents to answer the questions.

As has been established already, the purpose of the research is exploratory and the sample consisted of applicants to competitions or receivers of awards (see table 6-5). There are clearly limitations to this sample and this impacts generalisability. There are dangers of inherent bias in self-selection, questions are begged about innovations from other successful and, indeed, less successful teams who, for a variety of reasons, have chosen not to enter for the awards. In spite of the inherent dangers of skewing, the sample is legitimised by the exploratory nature of the research (Malhotra and Grover, 1998).

	2002		**2001**		**2000**	
Source	**Mailed**	**Responded**	**Mailed**	**Responded**	**Mailed**	**Responded**
British Association of Medical Managers (BAMM)	4	3	8	3	27	8
British Journal of Renal Medicine	4	3	-	-	-	-
Hospital Doctor (magazine)	105	79	13	9	-	-
Doctor (magazine)	54	33	16	4	-	-
British Medical Association (BMA)	79	54	-	-	-	-
Total	246	172	37	16	27	8

Table 6-5: Phase II sample

There are various approaches to determining informant selection, the most competent person to act as informant who is best placed to pass comment on the innovation. Tornatzky and Klein (1982) suggest that several ratings from several echelons within an organisation should be gathered, with respondent selection perhaps guided by Hage's (1980) notion of the 'dominant coalition'. However, there may be disagreement amongst respondents on the rating of attributes, thereby producing unmanageable divergences in responses. The experience of the first phase of empirical research suggested, however, that the team leader was the most knowledgeable with the widest purview of the innovation. Huber and Power (1985) advocate that where only one respondent is selected then that respondent should be the individual most knowledgeable about the subject matter. The key criterion, therefore, for selection of competent witness is significant experience of the innovation. This was generally assumed to be the project leader as specified on application forms.

Data collection in Phase II relies, therefore, on the recall, and possibly idiosyncratic view, of single respondents. This individual though, is judged to be best informed of potential candidates and sufficiently near in time (in that all the innovations studied are relatively recent) to the innovations to provide data pertaining to the attributes of their innovation. Clearly there are limitations with regard to reliance on a single witness (Bowman and Ambrosini, 1997). Arguably, other individuals have valid perspectives and, cumulatively, could offer a valuable aggregate view on innovations. However, because each of the innovations is relatively recent (within the last 3 years), the respondents were intimately connected with the innovations and because the innovations had been submitted as entries for awards (and had therefore been reflected upon and recently surfaced in the respondents' minds), the recall of individuals is anticipated to be valid. This is consistent with other studies of innovation (de Brentani, 2001; Avlonitis et al., 2001).

Table 6-6 considers the range of potential competent witnesses. It is apparent that there is not immediately one single informant type who best fits the requirements of competent witness. Those who have the most experience of the innovation (the teams that develop and implement the innovation) may be disadvantaged as informants by limited previous experience of other innovations or by bias. Those with wider experience of innovation within the NHS (Chief Executives) may be too remote or tainted by political bias to be a reliable witness for the innovation in question.

Potential Informant	**Potential Advantages**	**Potential Disadvantages**
NHS Trust Chief Executives	Separate from team, free from team bias, multiple previous experience, context sensitive.	Possibility of political bias and remoteness.
Directors for Modernisation	Objective, free from team bias, multiple previous experience, context sensitive.	Not a universal post within the NHS, and might not exist to comment on some of sample.
Commissioning body	Objective, free from team bias, multiple previous experience, context sensitive.	Possibly remote. The innovation may not have been commissioned.
Award application form	Written independently of this research project reducing potential for socially acceptable responses.	Not comprehensive, though potential source of triangulation.
Other members of innovating team	Well acquainted with the innovation.	Possible limited previous experience, potential for bias.
Award judges	Objective. Able to make comparisons.	No contextual experience & remoteness.
Team leader	Well acquainted with the innovation.	Potential for bias or innovation myopia depending on previous experience.

Table 6-6: Evaluation of suitability of potential respondents

6.3.4 Phase III: Exploring the utility of the taxonomy

Following the identification of discrete types of innovation based on configurations of attributes, the final phase of empirical research investigates the processes that underpin each of the types. Chapter four argues that one means by which a classificatory system may be measured is by its usefulness. The brief exploration of process in Phase III is an exploration of the utility of the discovered taxonomy to see what new insights on process it is able to facilitate. Recent innovation literature makes a strong case for longitudinally designed process research arguing that prior knowledge of the outcome of the process can bias a study's findings (Poole et al., 2000). Efforts though, can be made to minimise the dangers of this bias thereby benefiting from the advantages that a historical perspective offers, which is to understand patterning and significance of events in the development process, in the context of the 'big picture'.

Contextual issues at this phase are similar to those encountered in Phase I and the focus of the enquiry is on capturing historical data on process. Innovation theory on process tends to focus principally on temporal aspects, but new insights on process have recently emerged from psychology, for example the team climate inventory (Anderson and West, 1996), and from chaos theory (Koput, 1997; Cheng and Van de Ven, 1996), and also the large body of work that looks at group and team processes (Cohen and Bailey, 1997). Chapter ten describes in greater detail the theoretical underpinnings of the research frame for Phase III, however, it remains consistent with the overall philosophical approach to explore process retroductively, cycling between theoretical perspectives and empirical data, on case study basis, using extreme case sampling as the basis for case selection.

6.4 Validity and reliability

The multi-method approach adopted for the current research demands special consideration of issues of validity and reliability. Specific issues are dealt with in subsequent chapters as they occur. The objective of this section is to outline some guiding principles.

Validation is about limiting the risk that the findings of the research are erroneous (Murphy et al., 1998). Validation, argues de Vaus (1996), is a difficult area, and the method(s) chosen will depend on circumstances and the situation. The nature of this research is to propose a framework for which well-established referents appear not to exist. That is to say, there is no well-established model against which to validate results. In these circumstances de Vaus (1996; 57) recommends that

> " *…if all else fails we have to say 'this is how the concept is defined and these measures, on the face of it, seem to cover the concept', and to give the measure to other people to see what they think*".

What there are though, are competing typologies of innovation which form the basis for theorising about process, organisational performance and so forth. The taxonomy resulting from this study can be mapped against these alternatives in an exploration of similarity and difference.

In the context of health service research Murphy et al. (1998) argue that the validity of qualitative research is partly determined by the extent to which users can be confident in the knowledge generated and in which findings are relevant to policy makers and practitioners (qualitiative research has not been widely endorsed or practised in health care research, it is however increasingly utilised as researchers are increasingly concerned with the social processes that operate within health care systems (McNulty and Ferlie, 2002).

Various perspectives on reliability exist but tend, principally, to revolve around the issue of whether or not the same results would be reached by different researchers using the same tools and data on different occasions. However reliability, a concern with the consistency of results obtained in research, arguably a preoccupation of the positivist perspective, is incommensurate with intrepretive approaches. That is not to say the preoccupation is inconsequential, and, interpretivists have developed alternative criteria against which levels of confidence in the dependability or auditability of qualitative research can be assessed (Miles and Huberman, 1994). Thus an alternative schema as represented in table 6-7 guides the validation and reliability in this research.

Concern for	Rigour
Internal validity	Do measures measure what they are supposed to measure? Have the correct operational measures been established? Use multiple sources of evidence, have key informants review cases, make explicit theoretical bases, have a clearly specified structure to the collection and analysis of data.
External validity	Establishing the domain to which a study's findings can be generalised, though arguably not applicable in exploratory research.
Reliability or, dependability and auditability	Demonstrate that the operations of a study – such as data collection procedures – can be repeated, with the same results. Use if interview and case study protocols. Ensure consistency and stability of research over time. Congruency of research question and research design. Data collected across appropriate settings, times etc. Make coding checks. Check data for bias, deceit etc.

Table 6-7: Validity and reliability, guiding principles (adapted from Yin, 1994; Miles and Huberman, 1994)

Different authorities place different emphasis on the different methods of ensuring validity and reliability. For qualitative research Yin (1994) advocates strongly the use of triangulation and regular reviews by key informants. Conversely, Murphy et al. (1998) discount respondent validation and triangulation as 'sure-fire' routes to validation. Instead they emphasise a clear exposition of the processes of data collection and analysis, in which data are related to the circumstances of their production. The risk of error, they continue, will be further reduced where the researcher pays systematic attention to the analysis of negative cases.

6.5 Summary

The research design described in this chapter cycles from case-oriented to variable oriented and back to case-oriented. Phase I utilises qualitative and quantitative techniques and multiple methods in order to explore difficult-to-articulate perceptions of a multi-dimensional phenomenon. Phase II is a quantitative process using multivariate statistical techniques to manage and investigate many data sets. The objective of the third phase is to explore the utility of the taxonomy developed in Phase II through its application in the context of process and returns to a qualitative interview-based approach for this brief investigation.

The method is applied within the context of a logic described earlier in the chapter as an inductive/retroductive strategy in the Realist convention. Reasoning from the particular to the general and cycling between the empirical and theoretical successively modifying the framework forms the basis for the investigation into innovation classification in this research. Realism recognises the qualitative differences between the natural and social sciences and, because of this, appropriate methods for data collection and analysis, appropriate to the particular subject matter, must be designed (Blaikie, 1993; 58). The Realist perspective and the research design are argued to be consistent with the pragmatic exploratory approach underpinning the current research.

This chapter has described the philosophical position and design proposed for this research. The following chapter describes the first phase of the empirical process, the development of the framework of attributes whose component parts are drawn from an extensive study of the literature and four case studies of successful innovation.

7 PHASE I, DEVELOPING THE SURVEY INSTRUMENT

7.1 Introduction

Preceding chapters have located innovation in a social context, where it originates and has impact. They illustrated the importance of classification to current understanding and theory development but highlighted limitations of the three dominant approaches to classification: newness, area of focus and attributes. A case has subsequently been made for the necessity of a comprehensive framework of innovation whose utility would be in facilitating comparative research and a contribution of possible new insights into and understanding innovation. Further, it was suggested that such a framework should be multidimensional and based on innovators' and users' perceptions. Several extant frameworks have been identified and these have been discounted from operationalisation in this research for several reasons:

- Absence of empirical justification for extant models;
- Extant models applied to relatively small samples of innovations of a particular type. Moore and Benbasat (1991) developed their instrument with regard to a personal (computer) workstation, Meyer et al. (1997) to three preventive health innovations, Wilson et al. (1999) to the adoption of imaging technology innovations, Agarwal and Prasad (1997) to the usage of the Internet amongst a sample of MBA students, and Dearing and Meyer (1994) to nine hazardous waste bioremediation technologies;
- In strategic management studies researchers have found that managers tend to group, and therefore think about, firms differently from researchers (Friar, 1995). It is not unreasonable to expect that a similar condition prevails in innovation research, a view reinforced by the absence of any strong empirical support for frameworks reviewed in previous chapters;
- Personal experience and a series of unstructured interviews in the period preceding the design and commencement of Phase I suggested that innovators thought differently and that the literature review, at that date, had failed to deliver a comprehensive list of perceptions;
- Distance between context of this study (NHS) and context of majority of innovation literature (NPD, research and development, commercial sector, profit-driven).

The key question remains, then: which characters should be selected to comprise the framework in this research? This chapter reports on the process by which characters were selected for and incorporated into the framework that underpins further stages of this research. Empirical investigation (Phase I of this research) using innovators' experiences and recollections provides triangulation for attributes identified in the literature.

In this chapter, a framework consisting of 13 innovator- and user-perceived attributes is described and operationalised into a survey instrument. de Vaus (1996) describes the process of operationalisation as the process of translating abstract concepts into something more concrete and directly observable. Malhotra and Grover (1998) commend that, where possible, in order to create a cumulative tradition of research, existing and pre-validated scales should be adopted. However, there is a general lack of scale development in the literature (Meyer et al., 1997). Those scales that do exist tend to be study-specific and consequently problematic to apply in new studies. It was necessary, therefore, to develop some new scales for this study, some measures were also drawn from previous research. The basic approach for the operationalisation of constructs outlined by Churchill (1979) was followed (see below).

7.2 Paradigm for framework development

The basis for the development of the framework and the survey instrument was Churchill's (1979) paradigm for developing better measures of constructs (see figure 7-1). This enabled the integration of both theoretical and empirical attributes into a single framework. The process of developing construct measures involves eight steps. This chapter focuses on stages 1, 2, 3 and 4 of Churchill's paradigm. Stage 1, 'specification of the domain' has been achieved by the identification of four categories from West and Farr (1990), an indicator level classification (Bailey, 1994): newness, ideation, application and benefit. Subsequently, these are further populated by constructs derived from the literature and empirical work.

The domain of the study is circumscribed by the four categories derived from West and Farr (1990) and defined in table 7-1. Following the broad specification the next stage necessitated populating each of the categories with attributes of innovations drawn from an ongoing review of the literature and an empirical study.

Element	**Recognised as**
Newness	The extent of the difference from previous state and repercussions of that difference.
Ideation	The information, idea and knowledge origins of the innovation. From where do they originate?
Application	The innovation in action, what is it like to live with?
Benefit	Planned and unplanned consequences, including degree to which original objectives have been met.

Table 7-1: Component parts of innovation (after West and Farr, 1990)

As the circulating arrows in figure 7-1, depict the process was not linear, the literature was not 'left behind' but continued to play a significant informative role. As the empirical investigation progressed attributes identified in the literature form the starting point for empirical investigation of innovators' perceptions. Similarly, 'discoveries' in the empirical field spark further rounds of investigation of the literature. Attributes derived from these conjoint studies are the raw material for the development of the framework.

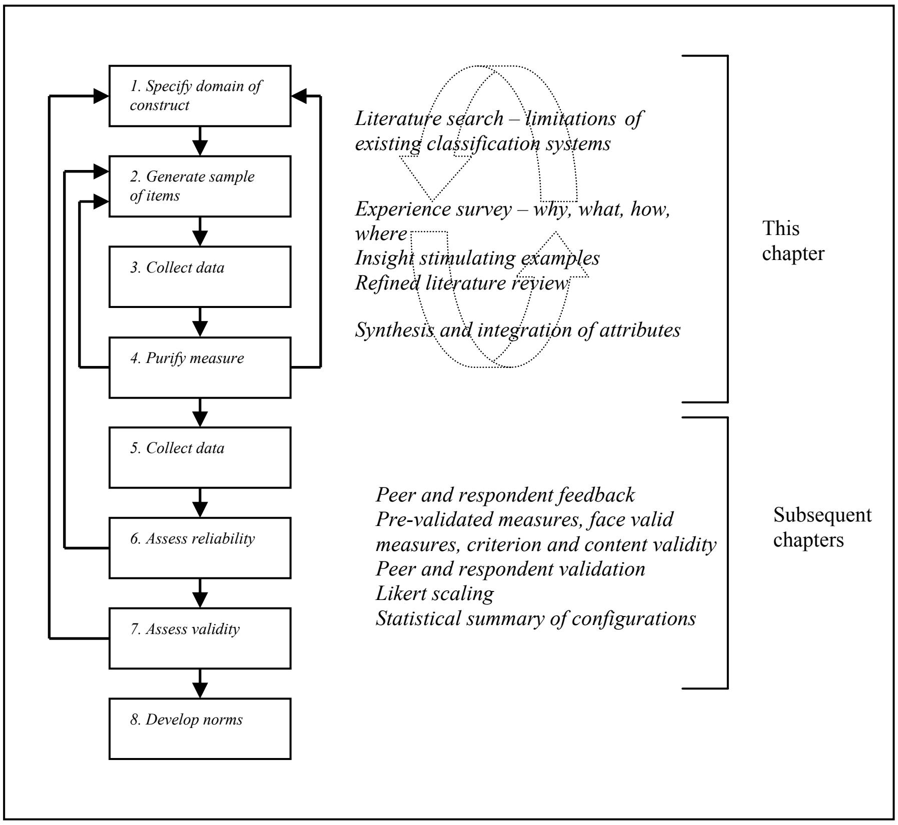

Figure 7-1: Paradigm for the better measurement of constructs (adapted from Churchill, 1979)

7.2.1 Domain specification

The data from the empirical study are described in greater detail below. Criteria were drawn up to determine inclusion of attributes in the framework. In order to merit inclusion attributes had to be:

- Consistent with one of the four categories derived from West and Farr (1990). This is consistent with Downs and Mohr (1976; 702) who argue that any "*typology dividing innovation into groups or categories must itself be based on a characteristic or attribute of the innovation*".
- Evident in both the literature and each of the four cases of the empirical study.
- Capable of independent measurement (not synonymous with other items).
- Made reference to by the majority of informants in each team.

Attributes that did not meet these criteria were excluded. Ultimately, a framework consisting of 13 sub-categories was drawn up, this is summarised below in table 7-2.

First-order Categories	Sub-category	Definition	Indicative previous research
Newness	Novelty	The extent of change represented by the innovation compared to what preceded it.	Continuous improvement (Bessant and Caffyn, 1997), evolutionary & revolutionary (Rabson and DeMarco, 1999), incremental & radical (King, 1992; Damanpour, 1988; Damanpour, 1991; Zaltman et al., 1973; Schroeder et al., 1989; Nahapiet and Ghoshal, 1998), magnitude (West, 1990)
	Departure	The extent of change to existing practice, routines, behaviour.	Pervasiveness (Tornatzky and Klein, 1982; Zaltman et al., 1973; Beyer and Trice, 1978)
	Disruption	The extent to which the departure from prevailing practice occurred in a disruptive manner.	Capacity and unknown potential to affect everyone and everything (Danneels and Kleinschmidt, 2001), impacting in a disruptive manner (Rabson & DeMarco, 1999)
	Risk	The extent to which the innovation is inherently risky or threatens individuals, the institution or user base	Risk (Meyer and Goes, 1988; Heany, 1983; Mohr, 1969), social cost (Zaltman et al., 1973)
Ideation	Ideation	Innovation is the consequence of combinations of existing and new knowledge. 3 levels of ideation: 'originated' (wholly original); 'borrowed' (copied, with no modification); 'adapted' (modified to fit the local context).	Originality (Pelz, 1983; Amabile et al., 1996), origination (Pitt and Clarke, 1999; Nonaka and Takeuchi, 1995; Utterback and Abernathy, 1975; Leonard and Sensiper, 1998; Boisot et al., 1996)
Application	Uncertainty	Knowledge concerning the link between innovation inputs, processes, and outcomes.	Communicability (Tornatzky and Klein, 1982; Zaltman et al., 1973), uncertainty (Wolfe, 1994; Tatikonda and Rosenthal, 2000; Shane, 1995)
	Scope	The extent to which the innovation stands-alone (within the context of its application), or requires changes elsewhere (outside the group).	Architectural, modular (Henderson and Clark, 1990), autonomous (Chesborough and Teece, 1996; Goodman, 1981), centrality (Wolfe, 1994), individual, synergistic (Goodman, 1981)
	Complexity	The extent to which the innovation, regardless of scope, by dint of its connections (inherent or in terms of other social units) to other parts, renders it difficult to understand and use.	Complexity (Pelz, 1983; Pelz, 1985; Tornatzky and Klein, 1982; Rogers, 1983; Zaltman et al., 1973; Tatikonda and Rosenthal, 2000), divisibility (Wolfe, 1994), instrumental, ultimate (Zaltman et al., 1973)
	Adaptability	The extent to which the innovation can be refined, elaborated and modified according to the needs and objectives of the group.	Compatibility (Tornatzky and Klein, 1982; Rogers, 1983; Zaltman et al., 1973)
Benefit	Relative Advantage	The extent to which an innovation is perceived as being better than the condition it supersedes.	Effectiveness (West, 1990; West and Farr, 1990; West and Anderson, 1992; Anderson and West, 1996; Anderson and West, 1998; Meyer et al., 1997), market merit, operational merit (White and Graham, 1978), relative advantage (Rogers, 1962; Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982; Dearing and Meyer, 1994; Meyer et al., 1997)
	Actual operation	The extent to which the innovation is perceived to have satisfied original objectives set for it.	Actual operation (Pelz, 1983), execution-oriented outcome (Tatikonda and Rosenthal, 2000)

Observability	The extent to which the innovation is observable by others.	Observability (Tornatzky and Klein, 1982; Rogers, 1983; Zaltman et al. 1973), visibility (Tornatzky and Klein, 1982; Moore and Benbasat, 1991; Agarwal and Prasad, 1997)
Profile	The extent to which the innovation raises personal, group or institutional profile.	Slack (Mohr, 1969), social approval (Tornatzky and Klein, 1982)

Table 7-2: Framework definitions and antecedent literature

7.2.2 Item generation

Following the specification of the framework with 13 attributes, the objective was to create pools of items from previous studies as measures for each of the attributes within the framework, or identify gaps where previous studies had failed to operationalise measures.

Measurement of innovation is a complex issue and various approaches are evident in the literature. In success studies of innovation the metrics frequently used to determine success (construed in terms of organisational or innovation performance) are financial and economic. Cooper (1998), for example, measures performance across 10 criteria which factor analysis then reduces to two substantial underlying performance dimensions: profitability and impact on the business.

However, not all innovations are easily assessed in economic terms nor, indeed are economic and financial metrics always particularly meaningful. Financial and market performance measures could suggest a preoccupation with efficiencies in the processes of innovation or with economic indicators and pay less attention to what it actually is that the processes of innovation produce. Dubiety also exists about the extent to which the relationship between organisational performance and an individual innovation can be determined. Where the innovation is of a social nature economic metrics might be inadequate to describe them and their benefit be better expressed in non-economic terms (Rogers and Shoemaker, 1971).

Qualitative and semi-quantitative measures are also useful because, as Rothwell (1992) points out, it seems that it is the intangibles that are more significant in innovation than the tangibles, that is, it is the strategic, behavioural and cultural features that are less easily amenable to managerial control. There are fewer measures of intangibles, which are, arguably, the more significant features of innovation. This might reasonably be assumed to be the case in health care innovation. Results from Phase I of this research appear to endorse that assumption that a broad conceptualisation of benefit beyond financial or performance metrics is required. The view is consistent with that of Warner (1974) who argues for a consideration of value or worth.

Werner and Souder (1997) have classically described methodological approaches to measurement of innovation in terms of the orthogonalisation of qualitative/quantitative techniques and subjective/objective perspectives – the latter in the sense of relationship to the organisation, i.e. non-organisational members (for example independent judges) could provide objective measures. The orthogonalisation leads to the description of three methodological approaches: quantitative-objective metrics; quantitative-subjective metrics; and, qualitative metrics (clearly a category 'qualitative-objective' is ontologically unsustainable).

Measures of attributes predominantly fall into the quantitative-subjective category. Quantitative-subjective metrics, or semi-quantitative metrics as Pappas and Remer (1985) call them, are based on subjective judgements then converted into numbers. Reliability is promoted by the collection of multiple opinions that are then aggregated. The merit of this approach is, for this study, that the semi-quantitative metrics provide a rich in-depth perspective on the phenomenon of interest and interrogation methods can encourage informants to reflect deeply.

Several items were discarded due to context specificity or double-barrelling (e.g. "To what extent is the innovation intellectually sophisticated or difficult to implement?" (Gopalakrishnan and Bierly, 2001; 128)). After developing new items, the instrument finally comprised of 64 items.

7.2.3 Purification of measures

The method of purification of measures was to determine the face validity of the instrument by testing amongst panels of judges and to test for internal consistency by statistical procedures. The former objective was achieved but, for reasons that are elaborated below, not the latter.

The purification of measures through pre-testing is a key element of the survey design process in which potential problems with data collection, inconsistencies in respondent interpretations of questions and/or statements and the mechanics of analysis can be identified and rectified. Pre-testing, therefore, offers the opportunity to refine questions and to check the reliability and validity of the instrument. Various authors offer different strategies for pre-testing. de Vaus (1996), for example, suggests a strategy might consist of 'declared' or 'participating' pre-testing and/or 'undeclared' pre-testing. The former is a strategy that makes explicit the expectation of feedback from panels of experts, colleagues and/or proxy-respondents in terms of their experiences of completing the questionnaire, meaning and interpretation of items, flow, redundancy and timing. The latter, in order to simulate actual conditions of administration, requires that respondents are not told that the instrument is still under development. Undeclared testing requires access to a naïve sub-group of the sample – naïve in the sense that they are unaware of the test in process.

Three rounds of instrument pre-testing were designed. In the event two took place, between April and June 2002. A round of declared domain expert pre-testing was followed by one of declared proxy-respondent pre-testing. The expert category consisted of scholars from the Centre for Research in Innovation Management at the University of Brighton, the Innovation Management Project at the University of Bradford and Cranfield School of Management (n=7). Individuals were expert in innovation and/or the process and management of surveys. Revisions following consultations with the experts reduced the number of items from 64 to 56, and refinements were made to individual items to address issues of variation, meaning and redundancy that had been highlighted.

The revised version of the questionnaire was subsequently sent to known health care professionals, clinicians and managers, (n=13). 12 returns were received from these proxy respondents. Where appropriate, telephone conversations took place to clarify certain issues. The response, on the whole, from health care professionals was that presentation and flow were clear, though small amendments were suggested.

There was a commonly held view amongst proxy respondents that a thinly veiled tension exists between clinicians and 'management-speak'. By way of coincidental independent corroboration, the title of the 2001 Rock Carling Lecture[8] was "Fads in medical care policy and politics: the rhetoric and reality of managerialism" (Marmor, 2001). It argued that clinicians are sceptical of managerial interventions, that managerial jargon threatens the clear thought and reasoned argument of clinical approaches. From the point of view of this study then, it was necessary to carefully target sympathetic respondents in non-jargonistic language. Failure so to do would have led to low response rates. Whilst every attempt was made to ensure a large response rate, it could not be guaranteed.

The two rounds of pre-testing appeared to establish acceptable levels of validity of constructs and items. A third round of validity testing by statistical method had been planned. Churchill (1979) advocates a measure of internal consistency through the application of alpha coefficient and factor analysis. However, it was felt unwise to cull a sub-sample from the 310 potential respondents in order to run a round of undeclared testing. Drawing off a proportion of these for undeclared pilot-testing would jeopardise opportunities of maximising response rates from a relatively small population.

A statistical test of internal consistency was, however, applied following the completion of the main survey (Phase II of this research). Cronbach's alpha is a measure of internal consistency based on the correlations between the variables concerned, and is particularly important in determining whether or not multiple sub-dimensions cohere to form a single dimension (Peter, 1979). That is, do the items operationalised to measure 'novelty', for example, correlate more highly with each other than they do any other attribute. If they do, then we can reasonably assume that they form a discrete factor. As has been described, statistical tests of reliability where not run prior to the application of the instrument in the main survey for reasons of protecting a limited sample. Cronbach's alpha was, however, run on the returns from the main survey (See table 7-3).

There is some discrepancy in the literature as to what value of Cronbach α indicates internal consistency. A reasonably widely accepted limit appears to be 0.7 and above, set by Nunnally (1967), though Inandi et al. (2002) suggest that a level of 0.6 is satisfactory. Meyer et al. (1997) describe values of below 0.45 as problematic. According to these criteria two of the items in the framework may be described as problematic (relative advantage and uncertainty) and four sub-categories in the grey area between 0.45 and 0.6 (novelty, ideation, adaptability and observability). This suggests moderate levels of internal consistency for the measures, which is tolerable

[8] The Rock Carling Fellowship is awarded by the Nuffield Trust to a distinguished individual who is invited to review the current state of knowledge in a field of UK health care (see http://www.nuffieldtrust.org.uk).

for exploratory research, but that they would benefit from further development and refinement in future research. Further, the analysis would appear partially to endorse Agarwal and Prasad's observation that scales comprising only two items tend to be unreliable. Four factors are measured by two items (adaptability, relative advantage, actual operation and observability) three of which achieve low alpha values. However, an alpha value of 0.791 was achieved for the actual operation scale.

Construct	Items	Alpha coefficient
Novelty	5	.579
Departure	7	.671
Disruption	6	.920
Risk	5	.823
Ideation	5	.458
Adaptability	2	.471
Uncertainty	5	.446
Scope	4	.699
Complexity	7	.736
Actual operation	2	.791
Relative advantage	2	.366
Profile	4	.642
Observability	2	.508

Table 7-3: Alpha coefficients of framework scales

In summary, conscious efforts have been made, in line with recommendations by Yin (1994) and Miles and Huberman (1994), to ensure that construct validity and the dependability of the study are maintained. The diversity of sources and data gathering methods overcome threats of common method and same source bias. Data and method diversity are employed in a strategy of triangulation to ensure construct validity. The final version of the questionnaire is presented in Appendix five with a sample cover letter and completion instructions. Individual items are also presented in the second section of this chapter. In order to avoid the use of potentially confusing statements some statements are reverse coded, in the tables that follow in this chapter these are marked with an asterisk (*).

7.3 Case histories

7.3.1 Introduction

The sample for Phase I consisted of four successful innovating teams in the NHS. This is purposive sampling in order to permit insightful examples from empirical data to provide a level of purification and finer-grained insight than reliance on a literature review alone could achieve (Churchill, 1979).

Access to award winners and runners-up was facilitated through the British Association of Medical Managers (BAMM) and, the European Forum for Teamwork (EFT). Choice of informant was restricted to those who had played a significant role in the determination of each of the innovations. BAMM or EFT facilitated contact with key individuals. The key contact subsequently recommended other individuals from the team for inclusion in the research, a technique commonly known as snowballing

(Miles and Huberman, 1994).

This research takes the position that it is unlikely that every actor will have made a significant contribution to the development of the innovation nor, will use it or will have been impacted by it to any great extent. Some individuals, that is, will have been involved in more significant ways than others. These significant individuals, it was assumed, would be identified by informants during the data collection process and that the researcher, would be guided to these significant individuals during the data collection process until such point that there was no one left to interview. Interviewing would stop when there were no remaining players to see or where a point of data saturation (i.e. no new insights being generated) reached. Documentary data also provided names of key individuals and validated the recommendations of the initial key contact.

Innovation case histories were written for each team on a specially designed pro forma summarising the main events and outcomes (see Appendix six). Data were noted onto the pro forma as they became available through any of the capture techniques described below. The case histories developed over time as new data were added, new insights gained and conundrums resolved. The activity of producing innovation case histories was an important part of the sense-making process. It served as a means data reduction, which Miles and Huberman (1994) describe as being part of the analysis not separate from it, and, through which, an almost overwhelming amount of data could be kept in check.

Each of these teams (Team A, Team B, Team C and Team D) comprised to a greater or lesser extent a group of 'unsocialised' (Jones and Jordan, 1998) individuals drawn vertically from the hierarchies and horizontally from across institutional and role boundaries of the NHS. The teams bear some similarities to Goodman and Wilson's (2000) exocentric teams in that they were time-limited and task-focused. The singular product of the activity of each of the teams was the resolution of the issue that caused the team to assemble in the first instance. Teams' case histories are briefly profiled below. Teams were interviewed and data gathered over a five month period between May and September 2001.

7.3.2 Team A

Team A was responsible for the redesign and re-launch of palliative care in one English county. Palliative care is the active total care of patients whose disease is not responsive to curative treatment. Control of pain, of other symptoms and of psychological, social and spiritual problems is paramount. The goal of palliative care is achievement of the best quality of life for patients and their families.

Two national events played a significant part in creating a climate in which palliative care services were encouraged to change. First, an Executive Letter from 1996 calling for, amongst other things, specialist palliative teams to be designed to work across organisational, departmental and specialist boundaries in order to achieve the best results for patients. Second, the Calman-Hine Report sought to establish, for England and Wales, the policy framework for commissioning cancer services. Specifically addressing palliative care, the report stated that care

> "*teams …should integrate in a seamless way with all cancer treatment services…work in close collaboration with their colleagues…be involved in regional audit and developing integrated operational policies and protocols…[and that] there should be a smooth progression of care between home, hospital and hospice*" (Calman and Hine, 1995; 18).

At a local level, the results of an audit of provision provided further impetus.

Palliative care has only been recognised as a speciality in the last 40 years or so. For some practitioners palliative care, as a speciality, is a difficult concept to grasp, after all, they reason, it is already practised within existing disciplines. Conversely, the patient, relatives and wider society tend to be very supportive of the concept. So, palliative care occupies a perhaps unique position within the context of the NHS. It has been relatively poorly understood within the NHS, but widely supported by the layman who tends to regard practitioners as 'saintly' and supports the delivery of care through considerable charitable and voluntary activity. The consequence has been that palliative care has developed in a fragmented fashion in the UK. For example, independent hospices tend not to be located at points of greatest need but at the seat of fund-raising efforts, that is, where people have cared enough to make an effort.

Palliative care in the case under study has been characterised by the range and depth of service. Care is provided by a range of personnel, from generalist staff to specialist care, by expert multi-disciplinary teams, and is delivered in a range of contexts from the patient's home to NHS hospitals, to independent hospices. The service has a wide remit and does not discriminate on the basis of age, sex, condition or institution. Three key groups dominate palliative care in this English county: Specialist NHS palliative care teams; Independent Hospices; Charities and Voluntary Groups.

By the early to mid 1990s it was apparent that palliative care in the county was not working as well as it might. Over a period of years delivery of palliative care and relationships between the providers had stagnated, or so some felt, and it became increasingly apparent that something needed to be done. The convergence of separate national, regional, county and local level agendas stimulated the commencement of a process to create a cohesive, integrated service to which there was equity of access for all the county's population. A core team of three, senior clinical and management personnel, was responsible for the development and implementation of the Integrated Service Directorate but, on its own, this team was not sufficient to ensure it saw the light of day. Rather like a planet's gravity attracts satellites, so too the concept and implementation of the Integrated Service Directorate drew other players into the team's orbit. So, with a stable core the team was dynamic, multi-disciplinary, cross-institutional (vertically and horizontally) and had a county wide remit.

Over a period of approximately two and a half years, culminating in a launch ceremony in April 2000, the concept of palliative care in the county was reconfigured as the Integrated Service Directorate for Palliative Care. The Integrated Service Directorate for Palliative Care has achieved Beacon Status within the NHS and was runner-up in the British Association of Medical Managers team of the year awards in

2000. The case has been published in the journal Clinician in Management (Adams et al., 2003).

7.3.3 Team B

At the time of the research, this NHS Trust Hospital oversaw a 420 bed general and acute unit, with approximately 1,500 staff, a budget of nearly £50 million, completed approximately 15,000 surgical procedures annually and had140,000 outpatient attendances a year. Over a period of years the hospital faced increasing numbers of emergencies, increasing demand for elective surgery and pressure to reduce costs. Problems were identified in the existing system which included: too many visits for patients and an inequitable system for booking operations, which was costly and not consumer-oriented. A massive hospital rebuilding programme provided the context in which a radical review of healthcare was undertaken.

An emergent multi-disciplinary, multi-level modernisation team addressed these problems. A clear focus on the 'patient-journey', underpinned by a commonly shared set of guiding principles and an information management and technology strategy, putting data capture at the heart of the clinical process, sustained the vision that inspired three innovative projects.

At the core of these was a research and development project to re-design the patient journey, from GP referral to operation to discharge with supporting client/server ITC systems. The team developed a modified form of Business Process Re-engineering as the technique for exploring new dimensions of hospital service which gave them the opportunity to ask the question, "*if we were designing the hospital from scratch, how would it look*?" The answer was, "*not the way it looks at the moment*" and the team developed a strong idea that it would be impossible to create and sustain service excellence in the context of the NHS without fundamental redesign of operational processes.

The first project ran from September 1995 to September 1997. At its conclusion (determined by a European Commission funding stream) the technology had not been delivered (though it did arrive at a later date and formed the technological basis of subsequent innovations), and so in those terms the project arguably failed. However, the project was widely hailed as a success, not least because of a series of unanticipated spin-off benefits. As the team leader remarked:

> "*…but now we have an organisation that is willing to make change*" **[B1]**[9]

The team was winner of the British Association of Medical Managers Team of the year award in 2000. The innovations proved significant in that they enabled first the modernisation team and subsequently the wider hospital community to conceive that fundamental redesign was a possibility within a large NHS Trust.

[9] In order to maintain confidentiality and individual anonymity informants are referred to in the text by team affiliation (A,B,C or D) and an identity number.

7.3.4 Team C

Team C formed to address concerns regarding the nutritional intake of inpatients at an NHS Trust hospital. The hospital has some 550 beds and over 2,000 staff providing acute and rehabilitation services and serves over 1,800 meals a day. The concurrence of national and local drivers provide the context for the innovation. In the mid-to-late 1990s the national press reported stories of patients starving to death in the NHS, whilst Trust hospital audits strongly suggested that patients were not having their nutritional requirements met and that provision was fragmented and insufficient. Prior to the establishment of a team to address these issues, it was recognised in some quarters that the possibility of malnutrition had been an issue at this hospital for several years. In the absence of an interested and supportive senior medical practitioner, however, the initial, ad hoc nutritional team lacked the gravitas or authority to persuade board-level management of the criticality of their concern.

The team consisted of a core membership of medical/nutrition, dietetic and catering specialists but drew, also, on the knowledge and skills of a range of external experts in various medical, catering and nutritional specialisms. A wide-ranging consultation exercise and a series of audits of the problem preceded the development of a project plan and a bid for funding support. The consequent 'Eating Matters Project' made a significant improvement in nutrition awareness and screening in the Trust. One unexpected, but welcome, outcome was the restoration of relations between catering department and the wards. Historically perceived as providers of 'hotel-type' services catering had become dislocated from the caring-type roles, the renewed focus on patient-benefit was instrumental in enabling catering to be reconceived by users and managers as part of the care infrastructure. Team C won the team of the year award from the European Foundation for Teamwork

7.3.5 Team D

Team D, whose membership is dynamic, is a small multidisciplinary service delivery unit and orbits around a dynamic and inspirational senior anaesthetist. Team membership tends to be drawn from departments of anaesthesia, operating theatres and day case units. Team D is active in an acute hospital that operates somewhat in the shadow of a proximal major teaching hospital of international reputation, with which it recently became integrated. The hospital has been responsible for some significant patient-focused innovations. Examples include an early example of nurse-led pre-assessment, which involves taking patient histories, social as well as medical, in order to assess implications of their treatment beyond their time at the hospital and, organising investigations such as blood tests and x-rays. The consequence is that patients are seen quicker, they are better educated about their contact with the hospital (easing levels of distress), patient-flow is improved and a substantial reduction in cancellations on the day of operation have been achieved. The team was successful in winning funding to help in the establishment of an acute pain service. The acute pain service was a significant departure from conventional pain management techniques in which patient controlled analgesia is facilitated in all post-operative patients by daily pain rounds of surgical wards. The team also developed a novel technique for patient control epidurals. For the pain service work the team has received commendation from the Audit Commission and, is actively diffusing their experience to the proximal teaching hospital.

7.4 Data collection and analysis

7.4.1 Collection and analysis of interview data

In order for a question/answer session to make sense, it seems reasonable to ensure that informants understand the question (Foddy, 1993). An interview protocol, that attempted to promote a uniformity of understanding amongst informants was, therefore, established. Each informant received prior notice of the substantive interest of the research in the form of background documentation (see Appendix four). Interviews lasted between 40 minutes and 3 hours and each was opened with a sequence of introduction, explanation and assurances as recommended by (Lofland and Lofland, 1995). Interviews were semi-structured around issues of innovation processes and attributes but allowed for other lines of inquiry to be pursued as dictated by exigencies of the circumstances. The protocol remained consistent within and across cases.

Interviews were transcribed and then coded, the process being facilitated by the use of NVivo® software. Data were analysed using the well-documented method of data categorisation, sub-categorisation and constant comparison (Glaser and Strauss, 1980; Miles and Huberman, 1994). Coding was accompanied by extensive annotation describing why an item had been coded in each particular way. This transparency was particularly useful later in synthesising findings across the various interview transcripts. Achieving synthesis from the diverse datasets represented by the empirical data from the interviews in the name of objectivity and representativeness posed a challenge. It is always problematic to generalise findings from a series of interview data which are unique.

Systematically coding interview responses enabled a clear audit trail for findings and conclusions drawn from the data. Coded items were assigned to a pre-existing category (or 'node' in NVivo®) from Rogers' (1983) framework. Alternatively, a new category or sub-category was developed. As new items were categorised, category labels and definitions were re-evaluated in a process that gradually focussed the coding and winnowed out unproductive categories as others assumed the status of overarching ideas or propositions. The process resulted in the development of a thirteen-item framework of innovation attributes, incorporating and supplementing Rogers' work.

In addition to tape recording the interviews, notes were taken and interview reflections captured on a pro forma at the earliest opportunity following the conclusion of the interview. The aim was to record not only what was said but also contextualise the interview in terms of demeanour of the informant and responsiveness. Further, the significant issues, those that had been overlooked or that warranted further exploration and so forth were highlighted. A recording malfunction resulting in two inaudible cassettes confirmed the value of this. Both tapes were subjected to forensic audio techniques and were partially recovered which, when combined with the notes and reflections, covered the gaps and averted a potentially problematic situation. Subsequently interviews were transcribed for content analysis with the aid of NVivo® software.

7.4.2 Collection and analysis of repertory grid data

The repertory grid constitutes a mechanism for both the elicitation and the representation of cognitive models, emphasising the idiographic characteristics of personal construct systems (See Chapter six). It is necessary to make two points here. First, repertory grid technique was adopted as an elicitation mechanism not particularly for the facility of cognitive representation. Second, the technique has a weakness in dealing with groups, it does not provide a direct method for eliciting team mental models (Lambe and Spekman, 1997), as different people construe the same things in different ways. From the point of view of developing a framework capable of describing innovations, the idiosyncrasy of perspective is advantageous as it provides volume and the technique captures the diversity of views. The question, therefore, that needs to be addressed is how to synthesise this diversity into a valid, parsimonious framework. In other words, rather than trying to establish some sort of commonality of construing within the project teams, the objective was to continue to develop and modify the emergent framework in such a way that the framework could capture, concisely, that diversity of view.

The execution of the technique requires some elaboration. The following description is adapted from Goffin (2002). The technique takes the form of a conversation that is structured by conceptualisations of the subject under discussion. In the case of this research the subject, for each team, was innovation. In order to uncover the ways in which informants think about the phenomenon of interest they are forced to compare and contrast different manifestations of the phenomenon and describe the ways in which they are similar and different.

The repertory grid technique terms these manifestations of phenomena 'elements'. The elements in this research were innovations with which team members were familiar. The name of each element is written on separate, numbered cards, each card having been pre-numbered in a random sequence. Once all elements have been annotated onto separate cards the informant is presented with a set of three cards, which, in the terminology of repertory grid technique, is called a 'triad'. The informant is then asked, 'In what way are two of these innovations similar to each other and different from the third?' A typical response – termed a 'construct' – could be that two innovations are simple and the third complex. The construct forms a bi-polar scale (in this example 'simple…complex') and informants are asked to rate each element on a five-point scale against this construct and pole. These ratings are recorded on a pro forma (see figure 7-2). Often, the reflection that is the consequence of comparing and contrasting elements in this way, causes informants to 'think aloud' and explore the different dimensions of innovations. This articulated reflection is a valuable source of qualitative data. Under time-limited conditions repertory grid technique proved a useful elicitation device and conversations invariably sparked from the comparing and contrasting elements.

Further triads, in which at least two elements must be different from those contained in the previous triad, are then presented to the informant and the process repeated. Informants are not permitted to repeat constructs and so, each presentation of a triad results in the elicitation of a new construct and pole and, fresh, insightful reflections. The process continues until a stopping point is reached, this is usually when the informant struggles to find any meaningful ways in which to discriminate between elements. Frequently, this point is reached at between seven and 12 constructs.

Figure 7-2 usefully illustrates the technique in action. Nine elements (innovations with which team members were familiar) were identified from secondary data and confirmed in conversations with team members. In the first triad, informant C2 was asked to consider elements 1, 2 and 3 and describe how two were similar to each other and different from the third. The construct that was chosen to discriminate between elements was ‘simple’ and as its pole, ‘complex’. Subsequently each element was rated on the 1-5 scale. The next triad consisted of elements 4, 5 and 6 and elicited the construct and pole ‘people’ and ‘project’. The process continued, with informant C2, until seven constructs had been elicited, after which no new meaningful constructs could be identified.

Tape ref: C2	**Elements by card number**									**Date: 18 05 01**	
Construct (1)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Pole (5)**	**triad**
Simple	3	5	3	2	4	5	2	3	4	Complex	123
People	3	4	3	1	2	5	2	2	1	Project	456
Beliefs	3	4	4	4	2	3	4	2	1	Action	789
Staff's expressed wishes	1	2	2	1	5	3	1	4	3	Nutrition team's wants	245
Low combinatorial newness	2	3	4	1	2	5	1	2	2	High combinatorial newness	369
Focused	5	5	4	1	4	5	3	5	5	Trust-wide	234
Small numbers of staff required	3	2	4	2	5	5	2	5	5	Large numbers required	157

Figure 7-2: Repertory grid, informant C2

Elicitation of the construct led to a debate regarding the nature of this newness and its relation to the Eating Matters Project, for example:

> “*…you could say none of these ideas are new, they are a rehash of what has gone before, so we have made something new come out of the whole*” **[C2]**.

Repertory grid technique was applied to each of the teams as an elicitation technique apart from to team A. Team A was excluded from the process because it proved impossible to identify a set of elements that could be commonly recognised by all informants.

7.4.3 Collection and analysis of documentary data

Documentary texts, for qualitative research, are important “*because…in general, access can be easy and low cost, because the information provided may differ from and may not be available in spoken form, and because texts endure and thus give historical insight*” (Hodder, 1994; 393). The use of documents is also an important method of triangulation (Easterby-Smith et al., 1994).

Documentary and archival data were available in several forms across each of the teams. Teams A and D were able to provide supporting documentation from archived files – relating more to process than to outcome. Extensive documentary data existed for team B: detailed records had been maintained as part of the EU audit process. Team B had also written up some of their experience in the form of journal articles. EFT competition rules stipulated maintenance of a detailed log of team activities for all applicants, access was granted to that for Team C, who also had achieved some press coverage. Documentation proved to be an important source of insight into both the processes and the outcomes of the innovating, they provided a means of triangulation and verification for the spoken 'recalled' evidence.

7.4.4 Data coding

In constructing the framework, transcript management and coding was facilitated by the use of NVivo® software. Codes are "*tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study*" (Miles and Huberman, 1994; 56). In NVivo® codes are stored in 'nodes' which can be organised and presented graphically in a hierarchical tree-like structure showing relationships between nodes. Further, nodes can be given properties, the rules that govern or text that describes the code allocation criteria. Node properties in this instance were described by the four categories derived from West and Farr (1990). Sub-categories were then drawn from the literature and the empirical study with modification taking place at sub-category, but not over-arching category, level. Thus was it possible to synthesise data from the literature and empirical studies. Copies of coding, nodes, and properties were printed off at regular stages facilitating reviews of the state of play and, also, providing an audit trail for the development of the framework

Tentative categories already existed prior to transcription and analysis so coding commenced with a provisional list of high level categories (newness, ideation, benefit and application). Data were categorised, sub-categorised and compared as they emerged. Data from interviews, repertory grid analysis, documentary sources and theoretically-derived attributes were synthesised into these four categories. Definitions of each of the attributes found in the literature, where available, were examined and grouped according to their similarities. Some attributes are common across a number of studies, some bore similarities and others are unique to specific studies. New categories were elicited from the empirical data, which sparked further rounds of investigation of the literature. Data that did not fit within the categories derived from West and Farr (1990), or the criteria established for inclusion, were discarded.

Coding of the transcripts and grids began with what Lofland and Lofland (1995) call a 'broad-brush' approach where early analytic coding can be emergent, venturesome and experimental. Broad-brush coding was accompanied by extensive annotation describing why the item had been coded in such a way. Coded items were then assigned to a pre-existing category (node) in NVivo® or, a new category or sub-category was developed. As new items were categorised, category labels and definitions were re-evaluated in a process that gradually focused the coding and winnowed out unproductive categories as others "*assume[d] the status of overarching ideas or propositions*" (Lofland and Lofland, 1995; 193). The process was highly iterative and continued until saturation was reached and additional data no longer contributed to the refinement of concepts (Eisenhardt, 1989). This point was reached during the fourth case-study. The objective was not though, the formation of propositions but validating, modifying and dimensionalising a descriptive framework of innovation. The process of populating a pre-existing category is illustrated in table 7-4 and, table 7-5 illustrates the emergence of a sub-category unsupported in the pre-existing framework. Fuller examples are presented in Appendix seven and Appendix eight.

Interview 'raw' data	Paper protocols never work. They get developed and put on shelves, they become too difficult to use. So we pinched these, I made…it wasn't sort of plagiarism, but we used somebody else's piece of work -- they gave us the idea. And we developed it ourselves, we developed paper protocols but in such away that they have to use them because this is the only process that they can use for that disease. So the old medical records, we didn't use it. And we developed this patient record that was... maps out their disease…**[B4]**.
Broad brush coding and annotation	Newness derived from combinations of new knowledge or recombinations of existing knowledge that can exist within or be drawn from outside the group. Similarities to attributes revealed in the literature: originality (Pelz, 1985), inventive merit (White and Graham, 1978)
Coded to category	Newness
Sub category	Ideation: origins of the idea

Table 7-4: Data analysis, coding to a pre-existing sub-category

Interview 'raw' data	We probably haven't delivered as much as people would like us to. What we haven't delivered is the holy grail which is reduced cost, reduced patient stay, reduced incidence of pressure sores, and reduced antibiotic use **[C2]**. Yes, that is about as good as you get. Highly successful project, beacon status for doing it. Were there any weaknesses? No, we did it all. **[B1]**. I think more [patients] are being seen and they are being seen quicker. The access to the service is better and clearer **[A7]**.
Broad brush coding and annotation	The extent to which the innovation addressed and solved the problem that triggered the whole process. Different from relative advantage in that it considers the innovation in the context of its original aim. An innovation may not have achieved all that was intended for it (in its actual operation) though it may be a considerable improvement on what went before (relative advantage). This is about the effectiveness of the innovation but does not seem adequately to fit existing sub-dimensions. Seems similar to relative advantage in as much as the innovations appear to be better than the conditions they supersede. However, they also include a sense of the 'innovation-in-use'
Coded to category	Benefit
Sub category	Actual operation

Table 7-5: Data analysis, coding to emergent sub category

Check-coding, say Miles and Huberman (1994) aids definitional clarity and is a good reliability check but, they also make the point that this sort of analysis is inescapably a selective process and, in any transcript, people 'see' the same things differently. Nevertheless, check-coding and feedback from informants can contribute to the dependability of the study. Two forms of check-coding were used in this study. First, feedback from the informants on the results of the analysis. This was generally positive as the excerpt below illustrates:

> "[the draft]…*was the best bit of 'he's got no clothes on!' I've read in a while. I got defensive when I read it but actually it is closer to the truth I lived than anything I'm allowed to say. I've been normalised into the way the NHS works…Can't tell you how good it is to have you doing this…I sort of feel you are giving me an external reference point if only in my head*" **[A1]**

The second form of check-coding was with a fellow doctoral student. Consensus though, was not the objective but rather as a check against unconscious bias.

7.5 Framework elaboration

Following the collection, analysis and synthesis of the data a framework consisting of 4 categories and a total of 13 sub-categories was developed, this is presented in figure 7-3. The framework changed considerably over the lifetime of its development, reflective of the iterative nature of its construction. Two previous renditions are illustrated in Appendix nine.

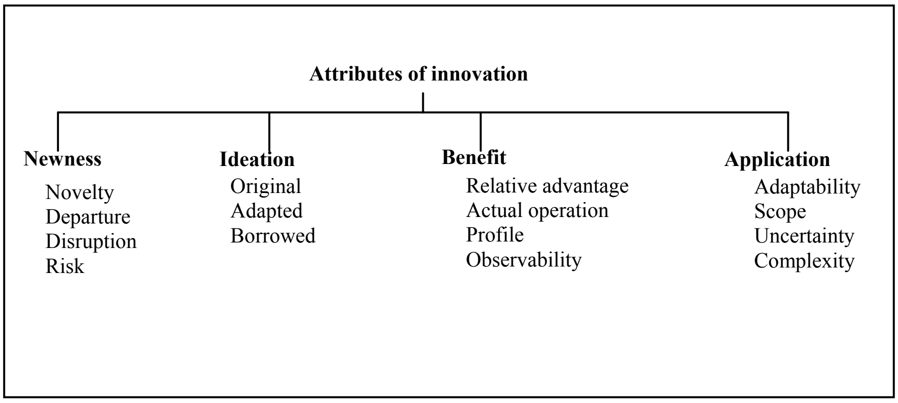

Figure 7-3: Framework of attributes of innovation

The following sections describe in greater detail the theoretical and empirical synthesis for each of the 13 sub-categories of the framework.

7.5.1 Newness

In previous chapters newness has been identified as a significant construct in innovation research and it features as one of the four factors in the West and Farr definition (1990). Multiple conceptualisations of newness are evident in both empirical data and the literature. Indeed, when one thinks of "newness" it is not the absolute or objective sense of the word that counts. It is the relative newness of an idea in the context of its use that determines perceptions (Mohr, 1969; 114).

Early iterations of the coding framework dimensionalised newness in accordance with a common approach found in the literature, by the sub-categories of radical and incremental. However, it became apparent that this was insufficient to capture the ways in which informants thought about newness. Significantly 'newness' was found to contain dual notions. First, there is the view of newness strictly in terms of novelty (the extent of the difference between the innovation and some pre-innovation state). Second, a broader conceptualisation in which newness implies change in the existing structure, functioning, behaviours and practices of any particular social context.

Indeed, in the broader conceptualisation of innovation some studies use proxies such as risk, departure and disruption to investigate newness (Damanpour, 1988). For Wilson et al. (1999) a radical innovation is one that breaks new ground, requires new skills to implement and operate and causes significant departure from previous practice (Wilson et al., 1999). It seems clear that the greater the degree of newness then the greater is the challenge to existing structures and behaviours within the adopting social unit.

Thus, the 'newness' category of the framework can be sub-categorised as presented in table 7-6. Illustrative excerpts from the case studies are presented below with supporting discussion drawn from the literature.

Newness	Risk	The extent to which the innovation is inherently risky or threatens individuals, the institution or user base.
	Novelty	This item assesses the extent of change represented by the innovation compared to what preceded it, the level of difference between the before and after.
	Departure	The extent to which the innovation results in changes in prevailing practice in the group and social contexts in which it is implemented.
	Disruption	The extent to which the departure from prevailing practice occurred in a disruptive manner.

Table 7-6: Sub-categories of innovation category newness

7.5.1.1 Novelty

Previous chapters have already discussed the concept of novelty in innovation literature and it is not proposed to repeat that discussion here. The following excerpts though, illustrate innovators' thinking in terms of a continuum of degrees of novelty.

> "*…and said "Tell us what your vision is and how we can do it", well, we didn't know how we could do it, to be frank. We knew that we needed somehow to intertwine everybody that was part of palliative care, and that was a completely alien concept, particularly here*" **[A3]**.
>
> "*she was the one who converted us completely to the concept that doctors don't make decisions at all, and that the whole process actually depends on patients making decisions and having sufficient support, information, guidance, and counselling for the patient to make the decision. Well for me that was a complete shift in mindset*" **[B1]**.
>
> "*…but, how can toast be radical*?" **[C2]**.

This sub-category captures the notion of degree of change from a pre-existing state, the level of difference between the before and after. It draws heavily on the ideas of newness and novelty from previous research identified in table 5-1, and incorporates the dichotomisations and continua implicit in continuous improvement, incremental, radical, evolutionary and revolutionary innovation.

7.5.1.2 Operationalising novelty

The terms novelty, newness and innovativeness are often used synonymously to describe the extent of change from some pre-existing condition. The variety of approaches to its measurement has been alluded to in Chapter four. In the literature attempts have been made to establish objective, quantitative measures of novelty such as Garcia and Calantone's (2002) typology of innovativeness based on context (macro or micro) and marketing and technological discontinuity (present/absent). Nevertheless, the commentator plays a significant role in determining the degree of novelty (Danneels and Kleinschmidt, 2001) and this sort of measure can, at best be described as semi-quantitative (Pappas and Remer, 1985), in that they are based on subjective judgements and converted into numbers. Some measures, however, determine innovativeness by quantity of innovations, for example percent of significant product innovations that were first to the market (Loch et al., 1996), number of new major products compared to industry average (Loch et al., 1996) or the number of incrementally or radically innovative products introduced in the past 3 years (Souitaris, 2002) or, simply counts of innovations (Hauser and Zettelmeyer, 1997). However, in practice the vast bulk of measures of novelty rely on the perceptions of individuals and take the form of statements against which respondents are asked to rank (a) specific innovation(s), usually on a Likert-type scale.

Statements range from the very context-specific, for example 'The degree to which the product was new to the firm in terms of new engineering skills for the firm' (Cooper and Kleinschmidt, 1990; 109) to the general such as 'How new in general was the innovation?' (West and Anderson, 1996; 686). Consistent with the objective to produce a formal framework, constituted at a higher level of generality, this research draws on and adapts generally-framed statements from previous research to develop five items to interrogate novelty (see table 7-7).

• There is a high degree of similarity between the innovation and that which it replaces*
• The innovation has allowed the adopting unit to provide (a) new service(s) for the first time
• The innovation consists only of minor changes*
• The innovation supplemented, but did not replace, an existing service*
• The innovation represents a major change in what the adopting unit is able to offer

Table 7-7: Operationalising novelty

7.5.1.3 Departure

Lambe and Spekman (1997) describe discontinuous technological change as that in which fundamental change in the activities of the organisation and a large departure from existing practices result. Rabson and DeMarco (1999) dichotomise newness in terms of revolutionary and evolutionary, the former being radical shifts in processes and technologies, the latter being continuous improvements through changes that are small enough to be made with minimal disruption.

Beyer and Trice (1978) describe this shift as 'pervasiveness', the proportion of total behaviours occurring within an organisation that are expected to be affected by the innovation. For Dewar and Dutton (1986) radicalness is the extent to which an innovation represents technological changes and thus implies new behaviours for organisational subsystems and / or members. Damanpour (1996) describes radical innovations as those that produce fundamental changes in the activities of the organisation and represent a large departure from existing practices, whilst incremental innovations result in a lesser degree of departure from existing practices. West and Anderson (1996; 686) distinguish between the novelty of an innovation (how new in general was the change), its impact (the extent to which a change to the status quo would be likely to result) and its magnitude (how great would be the consequence of the change).

The data illustrates how the teams were confronted with new ways of working, or conceived of their work that represented a departure from that which preceded the innovation:

> "*Oh enormous* [emphasised]. *Even though the scale was not large, conceptually this is massively challenging, massively. Like, you know, it contradicts so many cultural things about the way in which the NHS has worked. From strategic bodies like health authorities right down through to operational staff*" **[A3]**.

> "*And so that was very different to…there was new challenges there because we were looking at the whole process, looking at different ways of working and looking at different things*" **[B4]**.

> "*…the catering staff, the ones at ground level, they had much more work to do. They had to change the whole process, I mean not the process of presentation or the process of food delivery because it was all there. But they had to increase the number of dishes that each meal had, they had to increase the number of meals that they served, you know how many stations they have on a belt they had to provide additional sets, they had to provide additional hot evening meals where it had previously dwindled to nothing. So basically they are busier at all times of the day, doing various different things in addition to the main job that they were always there doing*" **[C2]**.

> "*Here, people tend to stay here and never move. So I did get a lot of 'Well, we've done it like this for 10 years, why do we suddenly have to change?' so you have got to keep making yourself visible*" **[D1]**.

Departure is, therefore, conceived as the extent to which the innovation results in changes in prevailing practice in the group and social contexts in which it is implemented. It incorporates some of the notions implicit in previous definitions of discontinuous (Lambe and Spekman, 1997) and radical innovation (Beyer and Trice, 1978; Dewar and Dutton, 1986; Damanpour, 1996) innovation magnitude (Wolfe, 1994; West and Anderson, 1996), and pervasiveness (Fliegel and Kivlin, 1966).

7.5.1.4 Operationalising departure

No previous measures of 'departure' were identified in the literature. Drawing on discussions in the literature and the empirical experience, seven items were devised to measure 'departure' (see table 7-8). These measures explored departure at three levels (adopting unit, organisation and stakeholders), inspired by Geisler (2000), in terms of familiarity (Roberts and Berry, 1985) and in terms of routines (Adams et al., 2003).

- Staff were immediately familiar with how the innovation worked*
- The innovation represented a large departure from existing behaviour for the adopting unit
- The innovation represented a large departure from existing behaviour across the whole organisation
- The innovation represented a large departure from existing behaviour for the wider stakeholder community
- Pre-existing routines (i.e. pre-dating the innovation), in the adopting unit, remained unchanged after the innovation*
- Pre-existing routines (i.e. pre-dating the innovation), in the whole organisation, remained unchanged after the innovation*
- Pre-existing routines (i.e. pre-dating the innovation), in the stakeholder community, remained unchanged after the innovation*

Table 7-8: Operationalising departure

7.5.1.5 Disruption

A further dimension of newness, alongside 'extent of change compared to a previous state', is the innovation's capacity and unknown potential to affect everyone and everything (Danneels and Kleinschmidt, 2001), both in its initiation and implementation, Therefore, innovation implies degrees of social, organisational or structural displacement. The resultant departure from extant behaviour appears to occur in more or less disruptive ways. So-called radical innovations impact existing systems in a disruptive manner (Rabson & DeMarco, 1999), conversely, innovations that are not, do not.

The two excerpts illustrate extreme examples of disruption from the cases. Whilst some disruption did occur in the case of Team C it was comparatively small and local (restricted to kitchens & catering), quite significant disruption was, however, observed in teams A and B:

> "*And so we changed the whole clinic structure and this is quite a big thing to have consultants change their clinic structure particularly by nurses it is rather like board directors having their working practices changed by assembly line*

workers" **[B2]**.

For team A, the disruptive implications impacted more broadly:

> "*But what they did not want to do was to let go of it. And there we were, suddenly talking about moving people into a single managed team and actually taking them out of their employer Trust to put them into a different one*" **[A3]**.

'Disruption' is, therefore, conceived as the extent to which the departure from prevailing practice occurred in a disruptive manner, and incorporates some of the notions implicit in previous definitions of discontinuous (Lambe and Spekman, 1997) and radical (Beyer and Trice, 1978; Dewar and Dutton, 1986; Damanpour, 1996) innovation, and magnitude (Wolfe, 1994; West and Anderson, 1996).

7.5.1.6 Operationalising disruption

Six measures of 'disruption' were devised (see table 7-9). As with 'Departure' three levels were explored (adopting unit, organisation and stakeholders), at stages of innovation initiation/development and implementation (Zaltman et al., 1973).

• Developing the innovation caused disruption in the adopting unit
• Developing the innovation caused disruption in the wider organisation
• Developing the innovation caused disruption in the stakeholder community
• Implementing the innovation caused disruption in the adopting unit
• Implementing the innovation caused disruption in the wider organisation
• Implementing the innovation caused disruption in the stakeholder community

Table 7-9: Operationalising disruption

7.5.1.7 Risk

Mohr (1969) warns that the introduction of something new entails resource, organisational or social risk of some sort. Burns and Stalker (1961) note that all novelty includes some degree of risk. Heany (1983) describes product innovation along a continuum of newness, anchored by 'least risky' style changes in established products, and major innovations, that have the potential to place major strains on all or most functional areas. Heany (1993) conceives organisational risk to be at its least where market, product and process repercussions are minimised or non-existent. In a similar vein, Meyer and Goes (1988) describe risk to the adopting organisation as the level of risk liability to which it is potentially exposed. Bessant and Caffyn (1997) suggest that for some organisations, unaccustomed to the innovation process, mobilising high levels of participation can be a risky business, not least of all because of the factors that militate against it such as fear of change, lack of innovation skills or inappropriate organisational structures.

It has become almost a taken-for-granted that risk and innovation, like risk and entrepreneurship, go hand-in-hand. An atmosphere where risk-taking is encouraged has often been linked with innovative environments and, a willingness to take risks. This is widely regarded as characteristic of innovative and entrepreneurial behaviour at the level of the individual (Bommer and Jalajas, 1999), the group (West, 1990) and the organisation (Casson, 1993). Risk, too, is associated with the innovation outcome both in terms of development processes and, ultimate application.

West (1990) notes that work group members are more likely to take the risk of proposing new and improved ways of working in a climate which they perceive as personally non-threatening and supportive. Characteristics of such climates include participative safety and support for innovation. The former describes an environment that is perceived as interpersonally non-threatening, where trust and support thrive, the latter being one in which the expectation, approval and practical support of attempts to introduce new and improved ways of doing things in the work environment (West, 1990). In circumstances of threat or insecurity risk-taking is likely to be diminished and the failure to make people feel safe in their jobs or experimentation can lead to a tendency to avoid risk-taking or experimentalism and so militate against innovating.

Individuals may also be sensitive to moral and ethical risk factors. It is arguable that in the medical and related fields there is a greater potential for exposure to these types of risk, for example the dilemma of prescribing high risk drugs to treat serious illness (Peay and Peay, 1994) or, the development, application and introduction of organ replacement strategies (Sass, 1997),

Taggart and Blaxter (1992) assess pharmaceutical firms' attitude to risk on dimensions of technical and market risk. Technical risk is the failure of the development process that is determined, largely, by approach to the research and development (technique) and the conceptual newness of the project. Market risk is the risk of an unsuccessful launch mediated by the context of application, the innovator's experience of that context and, the level and nature of competitive forces in that context. The excerpts illustrate risk at both individual and organisational levels.

> "*There were problems particularly when we got to* [name of innovation] *and we tried to move waiting lists to booking lists, and there was a fundamental move where you were taking the waiting list management away, and therefore the power, away from the surgeons and away from their secretaries, they weren't very happy about that and some people said I will not do it*" **[B2]**.

> "*I got warned by the health authority that I might get suspended and [that] if I was asked to go to a meeting with my chief executive and medical director [I should] say no and ring us. And I had a gagging letter from [senior manager] with whom my boats were burned really so I wrote back a brave letter… she said if I talked out of turn she would have to take it to the chief executive of the region*" **[A1]**.

> "*…we had quite a strict regime of deprivation before anaesthetic, we actually realised after a literature search that the risks that we were concerned about were actually non existent, well not non existent but so small that…*" **[D1]**.

Consequently, risk is conceived as the extent to which the innovation is inherently risky or threatens individuals, the institution or user base, and finds support in previous studies that consider risk (Zaltman et al. 1973; Heany, 1983; Bommer and Jalajas, 1999; Taggart and Blaxter, 1992).

7.5.1.8 Operationalising risk

Five items measure 'risk' (see table 7-10) and these reflect risk inherent in the innovation, risk to individuals, risk to the organisation and risk at stages of the innovation process.

- The innovation is inherently risky
- The innovation has been widely accepted as safe*
- Individuals took risks in developing the innovation
- Individuals took risks in implementing the innovation
- The innovation represents a risk for the organisation

Table 7-10: Operationalising risk

7.5.2 Ideation

Successful innovation can have its roots in creativity but originality in the sense of 'new to the world' is not a necessary antecedent. At the heart of innovation are combinations of new knowledge or re-combinations of existing knowledge (Nonaka, 1990; Boisot, 1995; Pitt and Clarke, 1999) so it is, that innovation can be conceived to embody different configurations of new and existing knowledge that exist/existed endogenously or exogenously to the group. These configurations of knowledge can be conceived of as different levels of originality. Originality is distinguished from newness in that it is concerned with the *source* of the ideas and knowledge that feed newness as opposed to a relative measure of the novelty of an innovation, see table 7-11.

Ideation	Origination	A first time solution to a problem without benefit of similar, prior examples.
	Adaptation	A few prior solutions have been identified and these are modified to fit the particular situation.
	Borrowing	Well developed solutions to the problem are found elsewhere and are copied with little or no change.

Table 7-11: Sub-categories of innovation category ideation

Pelz's (1983, 1985) work focuses on the extent to which disorderliness of process is related to different levels of a range of innovation attributes. For those innovations that are 'originated' (developed entirely in-house and are wholly original) the sequence of events in the process overlaps in time, is muddled and disorderly. For simple innovations that are borrowed (copied from outside with little change), a moderately clear succession of stages may appear. The research is inconclusive as regards normative statements about processes and outcomes, an effective innovation could occur in either an orderly or muddled fashion, and so could an ineffective one (Pelz, 1985). Nevertheless, the dimensionalisation is a useful means of classifying the idea sources of innovation artefacts.

The evidence of the empirical work corroborates this view of a scale of origin of ideas ranging from new to the world ideas to imported ideas and that the material sources of new knowledge components that make up the innovation artefact form a significant part of the perception of it. Further, it is reminiscent of Pelz's (1983) dimensionalisation of originality. Pelz's (1983) three dimensions of originality (source of idea) are: origination, adaptation, borrowing.

Original innovations are first time solutions to a problem without benefit of similar, prior examples. In the development of the innovations for which they won awards teams B and C pursued a series of smaller, contributory innovations, some of which were borrowed, others, wholly original.

> "*…that* [the innovation] *I know is very original because, having spoken to many people from many different Trusts they have never heard of something like this. In fact, nobody other than the nursing staff feeds patients. So this is original, it is original on the national scale, nationally it is very original*" **[C4]**.

Team A doggedly pursued an original innovation for 2 years:

> "*…how* [we] *integrated it was ours, self-generated. And it grew from thinking 'well instead of having Macmillan nurses in 5 Trusts let's have them in one…actually give them some specialist management so that they have got a manager who knows what it is they do and understands what the pressures are', it grew from that*" **[A2]**.

Adapted innovations are those where a few prior solutions have been identified and these are modified to fit the particular situation.

> "*Paper protocols never work. They get developed and put on shelves, they become too difficult to use. So we pinched these, I made…it wasn't sort of plagiarism, but we used somebody else's piece of work -- they gave us the idea. And we developed it ourselves, we developed paper protocols but in such away that they have to use them because this is the only process that they can use for that disease. So the old medical records, we didn't use it. And we developed this patient record that was... maps out their disease…*" **[B4]**.

Borrowed innovations, well developed solutions to the problem, are imported from elsewhere and are copied with little or no change. The data seems to suggest that Team C's innovation was borrowed compared to those of A and B which relied more on adaptation and their own origination.

> "*Nutrition as treatment: well it is not an original idea, but it was not used very widely and we borrowed it only for the benefit of our patients*" **[C4]**.

> "*…I mean when you say innovation…you go back to Florence Nightingale,*

> *that is what they used to do. That was considered their most prime nursing function. And there is lots of evidence that if you don't do it then people take longer to recover etc. but it still feels like we have got an uphill battle to maintain where we are*" **[C1]**.

7.5.2.1 Operationalising ideation

The knowledge origins of the innovation are measured by five items (see table 7-12) which determine whether or not the innovation is borrowed, adapted or original (Pelz, 1983; Pelz, 1985).

- The innovation was developed entirely in-house*
- The innovation required significant external input
- The innovation required minimal external input*
- The innovation was copied from an external source*
- The innovation was modified from external examples*

Table 7-12: Operationalising ideation

7.5.3 Application

The category 'application' describes perceptions of the innovation 'in use', what it is like to live with it. Warner (1974; 442) describes use and application as a factor of "*obvious import*" and that usage is essential for meaningful analysis. Warner's (1974) argument is that a technological perspective on innovations, which can be hard (physical objects), or soft (organisational changes) does not suffice to define or bound the innovation and that the multidimensionality of the innovation, based on its use (application) or profitability (value, worth or benefit), provides more sensitive analysis. In this study four sub-categories of application are presented: uncertainty, scope, complexity and adaptability, see table 7-13.

Application	Uncertainty	Knowledge concerning the link between innovation inputs, processes, and outcomes.
	Scope	The extent to which the innovation stands-alone or requires changes elsewhere.
	Complexity	The extent to which the innovation, regardless of scope, by dint of its connections to other parts, is difficult to use.
	Adaptability	The extent to which the innovation can be refined, elaborated and modified according to the needs and objectives of the group.

Table 7-13: Sub-categories of innovation category application

7.5.3.1 Uncertainty

Uncertainty, in respect of innovation, tends to be discussed as a contextual or environmental factor. Shane (1995) established that the cultural value of uncertainty acceptance is significantly associated with innovating, and that uncertainty-accepting societies may be more innovative than uncertainty-avoiding societies. A level of uncertainty is an important precondition for innovation to take place (Brouwer, 2000) and innovating has been conceived of as a process of reducing those uncertainties.

Uncertainty reduction is an information-processing activity in which novel combinations of existing and new knowledge are made: individuals and groups tap a pool of knowledge in order to deal with uncertainties in unrealised user requirements (Souder and Moenaert, 1992). Deyle (1994) describes this as 'innovation by groping along' in which there are echoes of Zaltman et al.'s (1973) scientific status. Tatikonda and Rosenthal (2000) describe uncertainty as the difference between the amount of information required to perform a particular task and, the amount of information already possessed by the organisation.

Uncertainty can be reduced by experimentation, piloting or trialing innovations (Fliegel and Kivlin, 1966). Divisibility is similar to trialing (Rogers, 1962). Although trialing did feature in some respondents' perceptions, it did not satisfy all the criteria for inclusion in the framework. There was, however, sufficient evidence of the notion of uncertainty in terms of imperfect or incomplete knowledge with regard to the inputs, processes and outcomes of the innovation to warrant the inclusion of uncertainty in the framework.

> "*Well, before I came they* [the Health Authorities and other local stakeholders] *went down to Southampton to look at palliative care services there…they also went to Oxfordshire…but the honest answer is: No, there was nobody that I could sort of think 'Gosh, I will find out what they do and I will do it the same way that they do it.' There was nobody*" **[A1]**.

> "*The whole concept was really difficult to get your head around, and sometimes I struggle as well and think 'What the hell am I doing sat here?', but I do…as long as I can hang on to the fact that at the end of the day whatever it is we are trying to do now is going to make a difference to patients then I can hang in there*" **[D2]**.

7.5.3.2 Operationalising uncertainty

'Uncertainty' is operationalised by five items devised for this research as no previous measures were identified in the literature (see table 7-14).

Users are well informed about the origins of the innovation*
Users are well informed about expectations of the innovation
The feasibility of the innovation was frequently called into question*
We were not aware of appropriate external solutions to the initial problem
The innovation is effective in its use*

Table 7-14: Operationalising uncertainty

7.5.3.3 Scope

The fundamental notion underpinning the scope of an innovation is the nature of the linkage between an innovation and its environment. That is, to what extent can the innovation stand-alone and be pursued independently or, does its introduction require changes elsewhere in the system? Chesborough and Teece (1996) call these autonomous and systemic innovations. Goodman (1981) suggests individual and synergistic innovations. 'Individual' innovations affect only a single functional area and do not affect other functions or cause wider change. A synergistic innovation is one that affects many functions. Henderson and Clark (1990) describe component and architectural innovations. With the former, one component simply replaces another, but architectural innovations require that whole systems be reconfigured.

> "*But in the teaching side of it that is my job now, many of the aspects of teaching about it are still ongoing, I am still talking about* [innovation name]*…But actually it becomes part of [the NHS Trust] nutritional care philosophy: that this is it, this is what we do now…this is now the way that we want to run our nutritional care*" **[C4]**.

> "*And a lot of things came out of that for us in redevelopment, you know we designed a slightly different day surgery, we have got a pre-assessment unit, we have got different people working in different ways we have got a whole different process for our patients*" **[B4]**.

> "*So the notion of them all coming into the room and…writing it up on the board which patients need to be seen today and who is going to see them -- you know that is a level of collaboration at an operational level that the service had never known*" **[A1]**.

> "*Oh enormous [change]. Even though the scale was not large, conceptually this is massively challenging, massively. Like, you know, it contradicts so many cultural things about the way in which the NHS has worked. From strategic bodies like health authorities right down through to operational staff*" **[A2]**.

These excerpts illustrate examples of scope. Excerpt C4 illustrates the extent to which the innovation has become embedded as organisational philosophy, and extends beyond the innovating group. Similarly B4, shows wide ranging repercussions at an institutional level, beyond the context of the group. Conversely, A1 suggests a narrower scope in that behaviour change has happened within the context of the innovating group. However, A2 alerts us to be aware that although there is evidence to suggest narrow scope, other evidence might indicate a dispersed and wider significance.

Some innovations require changes in the system in which they operate, others may stand alone directly replacing that which preceded it and requiring no adaptation on the part of the system (Goodman, 1981).

"*So…we were starting to challenge that by saying 'if you direct book you do not need waiting lists'. So, you had this direct access which was eliminating the waiting list but it reduced the flexibility of theatres because, with a waiting list you can cancel…So there was on the one hand the benefits of not having a waiting list and on the other the disbenefits of not having the flexibility - so the system had to make sure it could accommodate that*" **[B3]**.

"[The] *clinic co-ordinator flexes the clinic according to the needs, using capacity demand analysis, because it's a single consultant speciality so if he's away you can get queues forming again and she has the knowledge to change the clinic and flex it with the radiology department*" **[B2]**.

7.5.3.4 Operationalising scope

'Scope' is measured by four items (see table 7-15) adapted from conceptualisations in the literature, notably Henderson and Clark's (1990) ideas of architectural and component innovations. These are adapted for more general usage, the extent to which the innovation stands-alone (within the group), or requires changes elsewhere (outside the group), as opposed to their techno-centric view.

The innovation is self-contained within the adopting unit*
The impact of the innovation has been limited to the whole organisation*
The impact of the innovation has been widely felt beyond the whole organisation
The innovation has required changes to be made or accommodations sought in the wider stakeholder environment

Table 7-15: Operationalising scope

7.5.3.5 Complexity

The notion of complexity articulates innovators' and users' views on the ease or difficulty of making use of the innovation, and in this respect is similar to the attribute 'ease of operation' (Tornatzky and Klein, 1982; Adams et al., 1992). Complexity has received considerable attention in the management literature, particularly in recent times where it has been used as a lens through which to study and understand the dynamism of organisational change (Brown and Eisenhardt, 1997).

Cilliers (1998) argues that complexity results from the nature and level of the interaction between components of the system and can be determined by the analysability of that system at the level of the system. Thus, he suggests, a jumbo jet is not complex, because it is analysable and fully understandable, but is rendered complicated by the volume of relationships within the system. On the other hand, a mayonnaise is complex because it defies analysability, exact description and understanding. This conceptualisation is echoed in the data:

"*…it is very complex…there are a variety of dimensions to that. The number of different stakeholders, the number of different types of process that we are* *dealing with, the number of aspects of that process that we need to do something about…it is all of those*" **[B2]**.

Tornatzky and Klein's (1982) meta-analysis of 75 studies rated complexity (along with compatibility and relative advantage) as one of three consistently significant factors influencing adoption rates. It is generally assumed negatively to influence rates of adoption and can be a major reason for project delay (Griffin, 1997b). Hobday (1998) postulates complex innovations differ from conventional goods in terms of the complexity of both their origination (process) and outcome. He describes a complex innovation as many customised, interconnected control units, sub-systems and components rather than smaller numbers of mostly standardised components used in commodity products. In terms of process, complex innovations may be characterised by multiple design paths, concurrent development activity, multiple skills input and the application of a breadth of knowledge. The richness of these interactions and the interconnectedness between components and sub-systems can be embodied in the outcome (Henderson and Clark, 1990).

Pelz (1985) differentiated between technical and organisational complexity. The former recognises a continuum from loose to tight, describing the nature of the connectedness of the component parts of an innovation. Pelz (1985) defines organisational complexity in terms of numbers of units involved in the adoption of the innovation. It is clear though, that complexity is not simply a function of numbers but also about the nature of and uncertainties in the links between the units or component parts. Complexity can therefore be considered to be a function of the nature, quantity and magnitude of the units involved in its development and implementation, and of the component parts of the innovation rendering it difficult to understand or use.

Empirical data illustrate how informants perceive complexity in their innovations:

> "*I think it is the closed universe wherein they bring everybody together in palliative care. And the thing that the hospices particularly like is that they are given a stake and some say in the whole of the way in which palliative care works not just their hospice bit of it. So they have some say in the way NHS resources are used and Macmillan resources are used, not just how other hospice resources are used. And I think it is that holistic approach*" **[A5]**.

> "*What tends to happen now is that catering staff deliver the food that they have prepared to a nationally agreed standard and monitored it and cooked it to the right temperature for the right time and made it presentable… and it gets up to the ward, and somebody pushes the trolley into the ward, and that is the end of it, catering do not see the end user enjoy the product or even eat the product. So the idea of having the housekeeper or ward hostesses there was to complete that bit of the process and with the same kind of care*" **[C2]**.

> "*One and two* [the informant is speaking of elements 1 and 2 in the repertory grid] *require components of lots of individual people to achieve i.e. menu review, detailed discussions with dieticians, head of kitchen and chef team, suppliers etc., making compromises, checking out the menu clerks office, call it*

popularity of dishes, changes to food provisions, lots of parts to that, costings, financial implications, quality implications, the delivery time implications, food hygiene education..." **[C3]**.

7.5.3.6 Operationalising complexity

'Complexity' is measured by seven items (see table 7-16) principally adapted from Pelz (1985) but abstracted from technological interdependence to a more general view such that the greater the levels of interdependence, the more complex the innovation.

The innovation consists of modified existing components*
A large number of specialists (clinical and/or non-clinical) were involved in developing the innovation
A large number of specialists (clinical and/or non-clinical) were involved in implementing the innovation
The innovation requires co-ordination amongst many units
The innovation has been highly customised for local use
A large number of organisational units were involved in developing the innovation
A large number of organisational units were involved in implementing the innovation

Table 7-16: Operationalising complexity

7.5.3.7 Adaptability

'Adaptability' is the extent to which the innovation can be refined, elaborated and modified according to the needs and objectives of the group. Implicit within the definition are notions of 'applicability' (Dearing and Meyer, 1994), 'susceptibility to successive modification' (Zaltman et al., 1973), 'mutual adaptation' (Leonard-Barton and Sinha, 1993) and 'compatibility' (Rogers, 1962).

Susceptibility to successive modification is the degree to which the innovation can be modified in response to technological change or other requirements. Mutual-adaptation, the degree to which users refine a system to fit their particular need, is a key factor in the innovation/technology transfer process (Leonard-Barton and Sinha, 1993). Compatibility is the degree to which the innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 1983). The more compatible the innovation is with existing contextual factors the more likely it is to be accepted. Lower degrees of compatibility imply potentially disruptive effects.

The empirical data confirms adaptability as an attribute of innovations:

> *"...and what we have decided to do is we are going to buy into the health service package (database system) and adapt it to suit ourselves as best we can. It is not a perfect solution but I firmly believe it is the nearest we are going to get and, from a financial point of view we are going to save ourselves £100,000 a year on software – and that is a lot of coffee mornings*!" **[A3]**.

"*So, you had this direct access which was eliminating the waiting list but it reduced the flexibility of theatres because, with a waiting list you can cancel. If you are booking patients and you are booking them fast now and you are filling slots, then there is a danger of creating total efficiency because you would have no one you can bring in just like that - but with a waiting list you can put someone else on. So there was on the one hand the benefits of not having a waiting list and on the other the disbenefits of not having the flexibility - so the system had to make sure it could accommodate that*" **[B3]**.

7.5.3.8 Operationalising adaptability

Two items relating to 'adaptability' were operationalised for use in the survey instrument (see table 7-17).

The innovation fits comfortably with existing organisational values
Where necessary it has been possible to modify the innovation to suit local requirements

Table 7-17: Operationalising adaptability

7.5.4 Benefit

Geisler (2000) conceives of a series of outputs from stages of the innovation process that bring benefit to increasingly widely constituted communities as the process progresses. Innovations are generally regarded to have beneficial impact for an identifiable social unit (though that is not to deny that there may be negative impacts elsewhere). These benefits may be planned or unplanned and are determined, as is novelty, relative to initial prevailing conditions. Therefore, this category considers the planned and unplanned beneficial consequences of the innovation, including the degree to which original objectives have been met. Four sub-categories are identified: actual operation, relative advantage, profile and observability. These are defined in table 7-18.

Benefit	Relative advantage	The extent to which an innovation is perceived as being better than the idea it supersedes.
	Actual operation	The extent to which the innovation is perceived to have satisfied original objectives.
	Observability	The extent to which the innovation is observable by others.
	Profile	The extent to which the innovation raises personal, group or institutional profile.

Table 7-18: Sub-categories of innovation category benefit

7.5.4.1 Actual operation and relative advantage

'Relative advantage', the extent to which an innovation is perceived as being better than the idea it supersedes and 'actual operation', the extent to which the innovation is perceived to have satisfied original objectives appear, arguably, to be similar constructs. After all, if the innovation satisfies the objectives originally set for it (actual operation) then, *ipso facto*, it would satisfy the criteria of relative advantage of being better than the idea it supersedes. However, evidence from empirical and literature studies met the criteria for inclusion and justifies treating the two attributes as discrete.

Of the five atributes first proposed by Rogers (1962, 1983) and Rogers and Shoemaker (1971) relative advantage has been subject to most critical debate. Tornatzky and Klein (1982; 35) described it as the garbage can of attribute research into which non-specific characteristics can be dumped, and they dismiss it as being perhaps too broad and amorphous to be of much use. This is largely because of the diversity of ways in which relative advantage has been operationalised and measured, measured as it is on occasion by quantitative economic and financial metrics or qualitative metrics of perceived benefits (Utterback et al., 1976). Further, Dearing et al. (1994) noted that more than two-thirds of the comments they recorded in their study were related to non-economic factors.

For example, the relative advantage of a technical process innovation has been defined in context-specific terms as its ability to (1) foster superior service, (2) enhance productivity, (3) improve efficiency, (4) reduce costs, (5) ensure reliability and consistency, (6) enable intangible benefits – e.g. image (Wilson et al., 1999). Or, it has been more broadly conceived in terms of effectiveness. Effectiveness relates to the extent to which the innovation addresses the problem for which it was initiated. Damanpour (1990) reported on the extent to which the perceived effectiveness of innovations influences rates of adoption and contributes to an organisation's ability to fulfil its mission and achieve its objectives.

West and Anderson (1996) located effectiveness in the context of the application of the innovation in relation to the problem for which it was developed to resolve, but operationalised it quite narrowly. Informants from the current study certainly conceptualise innovations having impact in the context for which they were developed but have a broader conceptualisation of effectiveness than did West and Anderson.

Innovations typically are developed with certain purposes in mind, and they must be perceived to fulfil their intended purposes better than their precursors if they are to be adopted. Thus the concept of relative advantage has significant intuitive appeal as it is a very generalisable concept (Moore and Benbasat, 1991; 198). That is, the advantage is always 'relative' to the particular context of the innovation, and hence the perceptions of the innovators and/or adopters and users are important.

This comparative perspective, the innovation relative to the preceding condition, permits a richer understanding of the innovation itself. White and Graham (1978) identify market and operational merit. The former assesses end user advantages and the latter considers the effect on a company's existing business practices. Pelz (1983), as one dimension of the effectiveness of an innovation, operationalised actual operation, the extent to which an innovation achieved its purpose. Tatikonda and Rosenthal (2000) employ a measure they call execution-oriented outcome, the degree to which an individual project achieves its original objectives. Their operationalisation of execution-oriented outcome (i.e. technical functionality, product quality, product unit cost, and time-to-market) belies its origins in the product development, technological change and project management literature, but this does not preclude the application of the concept in non-production environments.

The excerpts presented below illustrate this comparative perspective in which innovators perceive their innovations in terms of actual operation and relative advantage.

> "*…but I think the other huge plus that I think we feel that we have achieved is that we have re-established relations between the nurses and the catering department. That we have actually re-established a dialogue and we feel that we are working with the catering department which before we weren't. You can't put it down as a specific 'we did this in order to re-establish the relationship' it is a consequence, it was a consequence of the improvements we sought to make*" **[C1]**.

This was unplanned but nonetheless significantly beneficial in the social context. It is a clear articulation of the outcome being better than that which preceded it but not necessarily in the manner in which the benefit was envisaged at the start of the innovating process. Contrast this with the commentary from team B informant 1 who was reflecting on two different innovations and considers them, quite clearly, in terms of the original project objectives:

> "*yes that's about as good as you get. Highly successful project, beacon status for doing it. Were there any weaknesses? No, we did it all ... On reflection ... outpatient modernisation ... there are some things that we haven't achieved within the time frame we wanted to -- there are some elements of it that we haven't implemented perhaps as fully as we wanted to and stuff like that. So it is not quite all perfect*" **[B1]**.

Consequently, both actual operation and relative advantage are included in the framework. Actual operation assesses the extent to which the innovation achieved its original objectives, relative advantage assesses the extent to which the innovation is perceived as being better than that which it replaces. Actual operation is different from relative advantage in that it considers the innovation in the context of its original aim. An innovation may not have achieved all that was planned for it in addressing and solving the problem that triggered the process (its actual operation) though it may be an improvement on what went before even though it bears little resemblance to initial terms of reference (relative advantage).

7.5.4.2 Operationalising actual operation/relative advantage

'Actual operation' and 'relative advantage' are each measured by two items (see tables 7-19 and 7-20) drawing on the various conceptualisations in the literature and notions of effectiveness (Pelz, 1983; Pelz, 1985; Wolfe, 1994).

The innovation has satisfied all the original objectives set for it at the start of its development
The innovation solves the problem that originally stimulated its development

Table 7-19: Operationalising actual operation

The innovation represents an improvement on the pre-existing situation
The innovation has achieved unplanned-for benefits

Table 7-20: Operationalising relative advantage

7.5.4.3 Profile

Several studies consider 'profile', the extent to which the innovation raises personal, group or institutional profile, as a factor in understanding innovation. It is similar to and variously labelled as 'image' or 'status' (Mohr, 1969) and 'social approval' (Fliegel and Kivlin, 1966).

Innovations may be pursued for the sake of 'profile' that can contribute to enhancing the social status of the adopter (Moore and Benbasat, 1991; Agarwal and Prasad, 1997) or be motivated by the desire for prestige and professional status, sometimes at the cost of organisational goals (Mohr, 1969). The only indication of personal aggrandisement in the empirical data is ambivalent:

> "*…yes, I think it was [the pursuit of personal ambition]…I think for [name] it was. And I think that that may be unfair…But I think it was thought that it was there to make a name, to make a difference, to make a change and that it was not about patient care*" **[A4]**.

On the other hand, the empirical data suggests an alternate view, one in which the profiles of individuals, groups or institutions may be raised by association with the innovation.

> "*the [innovation] to me, professionally, was a huge achievement and I got all the accolades for that. Nationally we got awarded beacon status and it was my name that was up there - so for me professionally that was quite important turning point*" **[B2]**.
>
> "*Because it's raised the profile of the catering services department and very, very significantly*" **[C3]**.

Further, innovation driven by a quest for prestige can be profoundly wasteful, and it is from this that the pejorative view derives. Wolfe (1994) differentiates the two types of slack by labelling the 'prestige-type' slack status. However, the term profile is preferred here as it more adequately captures the ideas uncovered in the empirical data and places less emphasis on the notion of personal aggrandisement.

7.5.4.4 Operationalising profile

'Profile' is measured by four items, two of which assess the motivations for pursuing the innovation in terms of organisational or individual prestige, and the remaining two the extent to which organisational or individual profiles have been raised by the innovation (see table 7-21).

The innovation was pursued for reasons of…
…organisational prestige
…personal prestige
The innovation has raised the profile of…
…the organisation
…individuals

Table 7-21: Operationalising profile

7.5.4.5 Observability

'Observability', the extent to which the results of an innovation are visible to others echoes profile but the two are differentiated by their focus: the former considers individuals, the group or the organisation whereas the latter is concerned only with the visibility of the innovation itself – i.e. object focused. The terms 'observability' and 'visibility' appear to be synonymous. Tornatzky and Klein's (1982) review (of 75 studies) found only seven studies in which 'observability' or 'visibility' featured. There is, however, strong evidence in the empirical data for observability as an attribute of innovations.

> "*So, the hospital food as treatment thing happened, and there was all the razzmatazz around that…then in 2000 in June I was asked to go and talk to the Prime Minister about hospital food and hospital cleanliness…it was in 10 Downing Street in the Cabinet Office…and there were just a few of us…and, we have been briefed 'this is your one opportunity, don't waste it', so I thought let's go for it. The Prime Minister was very open and asked brilliant questions and…I had lots of opportunity to tell him what the real problems were and make suggestions. Virtually everything I suggested ended up in the NHS plan*" **[C2]**.
>
> "*I think it is not so much what they will notice it is what they will not notice…I don't particularly ever want again to have a patient ever say to me 'don't all you people talk to each other*?'" **[A1]**.

7.5.4.6 Operationalising observability

'Observability' is measured by two items (see table 7-22) and is developed from the measure suggested in Wolfe (1994).

The innovation has…
…gained recognition within the NHS
…gained recognition outside the NHS

Table 7-22: Operationalising observability

7.6 Discussion

Frameworks define 'the territory' and bring us a step closer to theory (Crossan et al., 1999). Any valid framework of innovation must be capable of capturing its complexity and multidimensionality and be applicable across cases. The framework developed in this chapter starts with four high level categories drawn from the synthesis of data from the literature and an empirical study. The framework is populated with 13 innovator- and user-perceived attributes.

The objective of Phase I of this research has been to devise and operationalise a comprehensive but parsimonious framework that captures these perceptions and, through an iterative process cycling between theory and empirical research such a framework has been developed. The first part of this chapter has discussed this development process and acknowledged the debt owed to previous research in constructing the framework. The framework, and its heritage, is summarised and presented in table 7-23, this illustrates how the framework generated in this research is generally able to subsume previous frameworks into its ambit, with the exception of the attributes commutuality and reliability from Dearing and Meyer's (1994) study.

How is it possible to know that these are the 'right' attributes to have chosen to operationalise the framework? In developing a comprehensive parsimonious classification system, how is it possible to establish that the 'right' attributes have been selected? Two rounds of testing have established a degree of face, construct and content validity that is felt to be acceptable. Subsequent statistical testing has indicated a tolerable level of reliability (see table 7-3). The 'rightness' of attributes included in the framework may also be determined by the utility of the results that the instrument delivers. The variables chosen to populate any framework or describe configurations will differ according to the research task at hand (Miller and Friesen, 1984). The task in this instance is exploratory so, in a sense, the 'rightness' of the attributes populating the framework will not be known until the final analysis.

Arguably, it may have been reasonable to have operationalised an existing framework (Rogers, 1983; Moore and Benbasat, 1991; Dearing and Meyer, 1994; Meyer et al., 1997), or to synthesise a framework from the attributes identified in table 5-1 for this study. The critic might legitimately argue that the framework presented in this research is not significantly different, other than in terms of numbers of attributes that comprises it, from other empirical studies (see table 7-23). This begs the question 'why the need for the four in-depth case studies?'. The case studies can be justified in terms of the context of this study. Most of the attributes drawn from the literature have their intellectual heritage in the techno-centric NPD literature. There were legitimate concerns about the generalisability of these constructs to the non-profit, health care sector. It has been the contention of this thesis that conceptualisations of innovation in research studies have been narrow and contextual, the corollary of which is that operationalisations have, too, been narrow and contextual. Consequently, the survey instrument developed for this research adopts and refines pre-existing measures in the light of the process of synthesising extant constructs with the findings of the pilot study.

This study	**Holloway (1977)**	**Moore and Benbasat (1991)**	**Dearing and Meyer (1994)**	**Agarwal and Prasad (1997)**	**Meyer et al. (1997)**
Relative advantage (2)	Relative advantage – economic (4), status (4)	Relative advantage (5)	Economic advantage	Relative advantage (5)	Relative advantage (5)
			Effectiveness		
Actual operation (2)		Result demonstrability (4)		Result demonstrability (4)	
		Ease of use (4)		Ease of use (4)	
Observability (2)	Observability (4)	Visibility (2)	Observability		Observability (3)
Complexity (7)	Complexity (3)		Complexity		
Adaptability (2)	Trialability (2)	Trialability (2)	Trialability	Trialability (2)	Trialability (5)
	Compatibility (5)	Compatibility (2)	Compatibility	Compatibility (3)	Adaptability (5)
			Applicability		
			Reliability		
			Commutuality		
Novelty (5)			Radicalness		
Departure (7)					
Disruption (6)					
Risk (5)					Riskiness (5)
Uncertainty (5)			Divisibility		
Scope (4)					
Ideation (5)					
Profile (4)		Image (3)		Image (3)	
Figures in parentheses indicate number of items in each instrument					

Table 7-23: Comparison of multi-attribute innovation studies

Phase I of this research, including the systematic review of the literature, has provided the empirical underpinning for the development of a framework for describing innovations. The criteria against which attributes were judged for inclusion in the framework were (1) there was support for the attribute in the literature (2) there was evidence of the innovation being perceived that way in the pilot data and, (3) the attribute fitted within the boundaries of the definition of innovation underpinning this study (4) That the majority of informants in each team made reference to the attribute. Only if the attribute satisfied all four criteria was it eligible for inclusion. Framework validity is considered to be tolerable for exploratory research but it is felt that item scales might need to be revisited for future research.

The instrument combines measures derived from the literature and newly developed for this study. There is a small history of item and instrument development in the literature. Moore and Benbasat (1991) subjected their perception scales to intense validity and reliability testing and were assumed, therefore, by Agarwal and Prasad (1997) to be a satisfactory basis for further studies. From the point of view of this study many of Moore and Benbasat's (1991) items are too context-specific to their study of the adoption of an information technology innovation to be considered useful in developing a formal framework. Moore and Benbasat (1991) developed their instrument with regard to a personal (computer) workstation, Meyer et al (1997) three preventive health innovations, Wilson et al. (1999) the adoption of imaging technology innovations, Agarwal and Prasad (1997) usage of the Internet amongst a sample of MBA students, and Dearing and Meyer (1994) nine hazardous waste bioremediation technologies.

The framework has been developed as a sensitive measure of innovation with high potential for general application, where previously none has been found to exist. It presents a conceptualisation of innovation based on a synthesis of existing literature, developed and validated empirically, as a basis for the comparison of innovations across cases. Innovations are characterised in the framework in four distinct categories: newness, ideation, application and benefit. Each of the four categories is composed of a number of sub-categories. None of these categories or sub-categories is new or previously unknown to the innovation literature, though they differ one from another in terms of the attention accorded them in the literature. What is new though, is the attempt to deal with them simultaneously, in order that innovations may be classified according to differences in configurations. Such classification is a precursor to generating possible new insights into the phenomenon of innovation (Crossan et al., 1999).

It is an assumption of this research that it might be reasonable to assume the existence of different types of innovation based on different configurations of the presence, absence or degree of each of the 13 attributes that make up the framework when applied to a sample of innovations. These attributes have been operationalised into a 56-item survey instrument which has been applied to a sample of 310 innovations in the NHS. The process by which the instrument is applied, the method of analysis and results are the subjects of the following two chapters.

8 CLASSIFICATION BY CLUSTER ANALYSIS

8.1 Introduction

Through the discovery and explication of a taxonomy based on a multidimensional conceptualisation of innovation, one objective of this research is to develop new insights into the processes of innovation. The underlying logic of this research is based on the proposition that in much of the innovation literature the innovation as unit of analysis has been under-specified. The argument, developed in previous chapters, suggests that a comprehensively specified unit of analysis, more capable of capturing the multiple ways in which innovations are perceived, will liberate researchers from understandable, but arguably limited, conceptualisations of innovation.

Underpinning the research is a theoretically developed and empirically validated framework of innovation artefact. The framework has been operationalised by combining new measures with pre-existing, pre-validated scales in a 56-item survey instrument (see Appendix five) based on Likert responses on a scale of 1-7. 310 copies of the instrument were distributed to innovators in the NHS and met with a 63.2% (n=196) response rate. A data matrix of 10,976 data points from 196 responses across 56 variables has consequently been generated.

As demonstrated in the pilot study, repertory grid technique also generates such data matrices. Both qualitative (e.g. visual inspection) and statistical analyses can be performed on informants' grids in order to identify patterns in the data (Langan-Fox et al., 2000). However, grids generated by repertory grid technique generally are of manageable proportions, as both elements and constructs tend to be limited in number, and amenable to at least cursory visual inspection. The largest data matrix generated in Phase I of the study consisted of seven elements and 12 constructs, a total of 84 data points. With 10,976 data points generated in Phase II, a more sophisticated approach to pattern searching in large quantities of data is needed. Cluster analysis is one such technique and offers the researcher significant benefits in managing large amounts of data and reducing it into meaningful categories or groups about which observations might be made or hypotheses developed.

Cluster analysis is a generic term for a collection of statistical methods for dealing with multivariate data pertaining to individual entities (or cases, objects, items or members) in order to assign entities from a population to clusters (or groups, categories or classes) (Everitt et al., 2001). Unlike other statistical methods for classification, such as discriminant analysis, cluster analysis makes no prior assumptions about important differences within a population. Cluster analysis is a purely empirical method of classification and as such is an inductive technique that explicitly attempts to classify. Aldenderfer and Blashfield (1984) describe four principal applications for cluster analysis:

- The development of a typology or classification;
- Investigation of useful conceptual schemes for grouping entities;

- Hypothesis generation through data exploration; and,
- Hypothesis testing.

In this research the objective is to develop a classification of innovation artefact based on attributes and use that classification as the conceptual basis for further research. This objective reflects the first two applications identified in Aldenderfer and Blashfield's (1984) list.

Whilst cluster analysis is a powerful exploratory tool for determining patterns or structures in quantities of multivariate data, it has been criticised for lacking any strong statistical basis and is therefore vulnerable to researcher subjectivity. Users are strongly recommended to make explicit the steps they take in applying the technique, why certain selection(s) have been made and the implications for research results (Aldenderfer and Blashfield, 1984). This chapter reviews the techniques of cluster analysis and, in doing so, specifies the design of cluster analysis for this particular study.

8.2 Cluster analysis

Classification, through the identification of structuring or patterning in data, is one means by which sense can be made out of diversity in the natural and social sciences. Unlike many other statistical procedures, cluster analysis methods are mostly used when *a priori* hypotheses regarding that diversity are not available, and when research is still in the exploratory phase. Its origins are somewhat obscure, some authorities claiming that it originates in the biological sciences (Hair et al., 1998) others in psychology (Bailey, 1994). Aldenderfer and Blashfield (1984) attribute the credit for stimulating the development of many clustering methods to Sokal and Sneath (1963), two biologists, following the publication of their book *Principles of Numerical Taxonomy* in 1963. It is clear that the approach has been used in a variety of different contexts including engineering and the management sciences. Each application of the method has the common objective of partitioning data observations into homogenous groups (clusters) based on their proximity to each other in order to find distinct groupings or *natural relationships* (Hair et al., 1998).

Cluster analysis seeks to maximise homogeneity within clusters whilst simultaneously maximising heterogeneity between clusters. In the resultant clustering, individuals within a cluster are more similar to each other than they are to individuals in other clusters. Cluster members will share characteristics in common and so it is that clusters describe, in terms of the input data, the class to which its members belong. It is then possible to make inferences about the characteristics of members and, what distinguishes one cluster from another.

Clustering techniques use measures of distance (dissimilarity) or resemblance (similarity) between objects, which can be either individual entities or the emergent groupings. As a measure of correspondence between objects to be clustered, the concept of 'similarity of' or 'distance between' items, is central to the process. These ideas are more fully developed in Chapter four but, in brief, two cases are identical where they share the same scores on the range of variables. Absence of correspondence of variables can be construed as distance or dissimilarity. These distances can be based on a single dimension or multiple dimensions.

There are so many disparate approaches to cluster analysis (Bailey, 1994) that it is impossible to evaluate each one of them in this chapter. As Sneath and Sokal (1973; 202) suggest "*The difficulty of outlining the major kinds of approaches to clustering biological data is compounded by the inability of workers in the field to arrive at a logical system of classification of clustering methods*". Discussion of approaches to cluster analysis must perforce be abbreviated.

Cluster analysis can be characterised by two dominant technical methods: hierarchical and non-hierarchical methods[10]. The former method groups individual members into clusters on the basis of shared characteristics so that within clusters homogeneity is sought. The latter method assigns new observations to one of a known number of groups whose existence has been established *a priori* (for example on the basis of theory). Both approaches are discussed below.

8.2.1 Hierarchical techniques

Hierarchical techniques make no *a priori* assumptions regarding numbers or structures of groups present in the raw data, their objective is, instead, to identify structure and groups on the basis of similarities observable in the sample. Hierarchical techniques, so-called because they construct in step-like fashion, tree-and-branch-like graphical representations (see figure 8-1) of data based on combining or dividing entities into clusters, can be either agglomerative or divisive.

Agglomerative techniques begin with each entity as an individual existing in a cluster that comprises only itself. That is, a sample comprising *n* entities will, prior to the first iteration of the clustering algorithm, consist of *n* clusters. After the first iteration there will be *n*-1 clusters, as the two entities judged to be in closest proximity to each other are fused into a single cluster. Following the second application of the amalgamating algorithm, *n*-2 clusters will be formed, and so forth ultimately reaching the point at which all entities within the population have been joined into a single cluster, all previous results having become progressively nested in the results of later stages. As the process progresses, internal homogeneity within clusters (within-cluster variance) and external heterogeneity between clusters (between-cluster variance) is sacrificed. Divisive techniques share a similar approach but the process operates in reverse, starting with *n* entities grouped into a single cluster and then dividing to two, three and finally to *n* clusters. The (de-)clustering algorithm sheds those entities that are most dissimilar from those in the parent cluster(s) into smaller clusters.

Both agglomerative and divisive techniques can be diagrammatically represented by the dendrogram (see figure 8-1) which is an important graphical aid to interpreting the output of the clustering process. In fact, the dendrogram is a graphical representation

[10] There are other quantitative techniques of cluster analysis, space though, does not permit a full discussion. However, Bailey (1994) provides excellent background on alternative and more specialist approaches.

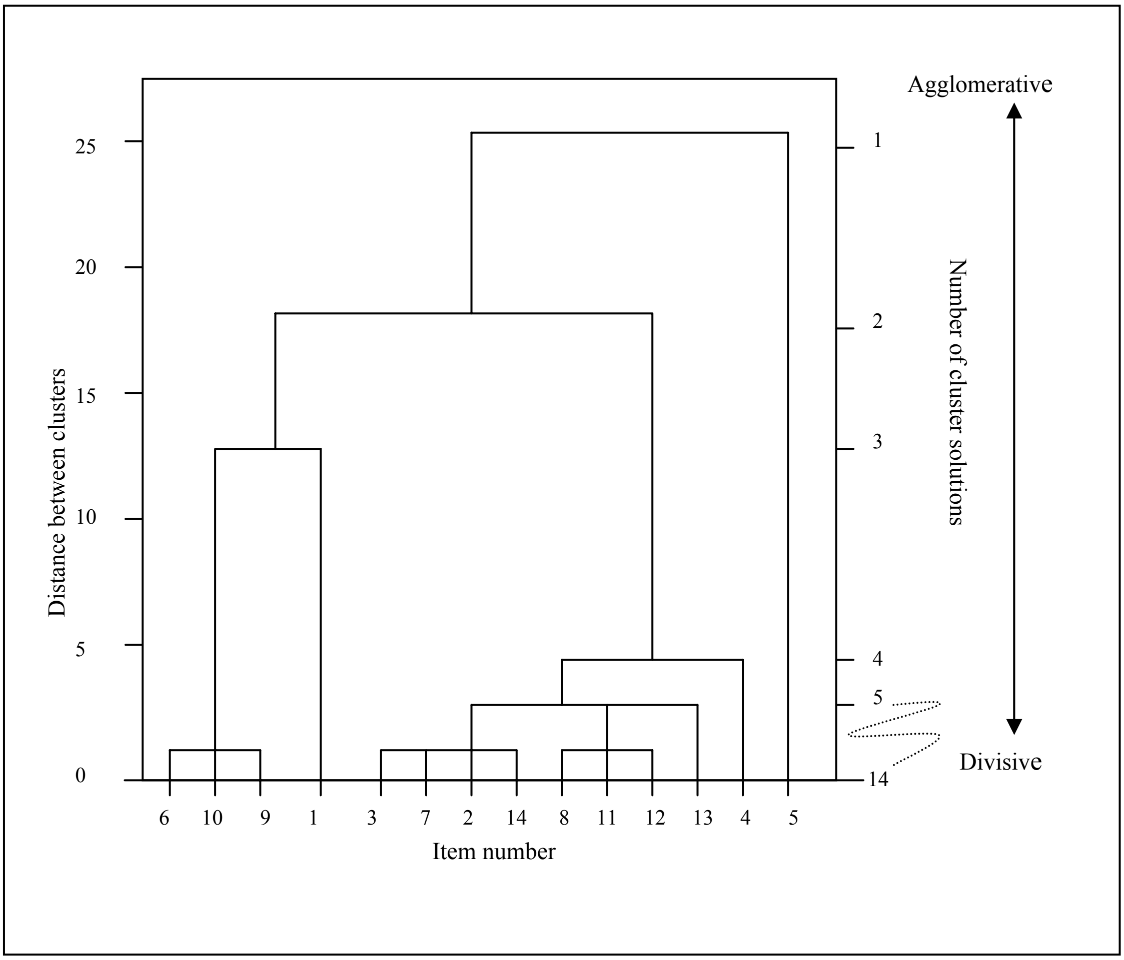

Figure 8-1: Dendrogram illustrating hierarchical clustering (fictional data)

of the ‘agglomeration schedule’ which is a numerical expression of the cluster solution. Table 8-1 presents an illustrative agglomeration schedule comprising fictional data.

Column number 1 gives each stage in the clustering process a number. So, at stage 1, the first iteration of the process, the first items to be clustered are items 6 and 10 which are judged, according to pre-specified criteria, to be most similar. As items that have been clustered items 6 and 10 now come to be regarded as a single cluster. This new cluster retains the label of the lowest numbered item to have been clustered and so, retains the label ‘6’. It will be noted that cluster 6 reappears at stages 3 and 11. At stage 3 it is clustered with item 9, and retains the label 6 (so after stage 3, the cluster

Stage	Cluster Combined		Agglomeration (similarity) Coefficient	Stage Cluster First Appears		Next Stage	% change in agglomeration coefficient	Number of cluster solutions
	Cluster 1	Cluster 2		Cluster 1	Cluster 2			
1	6	10	5.000	0	0	3	190.00	13
2	3	7	14.500	0	0	4	66.67	12
3	6	9	24.167	1	0	11	51.72	11
4	2	3	36.667	0	2	6	45.00	10
5	8	11	53.167	0	0	7	34.80	9
6	2	14	71.667	4	0	9	28.14	8
7	8	12	91.833	5	0	8	33.30	7
8	8	13	122.417	7	0	9	28.28	6
9	2	8	157.042	6	8	10	27.35	5
10	2	4	200.000	9	0	12	102.92	4
11	1	6	405.833	0	3	12	69.19	3
12	1	2	686.615	11	10	13	61.89	2
13	1	5	1111.571	12	0	0	--	1
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Column number								

Table 8-1: Illustration of an agglomeration schedule (fictional data)

contains items 6, 9 and 10, and retains the label '6'). At stage 11 cluster 6 is fused with item 1. Stage 11 is the first appearance of item 1. This is self evident in a short agglomeration schedule as in this example. However, where there are many hundreds of stages an item's first appearance can also helpfully be recognised by a '0' in either column 5 or column 6. Thus, it can be seen from column 6 that item 5 makes its first appearance in the final clustering stage of the process. That is, item 5 exists on its own until the very last stage of clustering. And so, columns 5 and 6 are useful in identifying the occurrence of outliers.

When the data contain a clear 'structure', in terms of clusters of objects that are similar to each other, then this clarity of structure will be reflected in the numerical representation. Analysis of the agglomeration schedule can uncover any such structure. Column 8 presents the percentage change in the agglomeration coefficient as the process moves from stage to stage. A large jump in the value of the percentage change, compared to previous values, indicates a possible cluster solution. This can be further graphically represented as a plot (see figure 8-2). The approach claims that the point immediately preceding steep upward curve gradients of the distance coefficient (or downwards for similarity coefficients) indicates the optimal stopping point for cluster solutions. Prior to this 'kink' in the data curve, flatness of the curve indicates that rules governing heterogeneity are not being relaxed and that objects being fused are similar to each other. The steepness of the gradient, which is a graphical representation of a large change in the amalgamating coefficient, is indicative of the rate of change in distance between the two clusters being fused. That is, it suggests that for the two clusters to be fused the rules governing between-group heterogeneity must be relaxed more than was the case in previous iterations, thereby indicating greater levels of distance between clusters. This may provide a useful visual aid in the identification of discrete groups or clusters.

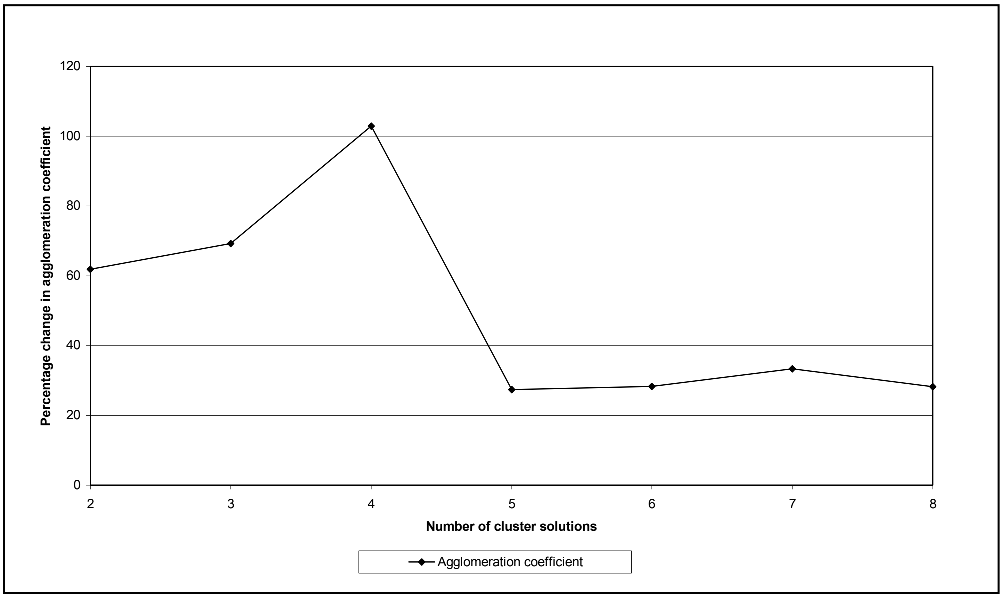

Figure 8-2: Graphical plot of agglomeration schedule (fictional data)

Through the analysis of dendrogram, agglomeration schedule and graphical plot, possible cluster solutions may be identified. In the instance of the fictional presentation from figure 8-2, the steepness of the gradient would suggest a 5-cluster solution. However, the 5-cluster solution in this case would comprise one cluster with eight members (items 2, 3, 7, 8, 11, 12, 13 and 14), one with three members (items 6, 9 and 10) and three clusters each with one member (items 1, 4 and 5), see figure 8-1. Whether or not such a solution makes sense will depend on the nature of the data, the objectives of the study and the interpretation of the researcher. As a rule of thumb though, such a preponderance of outliers in the final solution would be cause for a re-examination of the analysis.

All solutions are plausible depending on the context of the data and the method. Importantly though, guidelines exist to assist the researcher in deciding upon a preferred solution; these are discussed later in this chapter.

8.2.2 Non-hierarchical techniques

Hair et al. (1998) report that hierarchical procedures are giving way to non-hierarchical procedures in popularity of application. This is partly due to advances in computing power but also because of limitations of hierarchical techniques (see section 8.10, limitations of cluster analysis).

Hierarchical processes start without any strong theoretical underpinning, rather the algorithm is left to determine the extent and nature of clustering. Non-hierarchical methods may be underpinned by theory and are iterative. Data are partitioned into a pre-specified number of clusters that have been determined a priori. The ‘seed points’ from which clusters are initially developed originate either from theoretical justification, the use of a solution from a hierarchical process or by educated guesswork. Observations are assigned and reassigned to clusters whose centroid (mean of variables within the cluster) they most closely match. Centroids are recalculated following each new iteration (assignment of an object to a cluster) according to a clustering algorithm, until the process is terminated by the application of a stopping rule (e.g. all items are assigned to clusters). K-means clustering is a popular non-hierarchical method, so-called because it partitions data into a set of 'k' clusters so as to minimise the distance of cases from cluster means. The standard approach to K-means clustering was first described by MacQueen (1967) and is as follows:

- Select initial seed-points. This determines the initial centres around which clusters are formed and specifies the final number of cluster solutions.
- Calculate the distance of each entity from the cluster mean point and assign entities to clusters where that distance is the minimal.
- Following the assignment of new entities to any cluster, re-calculate the cluster mean.
- Continue to repeat steps 2 and 3 until such time that all entities are assigned and cluster means have stabilised.

K-means analysis clusters on the basis of establishing minimum distances of cases from cluster means in a way that hierarchical methods cannot achieve. K-means manages this by recalculating cluster means after each iteration. This contrasts with the static nature of some hierarchical processes in which cluster means are not recalculated. For this reason many authorities (Belson, 1986; Friar, 1995; Milligan, 1996; Ketchen and Shook, 1996; Hair et al., 1998) recommend the use of non-hierarchical clustering to refine solutions derived from a hierarchical process.

This research proposes to follow this recommendation. Decisions, therefore, need to be made with regard to which hierarchical clustering method(s) to use and the determination of similarity. The options are discussed in the following sections.

8.3 Selection of (Dis)Similarity Measures

Hair et al. (1998) identify three approaches to measuring similarity: correlational, distance and association measures. Correlational and distance measures require metric data where data are continuous, association measures are suited to nonmetric data. The use of Likert scaling, conceived of as quasi-interval data, (see section – standardisation of variables, below) dictates a choice between correlational and distance measures.

The difference between correlational and distance measures is that the former measure patterns across variables, the latter magnitudes. Correlational and distance measures require different interpretations because distance-based clusters have similar values across the set of variables, but not necessarily sharing any similarity of pattern (curve shape on a graph, i.e. relationship) whereas correlational-based measures have similar patterns but not necessarily the same values. These are illustrated in figure 8-3, below.

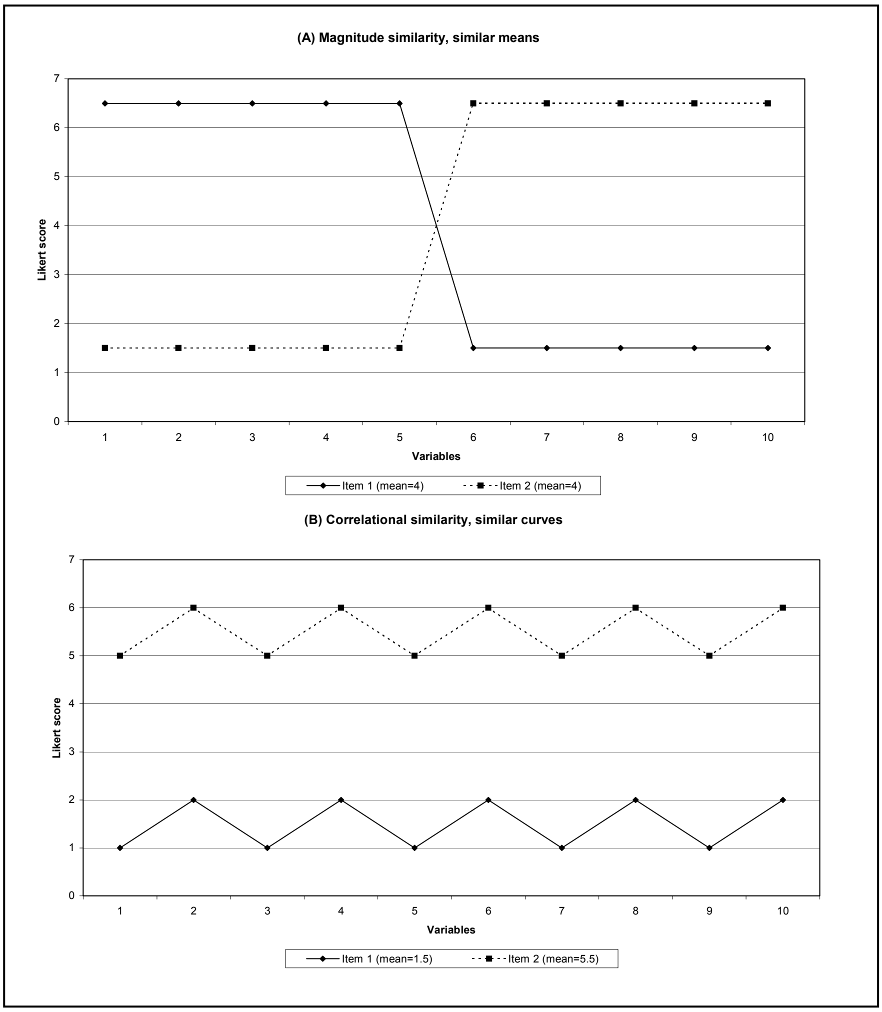

Figure 8-3: Comparison of distance and correlational measures

Correlational measures tend to be less frequently used in cluster analysis because researcher interest tends to be in similarities in the magnitude of responses to variables rather than curve relationships (Hair et al., 1998). However, the current research makes no assumptions about the nature of the optimal solution whether or not it is based on magnitude (the mean score of the variables over the whole case) or on profile (the shape of the curve describing variables across the case). And, so, for this exploratory study both approaches are considered valid.

The most commonly utilised distance measure for cluster analysis is Euclidean distance, or its variant Squared Euclidean distance (which tends to emphasise the influence of outliers). These simply measure the geometric distance in a multidimensional space.

Euclidean distance is a dissimilarity measure for continuous data which can be used for measuring distances based on Likert scale data. The distance between two items *i* and *j* (d_{ij}) is the square root of the sum of the squared differences in values for each variable and is defined as:

$$d_{ij} = \sqrt{\sum_{k=1}^{p} (x_{ik} - x_{jk})^2}$$

where

d_{ij} = the distance between items *i* and *j*,
x_{ik} and x_{jk} = the *k*th variable value of the *p*-dimensional observations for individuals *i* and *j*, respectively.

The only way $\mathbf{d_{ij}}$ can be zero is if the two objects are identical in value on all variables. As $\mathbf{d_{ij}}$ gets larger it signifies that ***i*** and ***j*** are farther apart on one or more of the variables, and so increasingly dissimilar.

Euclidean (and squared Euclidean) distances are usually computed from raw data. Depending on the nature of the raw data this can be problematic. Where raw data combines several different scales among the dimensions from which the distances are computed (e.g. height, weight, marital status) the measure can be sensitive to scalar differences. Under such circumstances algorithms exist that permit the standardisation of scales and variables.

This method has certain advantages (specifically, the distance between any two objects is not affected by the addition of new objects to the analysis, which may be outliers). Milligan’s (1996) comparison of similarity measures reported Euclidean distance measures and its variant to provide consistently acceptable results, which, in large part, may explain their widespread use as the distance measure of choice in many cluster analyses.

8.4 Selection of Amalgamation Rules

8.4.1 Hierarchical methods

Having established how similarity is to be determined, a decision must be taken on the rules that govern the way in which items are joined together. Several alternatives exist and these are synopsised in table 8-2. Each strives, in a different way, to maximise the distance between clusters whilst simultaneously minimising the distance between items within clusters.

Milligan (1996) reviews the recovery performance (the ability of the process to surface clusters from raw data) of a wide range of clustering methods under error-free (data with a known, clear structure) and error-perturbed conditions and suggests that the preferred method is Ward's method (Ward, 1963) used in conjunction with Squared

Euclidean measure of distance. Ward's method and squared Euclidean distance are therefore adopted as the favoured approach for this analysis.

Cluster Method	Description
Nearest neighbour or single-linkage	The shortest distance between any two clusters is the distance between any point in one cluster to any point in another cluster (i.e. nearest-neighbours). Objects separated by the shortest distance are joined together to form a cluster. Biggest disadvantage of the technique is its tendency to string objects together to form clusters, and the resulting clusters tend to be 'string-like chains' that can be indistinct. Also exhibits an item rather than cluster orientation. It is commonly used with standardised data.
Furthest neighbour or complete linkage or diameter method	The distances between clusters is determined by the greatest distance between any two objects in the different clusters (i.e. 'furthest neighbours'). The method performs well when the objects form naturally distinct groups. However, the method determines similarity based on the similarity of the least similar pair of objects within a cluster. This is suggestive of an item rather than cluster orientation.
Averaging methods	Attempts to overcome item-oriented bias of nearest and furthest neighbour methods by obviating reliance on extreme (nearest/furthest) measures. Calculates distance based on comparison of average distances between objects within clusters. Average linkage techniques from which to select include: **Between-groups linkage** – average distance calculated from the distance between each point in a cluster and all other points in a cluster. The two clusters with the lowest average distance are joined to form a new cluster. **Within-groups linkage** – clusters are fused so that within-cluster variance is minimised. Tends to produce tighter clusters than between-group linkage. **Centroid clustering** - Identifies the 'centre-point' within a cluster from the mean values of observations in the cluster. Each time a new cluster is formed a new centroid is formed. Can produce messy and confusing results but is less affected by outliers than other hierarchical methods. Distances between clusters measured from centroid to centroid. Very efficient when objects form distinct clusters, also performs well with 'chain-like' clusters.
Ward's method	Each object is initially treated as a cluster of one. Then objects are successively combined. The criterion for combination is that the within-cluster-variation as measured by the sum of within-cluster deviation from cluster means (error sum of squares) is minimised. Thus, the average distances among all members of the cluster are minimised (Bailey, 1994). Tends to be regarded as a very efficient method, though does also tend to be biased toward producing clusters of approximately the same size which often are small.

Table 8-2: Comparison of popularly used[11] clustering procedures (adapted from Aldenderfer and Blashfield, 1984; Milligan, 1996; Hair et al., 1998)

8.4.2 Non hierarchical methods

The literature on non-hierarchical methods is not as extensive as that for hierarchical methods. Milligan (1996) once again provides advice. His observation is that K-Means algorithms differ in their recovery quality depending on the quality of the initial seed points. When *rational*[12] starting seeds were used recovery performance was greatly improved (Milligan, 1996; 360). This was confirmed in Roth's (1992) study of configuration and co-ordination archetypes for medium-sized firms. Thus, the preferred cluster solution from a hierarchical method may be refined by K-Means analysis.

Having selected the rules that will govern the assignment of individual entities to clusters the process of their application needs to be explicated.

[11] Aldenderfer & Blashfield (1984) identify 12 different approaches

[12] Rational seeds are centroids recovered from a hierarchical process

8.5 Processes of Cluster Analysis

Authors are mostly consistent in their prescriptions of the process of cluster analysis. Discrepancies can often be accounted for in terms of different research objectives and/or differences in data. Table 8-3 compares the cluster analysis design proposed for the current research against the prescriptions of Hair et al. (1998) and Milligan (1996). Because of the range of methods from which to choose and the absence of clear rules for making decisions regarding method selection Milligan (1996; 342) strongly recommends that "*applied users of clustering technology clearly indicate in their reports the specific actions taken for each step in a cluster analysis*" as this provides an audit trail. The remainder of this chapter elaborates on those stages of the proposed design not already discussed, specifically stages 1, 2, 3, 6 and 7 as illustrated in table 8-3.

Stage	Hair et al. (1998)	Milligan (1996)	Proposed design
(1)	Research problem, defining objectives, select clustering variables	Select clustering elements: what are the entities that are going to be clustered	Specification of research objective: an empirically based classification of innovation
(2)	Address research design issues: treatment of outliers, standardisation of measures	Select clustering variables	Select variables: Variables drawn from theoretically-derived and empirically developed framework of innovation form the basis for clustering
(3)	Clarification of assumptions: representativeness, multicollinearity	Variable standardisation: do variables need to be standardised to a scale	Clarify cluster analysis design issues: Sample issues Standardisation of measures Multicollinearity Outliers Stopping rules Competing methods Stability of solutions
(4)	Select clustering algorithm	Select measure of association (similarity)	Selection of similarity measure: Squared Euclidean Distance
(5)	Interpret the clusters: of what do they consist?	Select clustering method	Selection of amalgamation rules: Hierarchical (furthest neighbour, within-groups, Ward's method, Pearson correlation) Select preferred solution Refine with non-hierarchical (K-means)
(6)	Validate and profile clusters	Identify number of cluster solutions: a priori or by stopping rules	Analysis and validation: Monte Carlo simulations Split-half test/replication ANOVA
(7)	-	Interpretation, testing, and replication.	Interpretation and profiling

Table 8-3: Comparisons of cluster analysis design in this research against the prescriptions of Hair et al. (1998) and Milligan (1996)

8.6 Specification of Research Objective

The research objective has already been established in previous chapters. The objective is to develop from unclassified data an empirically based classification of innovation artefact based on a theoretically derived and empirically developed sensitive measure. This new taxonomy will form the basis of further study into relations between process and innovation type where 'type' is construed in terms of configurations of attributes of artefact.

8.7 Selection of Variables

Because cluster analysis derives the most internally consistent groups across all variables, erroneous, aberrant or irrelevant variables can cause a deterioration of a solution's validity (Ketchen and Shook, 1996). The choice of the variables by which clusters will be formed is, therefore, one of the most important steps in the process of cluster analysis (Aldenderfer and Blashfield, 1984). As Milligan (1996; 348) states "*a variable should be included only if a strong justification exists that the variable helps define the underlying cluster*". Previous chapters attempt to establish that attributes are a warranted basis for describing and discriminating between innovations. The origination of the selected variables is described fully in these chapters. These are items that have been developed through the synthesis of empirical and theoretical attributes of innovation into sensitive framework that strikes a balance between parsimony and maximising the likelihood of discovering meaningful differences through the operationalisation of multiple valid variables.

8.8 Cluster Analysis Design Issues

This sub-section describes factors that have to be taken into account in designing a cluster analysis procedure. The sub-section concludes with a brief discussion of the chosen cluster analysis design.

8.8.1 Sample issues

Cluster analysis is not a widely used method in innovation studies and so it has been necessary to look to studies in other areas of the management sciences, where it has been used, for guidance as to appropriateness of sample size. It is a method that has some history of use in strategic management research and also in organisational research. In two separate studies of strategic groups Reger and Huff (1993) performed cluster analysis on the repertory grids of 23 informants and Harrigan (1985) ran cluster analysis on 92 retail establishments. In organisational research Roth (1992) clustered 126 medium-sized firms and identified 5 distinct archetypes whilst Ketchen et al.'s (Ketchen and Shook, 1996) longitudinal study of organisational configuration and performance analysed data from between 69 and 85 hospitals. Bierly and Chakrabarti (1996) use cluster analysis in a longitudinal study of 21 pharmaceutical companies to identify groups of firms with similar generic knowledge strategies, determine how these strategies change over time, and compare profit margins of the groups.

In innovation studies Poole et al. (2000) commend cluster analysis for identifying patterns in process studies, de Brentani (1995) clustered 276 cases of project success and failure, Joyce and Stivers (1999) 254 firms according to knowledge/innovation relationships and, Teng et al. (2002) 20 information technology innovations across 313 large American firms. Finally, Avlonitis et al. (2001) identified six distinct types of service innovativeness from the analysis of 132 service cases.

From this short review it would appear that the literature is not prescriptive about sample size. Ketchen and Shook's (1996) authoritative review of the application of cluster analysis in strategic management research makes no mention of the subject, nor do authorities such as Sneath and Sokal (1973) or Aldenderfer and Blashfield (1984). Wishart (1987) provides some guidance on sample size, inferring that fewer than 40 cases is small and that more than 150 is large. Clearly this is an observation made in the context of the ability of individual techniques to deal with small or large numbers of data.

The method is principally associated with exploratory research and is not an inferential technique, so, arguably, sample size is not particularly an issue. Instead the criterion by which assurance of confidence would seem to be established is the appropriateness of the sample size and response rates for the sort of investigation being undertaken. Even so, it should be noted that small samples are vulnerable to the influence of outliers, whereas large samples generate data matrices that may be difficult to manage.

Of the sample being used in this study no claims of representativeness can or will be made other than to say it is representative of itself. The view of Hair et al. (1998; 490) is that cases are obtained and clusters derived "*in the hope that they represent the structure of the population*". The view appears to be based on the assumption that the population and its structure are known *a priori* in order that a representative sample can be generated. This seems rather to overlook one of the principal applications of cluster analysis, which is as an exploratory device or, as Bailey (1994) describes it, pre-theoretical. This research locates itself as exploratory and contends that the sample is sufficient for exploratory purposes.

Efforts have been made to draw the sample from a variety of sources and response rate has been encouraging (63.2%). As such, and notwithstanding issues of non-response bias, we can be confident that the results generated are likely to reflect the structure to be found in the sample population. As such results may form the basis for a series of propositions about innovation types that can be explored, refined and tested in future research.

8.8.2 Standardisation of measures

8.8.2.1 Variables

Hair et al. (1998) report that distance measures are sensitive to the scales describing variables because these analyses utilise standard deviations and squared values. Where different variable scales are employed this can be a significant issue. For example, scales that included income in thousands of pounds, perceptions on a 1-7 scale and age in years will produce variances that are likely to differ markedly, and, possibly, unduly weight one variable at the expense of others. In such circumstances rescaling of data to a standard measure is thought to be appropriate. The basis for measuring perceptions of outcome throughout the survey instrument is a seven-point Likert scale. This establishes constancy of scale and so neither standardisation nor manipulation are thought to be necessary. However, the use of Likert scaling raises another important issue (see subsection *Scales,* below).

8.8.2.2 Weighting

The research instrument probes the 13 attributes of innovation as described in the innovation framework. A series of statements (ranging from two to seven) is attached to each attribute to which responses are solicited. Undue influence in the cluster analysis process may be exerted by those attributes to which a larger number of statements is attached. For example, the attribute 'observability', to which two statements are attached, exerts a weaker influence in the clustering process than does the attribute 'complexity', to which seven statements are attached. That is, the variables in the instrument are unevenly weighted.

One method of reducing variables to an equal number is to subject them to principal component analysis with orthogonal rotation and using the resultant uncorrelated factor scores for each observation as the basis for clustering (Hair et al., 1998). Such an approach may result in a less than optimal set of clusters and consequently the technique is not strongly recommended (Ketchen and Shook, 1996). A simpler and less controversial approach is adopted for this study and the means of the statements attached to each attribute will form the basis of initial hierarchical clustering. This reduces the number of variables from 56 to 13 and results in a matrix of 2,548 data points (13 variables x 196 responses).

Analyses will, however, also be run on the unconsolidated data (56 items) of the survey instrument. These analyses will provide a touchstone against which to compare the results of the consolidated analyses. Arguably, if there is clear structure in the data, the results of unconsolidated and consolidated analyses might be expected to have some features in common and the underlying structure be evident in both analyses. Unconsolidated data therefore has a role in validating the analysis.

8.8.2.3 Scales

Likert scales are non-parametric or categorical scales. Strictly speaking the mathematical processes of cluster analysis are based on the presumption of interval data (a fixed zero point and a constant interval between points). Likert scales generate ordinal data in which the different values of the scale are not separated by equal increments. This begs the question, 'To what extent can Likert data justifiably be used as a basis for cluster analysis?'.

First, Abelson and Tukey (1970) argued that ordered metric data, where absolute differences between categories are not clear, can be considered as interval level data for most statistical purposes. Second, there appears to be a convention in cluster analysis to treat Likert scales as though they were interval scales. Precedents have been established in the literature for the treatment of categorical scales as 'being like' interval scales, (for example Roth, 1992). Additionally, some statistical authorities condone the approach (Norman and Streiner, 2000).

The 'help' files in SPSS® v11.0 (the software used for the analysis in this research) state that Likert-type scales are 'close enough' to interval data to make the assumption reasonable and that strong relationships will not be distorted no matter what technique is used. It might be further argued that strong anchoring at the end and mid-points helps contribute an interval-type quality to the scale. The end-point anchors in this instrument are 'strongly agree' and 'strongly disagree', with 'neutral' as the mid-point. Clearly these are not absolute points, but they do provide a largely stable template for the framing of responses.

In order to further ensure the validity of treating Likert scales as interval data, separate enquiries were made of SPSS® technical help, Cranfield University and, the

Department of Applied Statistics at the University of Reading. With permission, their responses were, first from SPSS®:

> Ordinal variables like 1-5 rating scales are often used in Clustering as they are generally considered 'close enough' to interval data, and there seems to be no problem with this. Therefore, I guess it won't affect the validity at all (especially as it appears to be quite a statistically vague technique anyway)
> Evi Pournara MSc.
> Technical Support Analyst

Second, from Cranfield University:

> I don't see a problem with regarding these scales as being quasi-interval. They are well anchored at either end. I think there are more important issues in cluster analysis than whether or not the scales can be regarded as interval.
> Dr J Towriss
> Lecturer in Logistics and Transportation

Third, from The University of Reading:

> If the seven point scale is ordinal and you have coded the seven possible answers as 1,2,....,7, there is no serious problem in using it as an interval scale for the purpose of cluster analysis. I myself would be happy to use even a 5-point ordered scale as interval scale for cluster analysis. Remember that cluster analysis is just a descriptive technique and as such I don't see a great problem in simple approximations of this sort.
> Dr S. Abeyasekera
> Principal Statistician

Treating Likert scales as interval data seems, therefore, to be acceptable for the purposes of cluster analysis, indeed no objections have been found. The debate regarding the use of Likert scaling in Cluster Analysis has been deliberately laboured to this point in order to highlight a limitation of the Cluster Analysis method. Limitations are dealt with more fully in section 8.10, but the previous debate is illustrative of the extent to which researchers must be cautious not to over-claim on the basis of results found.

8.8.2.4 Item reversal

The innovator's perception of his or her innovation in this study is described by Likert scores on each of the 13 attributes of the framework. However, in order to avoid the use of potentially confusing statements some statements are reverse coded. High attribute scores (i.e. closer to 7 on the Likert scale), as rated by individual innovators, reflect the perception that the innovation has relatively more or a higher level of that attribute (for example, the innovation is perceived to be very complex or to have a higher profile). See tables in Chapter seven for details of reversed items.

8.8.3 Multicollinearity

Multicollinearity exists where correlation amongst independent variables is strong, it is the extent to which a variable can be explained by other variables in the analysis. Norman and Streiner (2000) suggest that where the multiple correlation between one variable and a set of others is in the range of 0.9 or greater then multicollinearity can be said to exist. In cluster analysis multicollinearity can be problematic because it may exert undue influence on or over-emphasise one or more underlying construct (Ketchen and Shook, 1996) thereby distorting the shape of clusters.

If multicollinearity or uneven weighting is thought to be problem two options exist:

- Reduce variables to an equal number (Hair et al., 1998).
- Use a compensatory distance measure such as Mahalanobis distance (Ketchen and Shook, 1996; Hair et al., 1998).

8.8.4 Outliers

Outliers are those items that do not fit easily into any cluster (though cluster analysis will ultimately force membership upon them), typically characterised by extreme values on one or more of the variables (Hair et al., 1998). These are unique profiles that distinguish the outlying item from other items. Outliers can be identified by visual scanning of the data prior to analysis, inspection of the graphical output (see figures 8-1 and 8-2) and examination of the agglomeration schedule (see table 8-1) for entities that make their first appearance late in the process (e.g. item 5 in the fictional presentation).

There are two possible reasons for the appearance of outliers. First, that they are aberrant observations and not truly representative of the sample. Second, it might be that the sample is incomplete and that under-sampling has caused an under-representation of groups. If, during the process of analysis, significant numbers of outliers are observed it may become necessary to respecify the clustering rules.

Options for dealing with outliers include:

- If outliers are considered to be unrepresentative of the population then they should be eliminated from the data set - but this biases the sample (Hair et al., 1998). Not relevant as representativeness is not an issue.
- Use a clustering method that is resistant to the presence of outliers such as Ward's method (Hair et al., 1998).
- If the first pass identifies a large number of outliers remove the outliers from the data set and run the test again (Ketchen and Shook, 1996).

Average linkage methods and Ward's method are reported to perform best at structure recovery in data where outliers are present (Aldenderfer and Blashfield, 1984).

8.8.5 Stopping Rules

Hierarchical methods are not designed to determine a specific number of clusters in the data and consequently methods, so-called 'stopping rules', for determining a level of cluster solution are necessary. The hierarchical method results in a number of solutions, from one (*1*) cluster to as many entities (*n*) as there are in the sample. As the number of solutions moves from *n* to *1*, homogeneity within clusters decreases. Homogeneity is at its maximum with *n* clusters (i.e. all entities exist in their own individual cluster) and at its minimum with *1* cluster. Neither a maximum nor minimum solution reveals much regarding the structure or types within a sample, however the reasons for selecting a solution that lies anywhere between *n* and *1* need to be explicated.

Choice of stopping rule is largely subjective and tends to be guided by rules of thumb. These rules of thumb tend, largely, to revolve around the tension between delivering a parsimonious manageable cluster solution, that favours fewer clusters, and maintaining a realistic perspective on homogeneity within clusters that favours more clusters. Milligan and Cooper (1985) identify and review over 30 different stopping rules. The study concluded that there was a wide range of effectiveness of the rules and that no single rule has been shown to be better in all circumstances than any other.

There are various heuristic aids to making stopping decisions: visual inspection of the dendrogram, interpretation of graphical presentations of number of cluster solutions against changes in agglomeration coefficients and visual inspection of agglomeration schedule.

In the absence of any completely satisfactory methods for determining the number of clusters for analysis decisions for this study are made on the following grounds:

- Parsimony and Manageability. A manageable cluster solution of between two and six clusters is preferred, though as well as being manageable the solution must also make sense within the context of the data (Milligan, 1996).

- Patterning. Decisions can be taken where distinct kinks in the data patterns are observable. Visual inspection of a dendrogram, searching for differentiation in its branches, will indicate sudden jumps in the level of similarity as dissimilar groups are fused. Small coefficients and small increments between coefficients in the agglomeration schedule indicate that relatively homogenous clusters are being merged. However, two very different clusters being merged would result in either a large coefficient or, a noticeably large increase in the distance between the previous and following coefficient (compared to size of previous transitions). A large increase implies that dissimilar clusters have been merged thus the number of clusters prior to the merger suggests the possibility of an appropriate solution.

Non-hierarchical techniques pre-specify the number of clusters to be formed according to a priori criteria and consequently stopping rules do not become an issue.

In one sense, the problem of the absence of clear stopping rules is not as intractable as first it might seem. It has been argued (Aldenderfer and Blashfield, 1984) that, in instances where the goal of the technique is to explore patterns, structures and relationships in the data, weak solution prescription should not be considered a hindrance as it allows the researcher some latitude in uncovering the most meaningful solution. However, the range of solution possibilities afforded by the techniques requires that the researcher be explicit about (1) how the preferred solution was selected and (2) the validation of the selected solution.

8.8.6 Competing solutions

Arabie and Hubert (1996) remind the researcher that most methods of clustering are deterministic and will produce a cluster solution regardless of natural structure existing in the data. Furthermore, different methods will produce different solutions based on the same data (Aldenderfer and Blashfield, 1984). It is reasonable, therefore, that different solutions will be generated by different methods, from the same raw data. Aldenderfer and Blashfield (1984) present worked examples of four agglomeration techniques with data whose structure is known *a priori*. They illustrate that each technique generates a different solution and that Ward's method performs best at group recovery, though not perfectly. Consequently, different solutions does not necessarily mean unstable solutions, though it may suggest that solution reliability is lessened.

Reger and Huff (1993) use cluster analysis to determine the existence of strategic groups. As a control against the tendency of cluster analysis to reduce data to the status of discrete groups regardless, or not, of the existence of such structure in the data, they report using three different clustering methods. The test is against one asserted weakness of the cluster approach in that the resultant clusters are an artefact of the clustering process rather than a reflection of data structure. The multiple approach adopted by Reger and Huff is a common and recommended strategy. The approach is justified that "*[I]f all three clustering methods give similar results using multiple criteria, confidence that the groups are an inherent part of the data and not an artifact of the particular clustering algorithm is increased*" (Reger and Huff, 1993; 109).

This justification arguably suggests a difference of opinion amongst users of cluster analysis. It has been suggested that, because they are underpinned by different assumptions, different techniques result in different cluster solutions (Aldenderfer and Blashfield, 1984; Hair et al., 1998). That is to say, groupings resulting from different clustering methods may differ from one another but the divergence does not necessarily imply the absence of a grouping reflecting 'reality' rather than groupings that are artefacts of the process. Conversely, Reger and Huff (1993) appear to suggest that constancy of solution across methods increases our confidence that the groups are 'real' and not an artefact of the data. Because of the different assumptions underpinning each of the clustering techniques it is reasonable to expect some variance between cluster solutions, but data with strong underlying structure might also be expected to retain its fundamental shape regardless of the chosen technique.

Both arguments are persuasive. If the data is strongly structured it would appear reasonable to expect that structure to be evident in the results of different techniques, yet Aldenderfer and Blashfield's (1984) experimentation suggests this need not necessarily be the case. Satisfactory analysis is therefore dependent, to an extent, on the subjective interpretation of the researcher being able to make sense of the results in the context of the data. This is consistent with Arabie and Hubert (1996) who suggest analysis by 'relative criteria' in which the researcher must decide which of the various structures is better, in some sense, than other structures. Nevertheless, robustness and stability of a solution imputed by consistency across analyses cannot be gainsaid.

8.8.7 Stability of solutions

Everitt et al. (2001; 4) define stability as the condition when the "*classification remains the same under a wide variety of additions of organisms*[13] *or new characteristics describing them*". Stability is particularly vulnerable where analysis is based on a small number of cases (Aldenderfer and Blashfield, 1984). Stability can be tested by dropping cases from or adding cases to the data set, or by applying a split-half test.

Ketchen and Shook (1996) criticise cluster analysis because algorithms will always provide some form of hierarchical classification and so it is difficult to establish whether or not the observed clusters are 'real' or are just an artificial structure imposed on the data. Their critique, that solutions may not reflect *real* conditions but may rather be nothing more than a statistical coincidence, does not discredit the technique. Monte Carlo simulations provide some remedy as does split-half testing. Indeed, adherents to Everitt and Dunn's (2001) maxim that the merit of any classification scheme is in its usefulness might argue the spuriousness of the critique if fresh understanding can be demonstrated to have been derived from an 'artificial' cluster solution.

8.9 Validation

Milligan (1996; 366) suggests that many researchers fail to validate solutions "*because they bring to the analysis an assumption that clusters actually do exist in the data*". But, validation needs to be conducted in order to ensure that the cluster solution is not an artefact of either the clustering procedure or of the sample (Wyatt, 2000). Indeed, the researcher must be prepared to recognise that one legitimate solution from the cluster analysis process is that the data does not structure into discrete and distinct groups – that there is no cluster solution (Everitt et al., 2001). This though, is a difficult solution to reach given the deterministic nature of the approach.

A number of methods, which can be described as heuristic or formal, for the validation of solutions can be identified in the literature. Formal, statistical validation techniques are not widely used because they tend to be unreliable. Aldenderfer and Blashfield (1984; 64-65) describe two statistical techniques, cophenetic correlation (which attempts to analyse the accuracy of the dendrogram as a representation of the pattern of dis/similarity amongst the entities) and Significance tests on variables used to create the clusters. The former they describe as a "*generally misleading indicator*" and the latter as "*useless at best and misleading at worst*". Thus both are discounted for this study.

A third statistical test is significance testing on variables *not* used to generate the cluster solution (see chapter nine). This test is useful under certain conditions – for example investigating the nature of sub-types within an existing classification. But, given the exploratory nature of cluster analysis it might be reasonable to expect that preferred solutions do not compare favourably to existing classifications. Given that

[13] They are writing from the perspective of biological and zoological taxonomic development.

this research is founded, at least partly, on the contention that existing classifications of innovation are under-specified, then it would be reasonable to expect that the classification generated in this study would not conform with those extant in the literature. Incongruity between the two will not necessarily invalidate either. This research will however compare against the conventional classifications of innovation (novelty and area of focus – see Chapters four and ten) and against demographic data captured by the survey instrument.

A final statistical test, which is utilised in this study, is to compare variable means across clusters and against variable means for the full data set. In strongly structured data one would expect to find within-cluster variance to be minimised and between-cluster variance to be maximised, whilst also being separate from the full data set mean. Everitt et al. (2001) suggest that for non-hierarchical K-means analysis cluster solutions should not be significantly affected by selection of different seed points for the initial clusters. Though this advice might appear to contradict that of Milligan (Milligan, 1996) with regard to quality and rationality of seed point selection (see above).

Consequently, the three heuristic validation techniques used in this research are, running multiple methods, a form of replication (split-half testing) and Monte Carlo simulations. Multiple methods are selected from the similarity rules and amalgamation techniques described above. Consistency of cluster solution across these tests will be taken to indicate the existence of an underlying structure in the data and imply robustness and stability of the solution. Replication and Monte Carlo simulations are described below.

8.9.1 Replication

One test of the integrity of the cluster solution is to replicate the study with a second data set. The collection of two separate data sets is impractical within the parameters of this research. Split-half testing in which data are divided and subjected to the same analytic processes as the full data set overcomes this logistical limitation. Replication by split-half testing validates (or otherwise) the underlying structure of the data recovered in the analysis of the full data set. Analysis will therefore consist of two split-half tests and the full data set. Recovered patterns are compared one against the other. In order to establish the extent to which patterns are an artefact of the process they can also be compared against patterns recovered from random data, a process known as Monte Carlo simulation.

Variations of replication methods, specifically tests of ‘robustness’ and ‘influence’, are recommended by Everitt et al. (2001). Robustness refers to the impact of errors in the data or missing values, and changes in data and methods. In this study entities with missing data are not included in the analysis but robustness is tested by a mixed method approach. Influence refers to the deletion of entities from the analysis and the impact of that on consequent cluster formation. It is considered that this test replicates the split-half test.

8.9.2 Monte Carlo Simulations

Milligan (1996) describes as Monte Carlo simulations the process of running dummy data through planned cluster analysis techniques. Milligan reports these mostly in terms of testing the recovery rates of the different methods with different data types. However, they are also a useful technique as a check against the deterministic tendency of cluster analysis as they test against the possibility that similar patterns to those found in the raw data might not also be found in random data.

If patterns do appear in the empirical data, how do we know that similar patterns would not also be found in random data? Using dummy data generated by Microsoft Excel® Monte Carlo simulations are run replicating the tests run on the full empirical data set. Thus the data input and processes of analysis for the Monte Carlo procedure will mimic, as closely as is possible, that for the empirical data. A number, equivalent to the number of usable returns, of dummy responses are generated and be subject to the same statistical methods and the results compared to those for the empirical analysis.

8.9.3 ANOVA analysis

Comparison of variable means across clusters and against variable means for the full data set has already been identified as one test of the stability of solutions. In this test if variable means are significantly different across clusters and from the grand mean then cluster distinctiveness is indicated (Wyatt, 2000). This can be corroborated by a measure of cluster separation. In addition, the f-ratio (the ratio of cluster variance to error variance) indicates the variables that are significant in separating the clusters one from the other, the larger the f-ratio the more significant is that variable for differentiating clusters. However, the F tests are indicative only. The whole purpose of cluster analysis is to pattern heterogeneous data. As such one might expect significant f-ratios. Because the clusters have been chosen to maximize the differences among cases in different clusters, f-ratios should be used only for descriptive purposes and should not be interpreted as proofs of hypotheses.

8.10 <u>Limitations of Cluster Analysis</u>

Simply, cluster analysis is the grouping of objects according to pre-specified criteria of proximity. Hair et al. (1998) describe the approach as atheoretical, Arabie and Hubert (1996; 7) suggest that "*[f]or many statisticians, the shady history of cluster analysis is an ongoing cause for suspicion*".

There is a range of limitations that has come to be associated with cluster analysis, particularly with the hierarchical approach:

- In the absence of a definitive, single method there is a diversity of measures of similarity and distance and, of amalgamation algorithms.
- Different approaches are deterministic and likely to generate different cluster solutions.
- Subjectivity is required in order to select the most appropriate cluster solution.
- Cluster analysis has no statistical basis on which to draw statistical inferences from samples to populations - there is no unifying theory of clustering. Results must therefore be treated with caution.

- There is no universally accepted definition of the term 'cluster', and so a variety of techniques have been employed to determine at which point in the analysis a solution is sought (Milligan, 1996).

Any of these limitations could lead to misleading analyses and erroneous conclusions being drawn from raw data. It is down to the researcher to identify the appropriate procedure amongst competing approaches that deliver competing classifications (Hair et al., 1998).

Strategies to minimise the impact of these limitations are considered in table 8-4.

Weakness of the method	**Implications for research**	**Counter measure**
Diversity of methods	Accusations of subjectivity. Different methods offer different solutions	• Be explicit in all decision-making • Choose methods appropriate to the circumstances • Run a selection of methods concurrently
Deterministic clustering	Cluster analysis will force data into clusters regardless of whether or not a natural type exists	• Apply validity testing and Monte Carlo simulations. • Replicate the analysis on subsets of the data to see if the structures emerge consistently.
Absence of unifying theory of Cluster Analysis	Statistical inference back to a population not possible	• Inference back to a population is not a significant issue in this research, which is exploratory.
Absence of a statistical basis	Cannot make statistical inferences from a sample to a population	• Be cautious in drawing conclusions based on the sample • Do not 'overclaim' on the basis of the analysis
Absence of single cluster solution decision making rule	Range of techniques leads to different solution possibilities. Loss of definition at highest levels of aggregation	Be explicit in decision-making. Make stop decisions according to: • Jump method: examines the distance between clusters at each successive step when that measure exceeds a pre-determined (according to an idiosyncratic 'local' rule) value or appears to make a sudden jump then this point might be deemed appropriate to identify a cluster solution. Hair et al. (1998) report that this method has been shown to provide fairly accurate decisions in empirical studies. This is really looking at the stability of the structure over distance. This can be done by eye or by reference to agglomeration coefficient. • Statistical methods: several are available but are reportedly overly complex compared to the jump method for the marginal benefits that they bring. • Appropriateness or Usefulness – makes sense within context of the data (Everitt and Dunn, 2001) or cluster groupings that agree with existing or expected structures. • Manageability and utility of cluster solution

Table 8-4: Counter measures to weaknesses of cluster analysis

Non-hierarchical procedures do not suffer from these limitations nor do they involve the treelike construction process.

The limitations of cluster analysis oblige the researcher to endeavour to establish as rigorously as possible the validity of the results of cluster analysis in order not to detract from the valuable role the approach has in exploratory research as the basis from which propositions may be developed and hypotheses tested.

8.11 Cluster analysis design specification

Ultimately, Hair et al. (1998; 499) conclude that in the final analysis "*it is probably best to compute a number of different cluster solutions and then decide among the alternative solutions by using prior criteria, practical judgement, common sense or* *theoretical foundations*". This view is widely supported in the literature, (for example Reger and Huff, 1993). The preceding discussion has highlighted the key features of undertaking a cluster analysis and their significance in terms of the results generated by the process. In the light of this discussion, this section details the design specification for the cluster analysis process for this research. Table 8-5 details this specification.

Issue	**Selection**	**Comments**
Choice of approach. Hierarchical or non-hierarchical	Both	Hierarchical: to investigate existence of underlying structure in the data accounted for by configurations of variables. Non-hierarchical: to refine preferred solution generated by hierarchical technique; to explore cluster formation based on a priori classifications
Choice of distance measure	Squared Euclidean Distance	Comparison of similarity measures reported Euclidean distance measures to provide consistently acceptable results.
Choice of amalgamating rules	Ward's method, Within-groups linkage, Furthest neighbour, Pearson correlation	Ward's method is the method of choice for this research. It has consistently been shown to perform well at structure recovery (Aldenderfer and Blashfield, 1984). Additionally it is selected because of its reported efficiency, minimisation of within-cluster differences, ability to produce distinct clusters and avoidance of problems of chaining of the observations found in the single-linkage method. To satisfy the requirement of testing with a number of cluster solutions three further methods are proposed: Within-groups linkage is selected because it fuses clusters so that within-cluster variance is minimised and tends to produce tighter clusters than between-group linkage. Furthest-neighbour method is selected as an item-focused method as a contrast to the two cluster-focused methods. Finally, Pearson's method will be used as the correlational method.
Selection of preferred solution	Relative criteria, manageability, visual inspection, stopping rules	Selection by 'relative criteria' requires the researcher to decide which of the various structures is better in some sense, such as being more stable or appropriate for the data (Gordon, 1996). A manageable solution will consist of between 2 and 6 clusters. Visual inspection of dendrograms and agglomeration matrices for jumps in the data.
Non-hierarchical analysis: selection of seed points	Preferred solution from hierarchical analysis	To refine the preferred cluster solution.
Testing	(1)Validation (Monte Carlo, Replication, ANOVA) (2)Multiple analyses (3)Expert opinion	(1) Monte Carlo: run simulations with dummy data to provide test against hierarchical clusters and chance of results being artefacts of the algorithm. Replication: split-half test to test integrity of solutions. ANOVA: to test stability of solution. (2) The degree of consistency of solutions can indicate reliability (Hair et al.,1998), though absence of consistency does not imply a necessarily weak solution. (3) Expert opinion can also establish the practical value of a study, when the experts are relevant practitioners their views can establish the 'real world' value of a set of results. That is, their opinion can help to validate results (Ketchen and Shook, 1996).
Analysis	Interpretation and profiling	Comparison against variables not used as the basis for clustering.

Table 8-5: Cluster analysis research design

8.12 Summary

One objective of this research is to identify clear and distinct groups of innovations, should they be present in the data. A strategy based on cluster analysis techniques has been proposed as the appropriate means by which these groups can be identified.

Cluster analysts tend to be united by the common objective of developing a sensible and informative classification out of initially unclassified data (Everitt, 1995). Hair et al. (1998) describe cluster analysis as more of an art than a science wherein a diversity of methods exist and choices must be made and explicated in undertaking an analysis.

Because of the diversity of methods that exist within cluster analysis authorities (Everitt, 1995; Hair et al., 1998; Belson, 1986) recommend running several of the methods concurrently in order that classifications with greatest potential value for understanding or further study can be identified. This chapter has reviewed the options available and decision criteria necessary for undertaking a cluster analysis. A design specification has been proposed at the core of which are four hierarchical methods (Ward's, furthest neighbour, within-groups linkage and Pearson's correlation) followed by K-means refinement of the preferred hierarchical solution.

Cluster analysis has its limitations. Issues such as subjectivity in cluster solution selection or opacity of stopping rule decisions have been discussed. In the final analysis decisions are made based on the utility of the output and the confidence one can have in using that output as a basis for further action, decision making and understanding. Confidence has been illustrated to be a product of tests of validity and the sense solutions make within the context of the data.

Notwithstanding the choices that must be made and its deterministic tendency cluster analysis is objective, empirical, elegant and neutral. Real theoretical or conceptual importance is not gifted to the data by the process of cluster analysis, whether or not these exist is the consequence of subsequent interrogation of the clusters and characteristics of and between groups made by the analyst in the context of the data. The following chapter attempts this task.

9 PHASE II, SURVEY RESULTS AND ANALYSIS

9.1 Introduction

This chapter presents the analysis and interpretation of the data as specified in the previous chapter.

Initially, four separate hierarchical cluster analyses are run: Ward's method, furthest neighbour, within-groups-linkage, and Pearson correlation. Each of these analyses is presented in the following format:

- Textual commentary on unconsolidated (56 variables) and consolidated (13 variables) data plots.
- Table summarising possible cluster solutions (where appropriate).
- Graphical plots of percentage change in agglomeration coefficients for unconsolidated.
- Monte Carlo and empirical data (full data set and split-half tests).
- Graphical plots of percentage change in agglomeration coefficients for consolidated .
- Monte Carlo and empirical data (full data set and split-half tests).
- Dendrogram illustrating possible cluster solutions (where appropriate).

Following a brief discussion of these analyses, a selection of a preferred cluster solution is made and justified in the context of the data. This solution is subsequently subjected to non-hierarchical refinement by K-means analysis.

However, prior to the analysis a brief description and justification of the use of the statistical software package (SPSS®) used in the process is provided.

9.2 Software for statistical analysis

SPSS® for Windows (Statistical Processes for Social Scientists) is a well-established statistical software package with a broad range of capabilities. Version 11.0 was used for this analysis. The software was chosen in preference to other software specifically designed to perform cluster analysis, for example CLUSTAN® (Wishart, 1987), for the following reasons:

- The author had a degree of familiarity with SPSS® but no experience with other packages.
- SPSS® was readily available on a single-user licence through the researcher's academic institute.
- SPSS® provides a wide range of statistical functions including, but not exclusively, some of the most popular, and some of the less frequently used, clustering methods.
- Technical support was readily available via email contact with SPSS®.
- SPSS® provides readily interpretable output in the form of tables and graphics.

There are, however, limitations to the SPSS® package when compared against software specifically designed for the task of cluster analysis. The most significant of these it was felt, was the absence from the SPSS® armamentarium of Mahalanobis distance as a measure of distance. As noted above (Chapter eight) Mahalanobis distance is a useful measure of distance where multicollinearity is a feature of the data matrix and high correlations amongst variables may exert undue influence on one or more underlying construct (Ketchen and Shook, 1996). Multicollinearity was not found to be present in the data and so the unavailability of Mahalanobis distance did not become an issue.

Other statistical packages, notably CLUSTAN®, provide a wider range of clustering methods and a more sophisticated representation of output, particularly in terms of graphics, than does SPSS®. This graphical output can be an aid in validating cluster solutions. However, the review of the literature on clustering methods led to the conclusion that the methods available in SPSS® were sufficient for the clustering task in hand. The difference between graphical output capability was not felt to be a significant issue. The difference in terms of aesthetics was tolerable in the context of the analysis. Whilst the absence of enhanced ease of interpretation that clear graphical representation of data offers, opportunities for interpretation and analysis were not felt to be diminished by the use of SPSS®.

It was felt, on balance, that the advantages of proceeding with SPSS® outweighed the disadvantages.

9.3 SPSS® procedure

SPSS® requires that separate files are created for each body of data that is to be analysed. Initially, therefore, 12 separate files were created, these are detailed in table 9-1.

	Monte Carlo data	**Empirical data**
Unconsolidated data	File 1 – Full data set (FDS) File 2 – Split Half 1 (SH1) File 3 – Split Half 2 (SH2)	File 4 – Full data set (FDS) File 5 – Split Half 1 (SH1) File 6 – Split Half 2 (SH2)
Consolidated data	File 7 – Full data set (FDS) File 8 – Split Half 1 (SH1) File 9 – Split Half 2 (SH2)	File 10 – Full data set (FDS) File 11– Split Half 1 (SH1) File 12 – Split Half 2 (SH2)

Table 9-1: SPSS® data files

The Monte Carlo analyses were run prior to analysing the raw empirical data. This served two purposes. First, to re-familiarise the author with some of the more specialist features of running an SPSS® cluster analysis and resolve any technical issues with regard to the matrix template. Second, it served to permit running a Monte Carlo simulation analysis without the risk of interpretation being prejudiced by prior analysis and understanding of the empirical data. Arguably, it may have predisposed the researcher to attempting to fit the results of the analysis of empirical data to that of the Monte Carlo simulation.

9.3.1 File template

Two file templates were created, both according to the same principles, one for unconsolidated data the other for consolidated data. The convention in SPSS® is for rows to represent the items or entities (in this case individual innovations) and for columns the variables (in this instance, innovation attributes) that are the basis for clustering. Consequently in both templates the matrix initially consisted of 196 rows (the total number of responses, and reduced to 171 after accounting for missing data) but the number of columns differed between unconsolidated data template (56 variables) and consolidated data (13 variables). Additionally, a further four columns were created to include variables not used as a basis for the initial clustering: respondent identity code, innovation area of focus, data source, functional type and clinical type.

In creating a file template the user is required to specify certain characteristics of the data and assign descriptive labels and formatting to columns and cells. In total ten labelling and formatting decisions must be made, the salient ones for this study are illustrated in table 9-2.

(Variable) **Name**: a maximum of eight characters available to label a column head, e.g. novelty. (Variable) **Type**: a selection of eight types defining the data as numeric, scientific, currency, alpha string etc. Each variable in this study was assigned a numeric value. (Variable) **Label**: supplementary to 'Name' (above) provides the opportunity for fuller description of variables (256 characters available), but does not appear as a column heading. (Variable) **Values**: specify the (numeric) values that cover the range of data. For this study this range was 1,2,3,4,5,6,7 representing all possible responses on the Likert scale. **Missing**: missing data was assigned the value '9'. (Variable) **Measure**: what sort of data is being used: nominal, ordinal or scale? Variables in this study comprised both scale (Likert responses) and nominal (e.g. respondent name).

Table 9-2: SPSS® labelling and formatting

9.3.2 Data integrity

Data input integrity was confirmed by running checks of descriptive statistics (maxima, minima, standard deviations and data range). This is a useful check against the possibility of large values being erroneously entered into cells. Random audits of data entry were also undertaken to ensure accurate transposition. Table 9-3 details the descriptive statistics for the survey response: of 310 mailed questionnaires, 196 were returned by the deadline of which 171 were usable.

Data were checked for signs of multicollinearity. No correlations equal to or greater than 0.9, Norman and Streiner's (2000) test of multicollinearity, were found in the consolidated data set. In the full data set, however, multicollinearity was found, but only between items 4.3 and 4.4 (individuals took risks in developing the innovation and, individuals took risks in implementing the innovation), with a correlation coefficient of 0.907.

A less stringent r-value of 0.7 was also applied. No correlations were found in the consolidated data, 12 correlations were found in the unconsolidated data. It is, though, unsurprising to have found some level of correlation in the unconsolidated data, where attributes are interrogated by multiple items. Consequently multicollinearity is not considered to be an issue for this research.

Sample size	310
Total response	196 (63.2%)
Missing items	25 (12.8% of total response, 8.1% of total sample)
Total usable responses	171 (87.2% of total response, 55.2% of total sample)

Table 9-3: Survey response descriptive statistics

9.3.3 Data analysis

Following the specification of the file template and data entry SPSS®'s statistical processes were invoked in order to generate cluster solutions. Using the **Analyze** function the procedure is illustrated in table 9-4.

- Select **Analyze, Classify, Hierarchical Cluster**. At which point the **Hierarchical Cluster Analysis** dialogue box appears.
- Select the variables to be used as basis for cluster analysis (56 or 13 variables for the two analyses).
- Select statistical output options and specify number of cluster solutions: agglomeration schedule and range of 2 to 6 cluster solutions selected.
- Select graphical plot output from choice of dendrogram and icicle plots. With large quantities of data dendrograms are more manageable and were, therefore, selected.
- Specify cluster method and distance measure from range of options.
- Stipulate whether the cluster membership output should be saved as a new variable. This new variable will be the variable data used to seed initial cluster centres in the K-means refinement.

Table 9-4: SPSS® analysis procedure

9.4 Analysis 1: Ward's method

9.4.1 Unconsolidated data

Visual inspection of the curves (figure 9-1) illustrating the Monte Carlo and empirical data indicates:

- Shape and magnitude of Monte Carlo and empirical curves approximate to each other from 10- to 6-cluster solution, though empirical magnitudes are greater. Beyond the 6-cluster solution gradients of the empirical curves begin to rise steeply in comparison to those of Monte Carlo.
- The internal relationships of empirical curves remain largely consistent. This - indicates that the structure recovered from full data set is also recovered in split-half tests. Steep gradient changes suggest solutions of 3- or 4-clusters.

9.4.2 Consolidated data

Visual inspection of the curves (figure 9-1) illustrating the Monte Carlo and empirical data indicates:

- Results similar to those of the unconsolidated analysis confirming underlying structure in the data.
- Steep gradients suggest rules determining uniqueness having to be greatly relaxed and 3-, 4- and 5- cluster solutions are suggested.

9.4.3 Comment

Analysis of consolidated and unconsolidated data recovers possible 3-, 4- and 5-cluster solutions. Differences in gradient and magnitude between Monte Carlo and empirical plots suggests that those solutions are not artefacts of the statistical process. Validity is further supported by synchronicity of full data set and split-half curves in the two empirical analyses. 3- and 4- cluster solutions also generate well-distributed cluster membership which are largely consistent across consolidated and unconsolidated analyses (see table 9-5). This is confirmed by analysis of the dendrogram (see figure 9-2) which illustrates clear clusters with many items having clustered at an early stage (indicating tightness of clusters). The possible 5-cluster solution is rejected on the basis of its less evenly distributed cluster membership. For these reasons the 3- and 4-cluster solutions are retained for later analysis.

	Cluster Number				
	1	2	3	4	5
Consolidated data	62	45	64		
Unconsolidated data	*108*	*37*	*26*		
Consolidated data	62	45	38	26	
Unconsolidated data	*53*	*56*	*26*	*36*	
Consolidated data	62	12	33	38	26
Unconsolidated data	*39*	*56*	*26*	*14*	*36*

Table 9-5: Summary of cluster membership. Ward's method, 3-, 4- and 5-cluster solutions, consolidated and unconsolidated data.

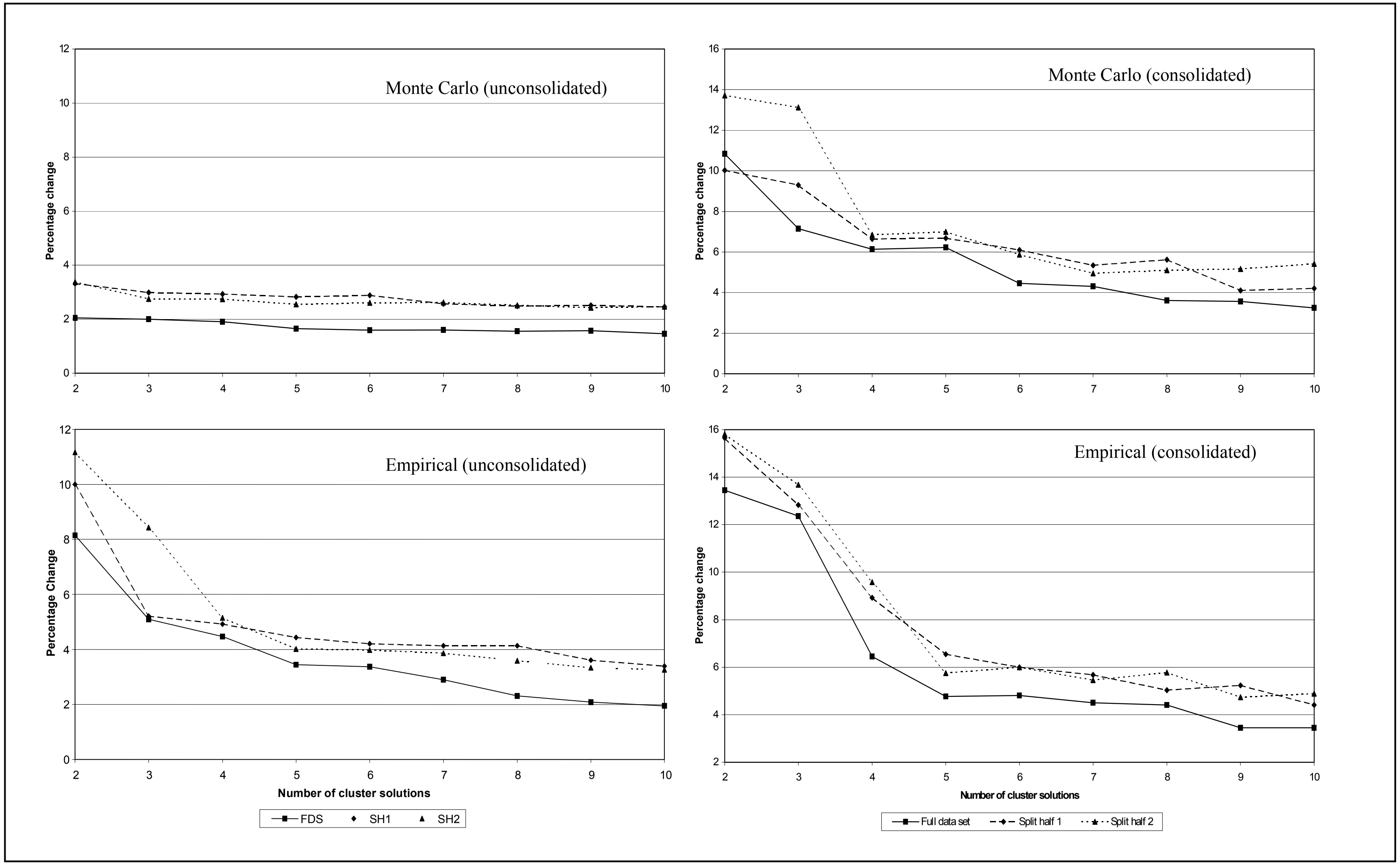

Figure 9-1: Percentage changes in agglomeration coefficient. Analysis by Ward's method. Consolidated and unconsolidated Monte Carlo and empirical data.

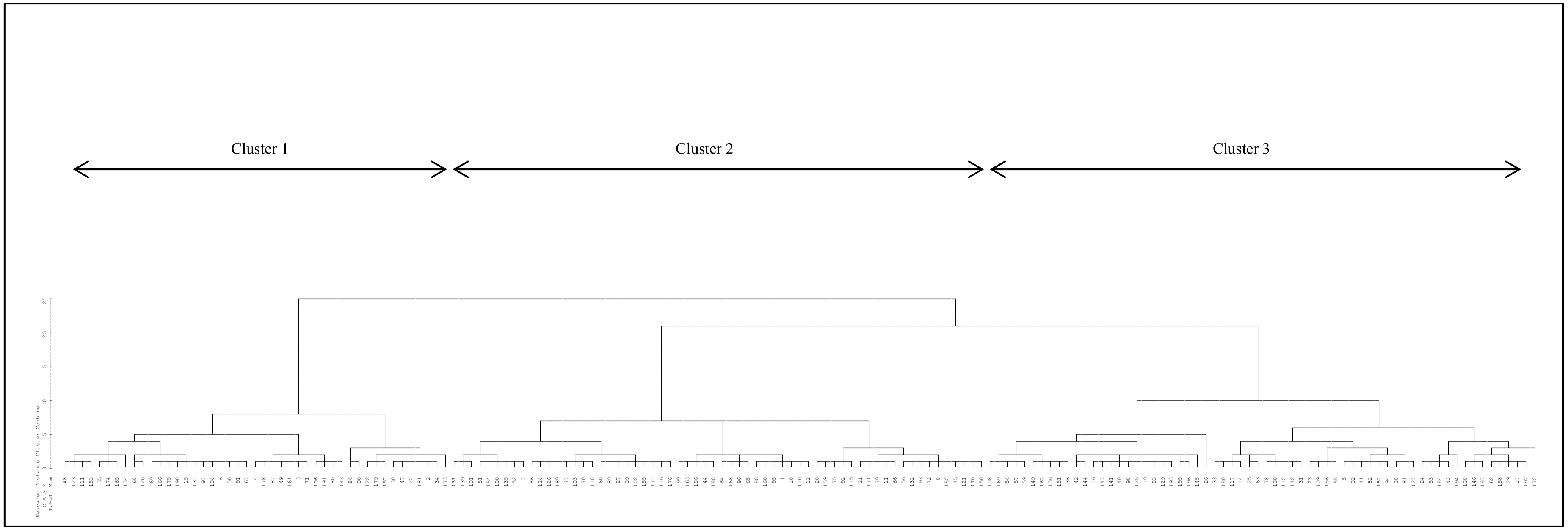

Figure 9-2: Dendrogram showing suggested 3-cluster solution from Ward's method, consolidated data

Note: The dendrogram is reproduced deliberately in small scale in order to fit on a single page. It is included for the purpose of illustrating the distinctness of clusters and early clustering only. At this stage in the analysis the item numbers that run along the x-axis are not relevant.

9.5 Analysis 2: Furthest neighbour

9.5.1 Unconsolidated data

Visual inspection of the curves (figure 9-3) illustrating the Monte Carlo and empirical data indicates:

- That both Monte Carlo and empirical plots appear moderately erratic, though less so in the case of Monte Carlo curves.
- Symmetry in the Monte Carlo curves from 10- to 4-cluster solutions after which symmetry lessens.
- Little symmetry between empirical curves except for 3- and 4-cluster solutions.
- A rise in gradient of empirical curves at 5-clusters suggesting a possible solution, but not sufficient to suggest a strong underlying structure exists in the data.
- Erratic movement of empirical curves relative to each other suggesting that no solution is validated.

9.5.2 Consolidated data

Visual inspection of the curves (figure 9-3) illustrating the Monte Carlo and empirical data indicates:

- Moderately erratic curves in both plots.
- Empirical curves rise steeply at 3- and 5-cluster solutions. This rise is mimicked in the Monte Carlo plot at the 3-cluster solution. This may imply the influence of the clustering algorithm rather than a strong structure within the data.

9.5.3 Comment

The analysis shows very erratic clustering of unconsolidated data, possibly reflecting the item-specific focus of the method and the multiple variables under consideration. There are some similarities in curve movements between plots (e.g. at the 5-cluster solution in figure 9-3, consolidated data), which might suggest the influence of the clustering algorithm rather than underlying data structure. The plots are considered sufficiently different in other respects to give confidence that the empirical data set is dissimilar from the randomly generated data set.

	Cluster Number				
	1	2	3	4	5
Consolidated data	145	24	2		
Unconsolidated data	*72*	*83*	*15*		
Consolidated data	39	24	99	7	2
Unconsolidated data	*72*	*33*	*22*	*28*	*15*

Table 9-6: Summary of cluster membership. Furthest neighbour method, 3- and 5-cluster solutions, consolidated and unconsolidated data.

Although a 5-cluster solution might be indicated, validation methods do not give it strong support. There is discrepancy between consolidated and unconsolidated plots and Monte Carlo plots are not sufficiently different to discriminate between empirical and random data. Further the empirical full data set and split-half 1 and 2 curves are also dissimilar. Further, as table 9-6 shows, the furthest neighbour method produces an uneven membership distribution. The stability of a 5-cluster solution by the furthest neighbour method must, therefore, be called into question.

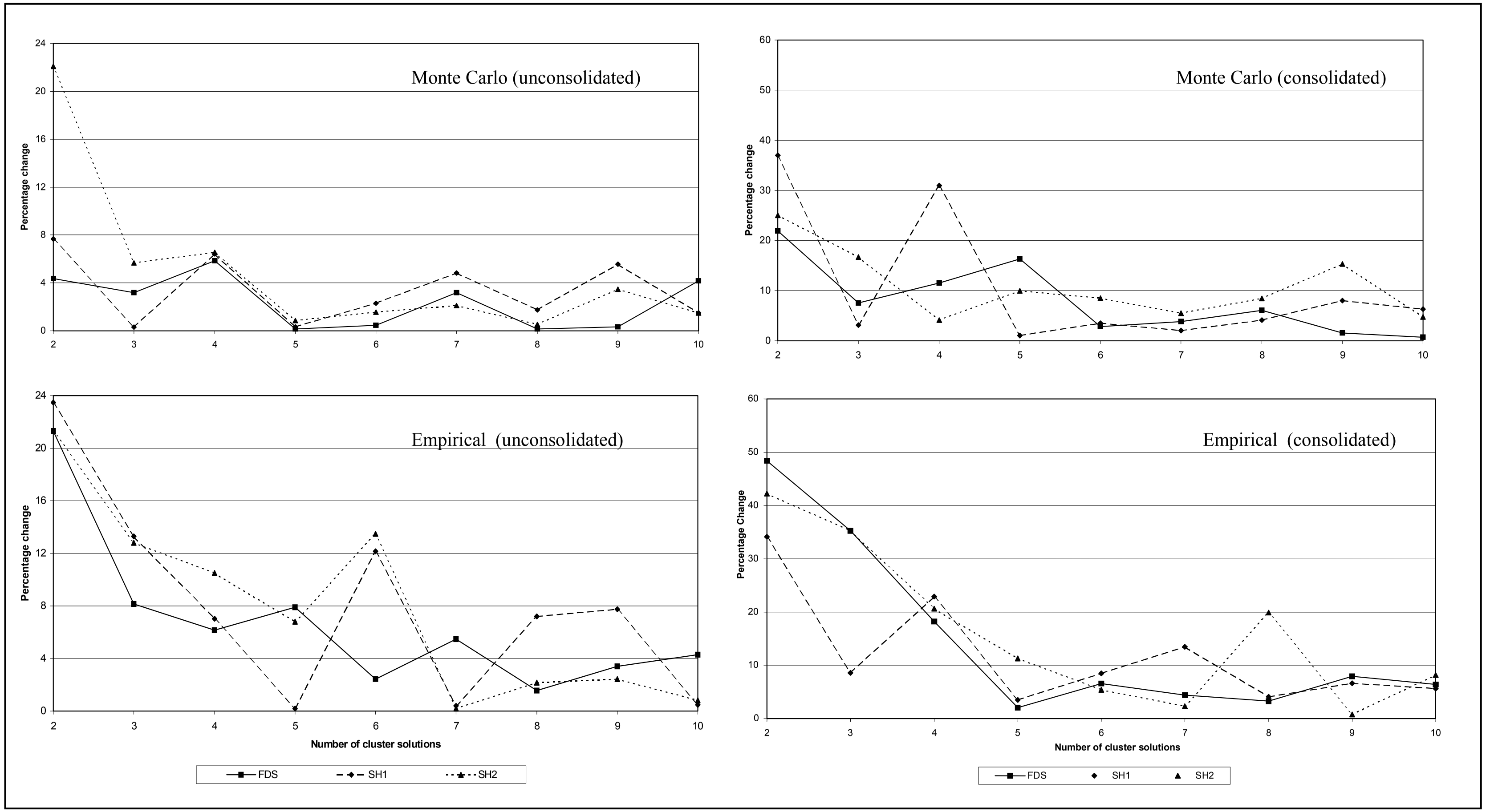

Figure 9-3: Percentage changes in agglomeration coefficient. Analysis by furthest neighbour method. Consolidated and unconsolidated Monte Carlo and empirical data.

9.6 Analysis 3: Within-groups linkage

9.6.1 Unconsolidated data

Visual inspection of the curves (figure 9-4) illustrating the Monte Carlo and empirical data indicates that:

- The Monte Carlo and empirical curves have neither shape nor magnitude in common leading to the conclusion that the empirical plot is unlikely to be an artefact of the clustering process and that empirical and random data are differently structured.
- Both empirical and Monte Carlo plots are erratic, though there is moderate synchronicity between empirical curves between 5- and 3-cluster solutions.
- 3-, 4- and 5-cluster solutions seem plausible.

9.6.2 Consolidated data

Visual inspection of the curves (figure 9-4) illustrating the Monte Carlo and empirical data indicates:

- That both representations appear to be erratic, though dissimilarly shaped.
- A possible 5-cluster solution as the gradients of each of the empirical curves steepen markedly and in concert, which is in contrast to the Monte Carlo plot.

9.6.3 Comment

The within-groups linkage method hints weakly at a possible 5-cluster solution from the consolidated data and possible solutions of 3-, 4- or 5-clusters from the unconsolidated data. Cluster membership for each of these solutions is presented in table 9-7. Because of the imbalance in cluster membership across each of these solutions, and particularly because cluster 5 of the consolidated analysis contains only a single item, these solutions are considered unsatisfactory.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Consolidated data	98	46	27		
Unconsolidated data	55	67	47		
Consolidated data	49	46	27	49	
Unconsolidated data	*28*	*67*	*47*	*28*	
Consolidated data	49	46	27	48	1
Unconsolidated data	*28*	*43*	*47*	*28*	*24*

Table 9-7: Summary of cluster membership. Within groups linkage 3-, 4- and 5-cluster solutions. Consolidated and unconsolidated data.

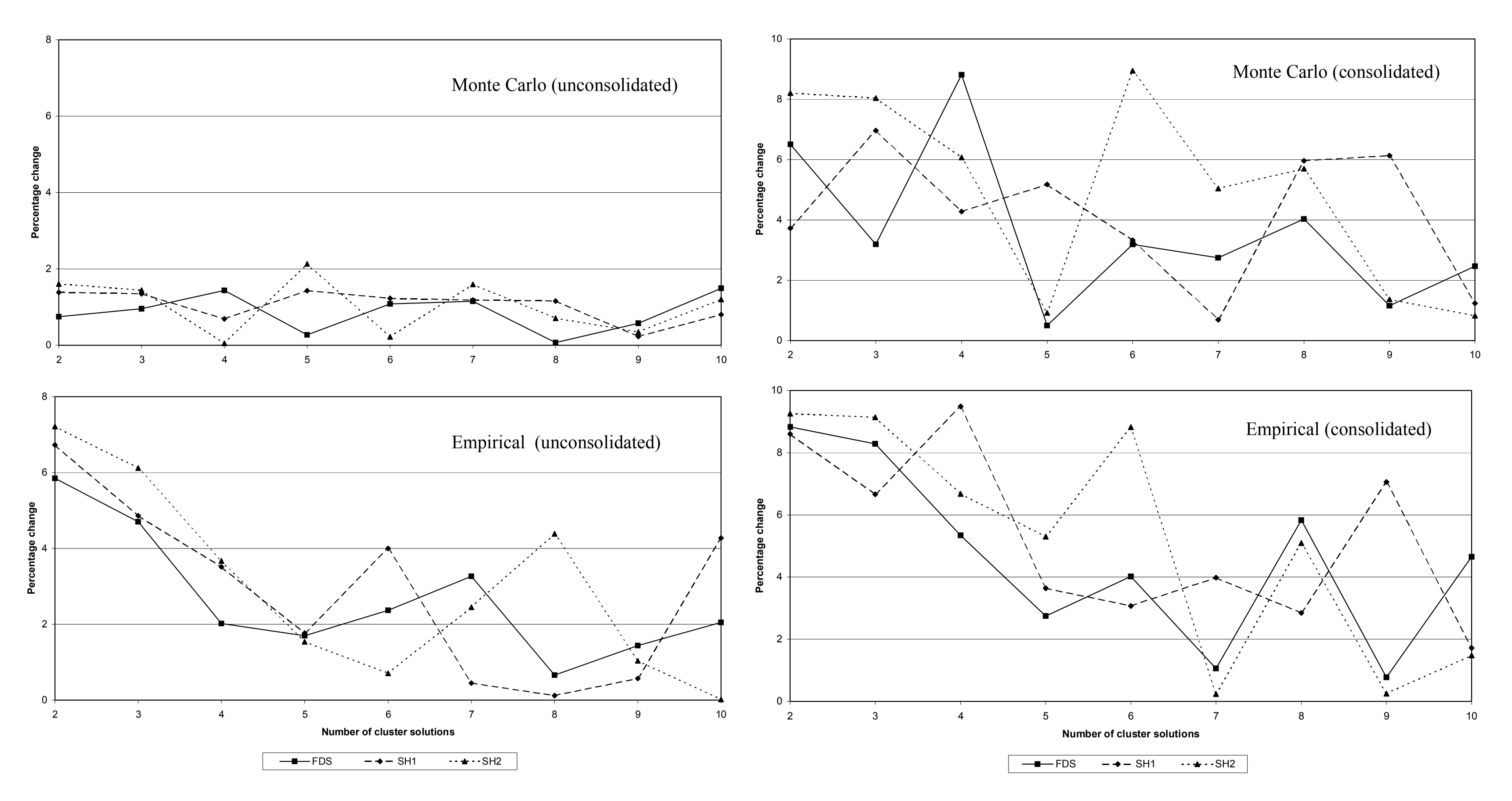

Figure 9-4: Percentage changes in agglomeration coefficient. Analysis by within groups linkage method. Consolidated and unconsolidated Monte Carlo and empirical data.

9.7 Analysis 4: Pearson correlation

Pearson correlation is a measure of similarity, therefore the agglomeration coefficient decreases and so the vertical scale moves from zero to a series of negative points. Potential cluster solutions can, once again, be recognised by kinks in the curve.

9.7.1 Unconsolidated data

Visual inspection of the curves (figure 9-5) illustrating the Monte Carlo and empirical data indicates:

- The difference in magnitude between the two plots. The Monte Carlo appears to be more erratic than empirical plot. This suggests that the data underpinning the Monte Carlo plot exhibits less similarity than does that for the empirical plot.
- That, because of the differences in magnitude and shape between empirical and Monte Carlo plots, the empirical presentation is unlikely to be an artefact of the statistical process.
- That the Y-axis scale manipulation allows for finer-grained analysis of empirical curves. Absence of any synchronicity between empirical curves suggests no strong cluster solution.

9.7.2 Consolidated data

Visual inspection of the curves (figure 9-6) illustrating the Monte Carlo and empirical data indicates:

- That the plots mimic those found in the analysis of unconsolidated data with clear differences in both shape and magnitude between the Monte Carlo and empirical plots.
- The empirical curves following Y-axis scale manipulation allows for finer-grained analysis. This shows some modest symmetry between the curves up to the 6-cluster solutions, after which symmetry is less pronounced. The absence of a clearly apparent, synchronous change in gradient suggesting no predominant cluster solution.

9.7.3 Comment

Analysis by the Pearson correlation does not suggest any clearly distinctive cluster solutions. Inspection of the dendrogram (see figure 9-7) indicates clustering takes place late in the process (which suggests large within-group distances, i.e. weak internal homogeneity). Inspection also confirms clusters to be string-like with a large number of possible solutions, several outliers and no clear structure (particularly when compared against Ward's method dendrogram, figure 9-2). Correlational analysis appears not to offer any promising solution and for this reason the method is discounted.

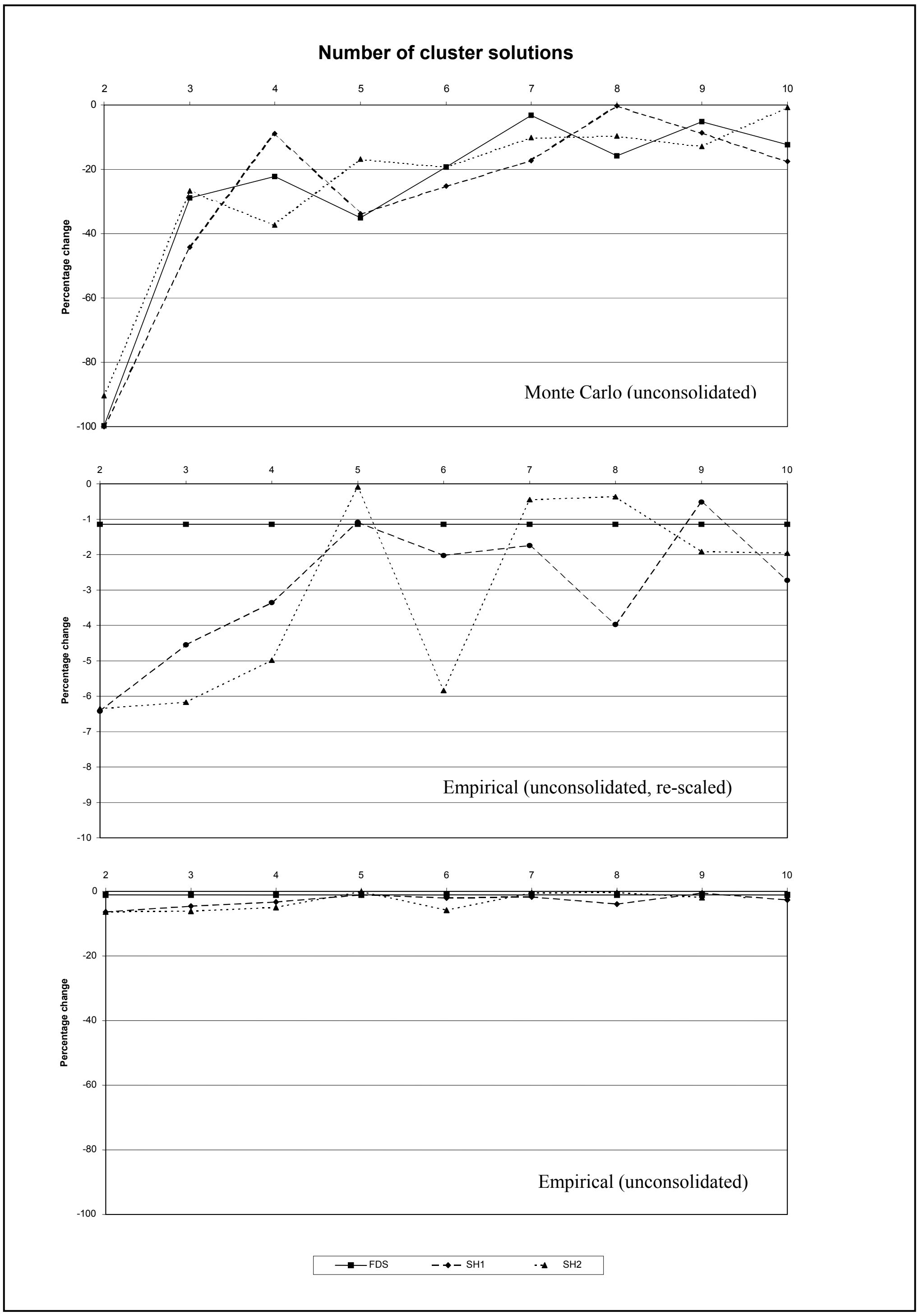

Figure 9-5: Percentage changes in agglomeration coefficient. Analysis by Pearson correlation. Unconsolidated Monte Carlo and empirical data.

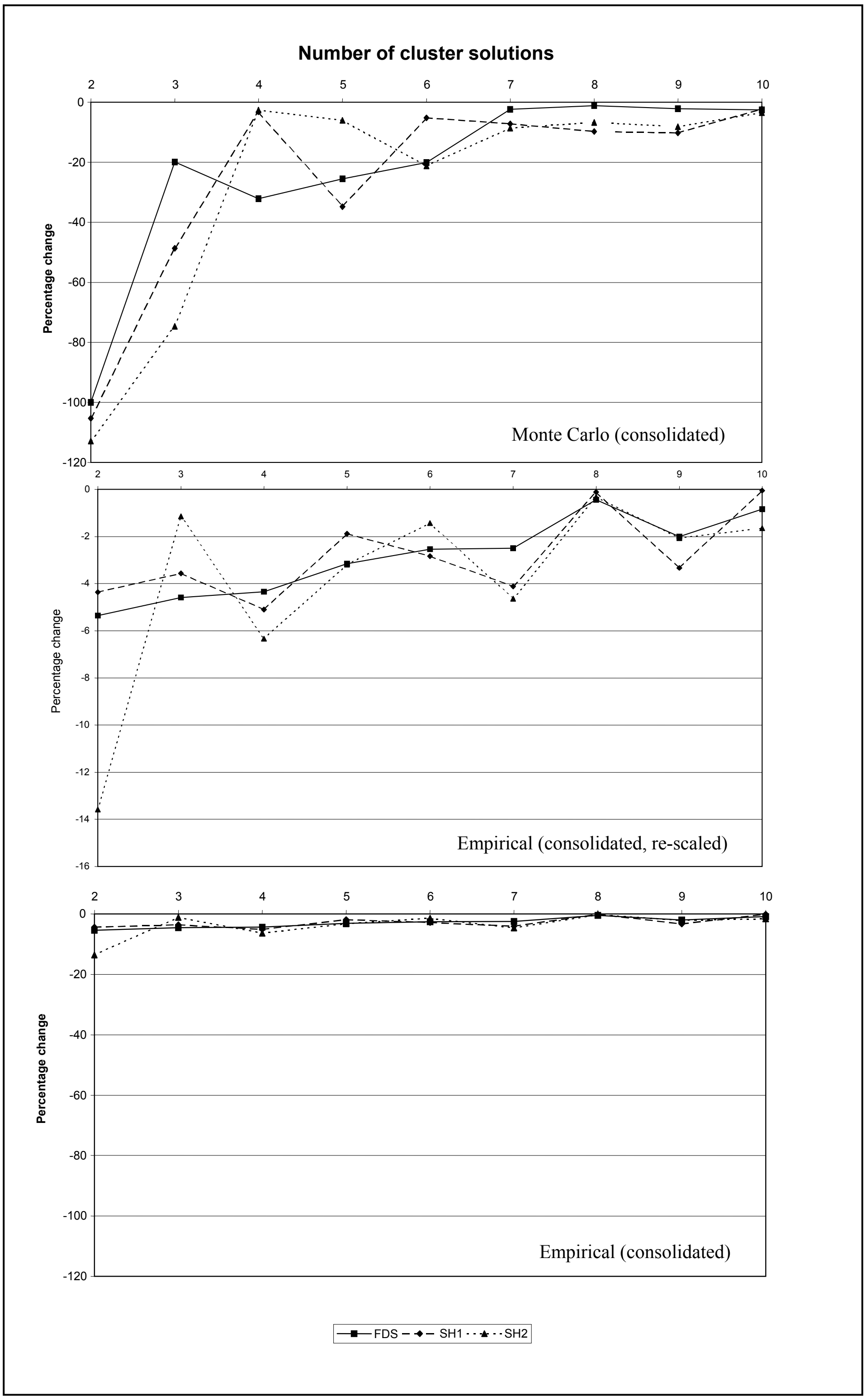

Figure 9-6: Percentage changes in agglomeration coefficient. Analysis by Pearson Correlation method of consolidated Monte Carlo and empirical data.

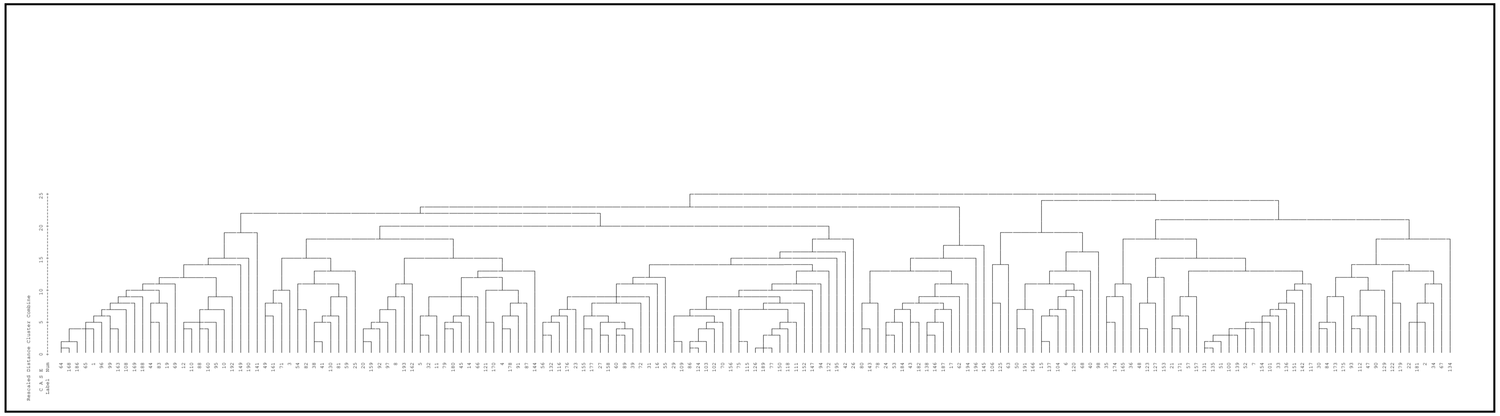

Figure 9-7: Pearson correlation dendrogram (empirical, consolidated)

Note: The dendrogram is reproduced deliberately in small scale in order to fit on a single page. It is included for the purpose of illustrating the lack of distinctness of clusters and string-like clustering only. At this stage in the analysis the item numbers that run along the x-axis are not relevant.

9.8 Preferred solution

Four different analyses have been run. Three of these are underpinned by measures of distance (dissimilarity), the fourth analysis (Pearson correlation) is underpinned by a similarity measure. Of the three distance measures one is item-focused (furthest neighbour) and the remaining two cluster-focused. All of the distance analyses suggest a 4-cluster solution, though some only very weakly. The Pearson correlation method did not strongly suggest any solution.

Whilst solutions do not indicate strong levels of structure in the data as suggested by Reger and Huff's (1993) test of constancy across different methods, several features are apparent. In each case empirical and Monte Carlo representations differ sufficiently enough to give confidence that clusters identified in the empirical data are unlikely merely to be artefacts of the statistical process. Furthermore, methods consistently suggest cluster solutions in the range from 3 to 5 which permits confidence that there is an underlying natural structure to the data.

The plots and dendrograms solutions from furthest-neighbour clustering and Pearson's correlation have been discounted due to the unbalanced string-like clusters that they have produced and indistinct cluster solutions. The two cluster-focused analyses have been demonstrated to recover the most stable solutions. Of these, Ward's method appears to have recovered the most stable solutions. At this stage either the 3- or 4-cluster solution from Ward's method would seem acceptable. As such both will be subjected to further analysis starting with K-means refinement.

K-means refinement is a non-hierarchical method of assigning items to a pre-specified number of clusters whose centroids (cluster means) are already established. K-means refinement is an iterative method, it makes repeated passes through the data each time recalculating the value of the centroid. The distance of each item from the centroid is then calculated and that item whose distance is minimal is assigned to the cluster. The method thus compensates for poor initial partitioning of the data, which may happen with hierarchical methods, and in this sense is regarded as an elegant refinement of hierarchical solutions (Aldenderfer and Blashfield, 1984).

Mindful of the advice from the previous chapter, that no cluster solution is a legitimate solution and that stability is enhanced when the same cluster solution presents itself across different methods, the author is cautious not to over-claim on the basis of the previous analysis.

9.9 Non hierarchical refinement

As commended by various authorities (Milligan, 1996; Hair et al., 1998) the preferred cluster solutions derived from hierarchical methods are subject to a process of refinement by non-hierarchical methods.

9.9.1 SPSS® procedure

Having selected the 3- and 4-cluster solutions derived from Ward's method as the preferred solutions for further analysis it was next necessary to refine the solution by running K-means analysis.

The hierarchical process was run as described above, though with additional actions:

Two hierarchical analyses using Ward's method were repeated and each made distinct from the other by the addition of a new variable (column) comprising 3- and 4-cluster solutions data respectively, and saved as separate files.

For both the 3- and 4-cluster solution files containing the newly created variable, the variable data initially used as the basis for running the hierarchical analysis is aggregated according to cluster membership. In essence this process determines the mean values of each variable for each cluster solution and generates a table such as these shown in table 9-8 and 9-9. The values in the individual cells are then used as the seed-points for the K-means clustering process. The process is as follows:

- K-means cluster analysis is run using the aggregated file to provide seed-point data:
- Select **Analyze**, **Classify**, **K-means cluster analysis**
- Select variables to be used in the analysis (these are the same 13 variables as used for the hierarchical analysis)
- Select other options required (e.g. ANOVA analysis)
- Select and open the aggregated data file
- Run K-means cluster analysis

K-means was also run with unspecified seed-points. This is a final validation technique, commended by Hair et al. (1998), to test the consistency of cluster membership across and within solutions.

		Cluster Variables												
		Nov	Dep	Dis	Risk	Idea	Adap	Uncer	Scope	Compl	AcOp	RelAdv	Profile	Observ
Cluster	1	3.89	4.29	1.65	3.16	3.67	6.46	5.21	4.13	3.79	6.35	6.31	4.6	5.61
	2	3.68	3.88	4.56	4.35	3.92	5.84	5.44	4.36	4.68	6.32	6.20	4.86	5.51
	3	3.88	4.01	2.62	3.95	3.94	5.53	4.70	3.95	3.66	5.42	5.73	3.78	3.84

Table 9-8: Initial cluster centres (seed points) 3-cluster solution

		Cluster Variables												
		Nov	Dep	Dis	Risk	Idea	Adap	Uncer	Scope	Compl	AcOp	RelAdv	Profile	Observ
Cluster	1	3.89	4.30	1.65	3.16	3.67	6.46	5.21	4.13	3.79	6.35	6.31	4.60	5.61
	2	3.68	3.88	4.56	4.35	3.92	5.84	5.44	4.36	4.68	6.32	6.20	4.86	5.51
	3	3.88	3.76	2.31	3.68	3.92	6.13	4.71	3.65	3.24	5.74	5.78	3.60	3.28
	4	3.89	4.37	3.07	4.33	3.97	4.65	4.68	4.39	4.29	4.96	5.65	4.05	4.65

Table 9-9: Initial cluster centres (seed points) 4-cluster solution

K-means refinement was run twice. For each iteration the 3- and 4-cluster solutions suggested by Ward's method for consolidated data provided the seed points. The results of the analysis were used as the basis for selecting between the 3- and 4- cluster solutions and then, for the profiling of clusters. This activity is described in the following section.

9.10 Comparison of K-Means analyses

Table 9-10 compares membership distribution for the Ward's method and two K-means solutions (one seeded, one unseeded) for a 3-cluster solution. Table 9-11 presents the same information for the 4-cluster solution. Hair et al. (1998) argue that if cluster membership is consistent across three such analyses then the solution may be considered stable. The distribution of items across clusters in table 9-10 is consistent across the clustering approaches. It is notable in table 9-11 that the K-means analysis with unspecified seed points generates a cluster with single-item membership. This suggests that the 4-cluster solution is less stable or meaningful than the 3-cluster solution.

	Cluster Number		
	1	**2**	**3**
Ward's method	62	45	64
K-Means analysis	65	55	51
K-Means analysis (unspecified seed points)	65	36	70

Table 9-10: Comparison of cluster membership for 3-cluster solution. Analysis by Ward's method and K-Means.

	Cluster Number			
	1	**2**	**3**	**4**
Ward's method	62	45	38	26
K-Means analysis	59	42	40	30
K-Means analysis (unspecified seed points)	1	43	56	71

Table 9-11: Comparison of cluster membership for 4-cluster solution. Analysis by Ward's method and K-Means.

There is no single universally agreed definition of what clusters are, though they are all united by two common themes: internal cohesion and external isolation. For example - the distance between any two points in a set is less than the distance between any point in the set and any not in it (Cormack, 1971). Cluster analysis is a technique that seeks to maximise heterogeneity between clusters and minimise homogeneity within clusters. The tightest cluster solutions will exhibit low values of within-cluster variance and high values of between-cluster variance. That is, looser clusters are distinguished by larger internal distances (within-cluster variance values) between members whilst, larger between-cluster variance values indicate greater distance between separate clusters (Harrigan, 1985). Harrigan (1985) calls the presentation of these data 'interdifference matrices' and, tables 9-12 and 9-13 present interdifference matrices for the refined 3- and 4-cluster solutions.

		Cluster Number		
		1	2	3
Cluster Number	1	1.397	3.367	3.095
	2		0.820	3.652
	3			0.978
Shaded cells = cluster tightness (within-cluster-variance) Non-shaded cells = cluster separation (between-cluster-variance)				

Table 9-12: Interdifference matrix for 3-cluster solution

		Cluster Number			
		1	2	3	4
Cluster Number	1	1.410	3.571	3.230	3.237
	2		0.891	4.417	2.943
	3			1.134	2.960
	4				0.609
Shaded cells = cluster tightness (within-cluster-variance) Non-shaded cells = cluster separation (between-cluster-variance)					

Table 9-13: Interdifference matrix for 4-cluster solution

Values for within-cluster-variance and between-cluster-variance for the 3- and 4-cluster solutions as illustrated in tables 9-12 and 9-13 are remarkably consistent with each other. Given the nature of the clustering process the expectation would be that, as the number of clusters in a solution increases, within-cluster-variance values decrease (as rules governing uniqueness are more strictly enforced). Similarly, as the number of clusters in a solution rises the value of between-cluster-variances will also rise as clusters become increasingly distinct from one another. In tables 9-12 and 9-13 the within-cluster-variances for the two proposed solutions show no significant differences one from the other. Their between-cluster-variances also are similar, with the exception of the high between-cluster-variance value that distinguishes between clusters 2 and 4 (between-cluster-variance 4.417). On the basis of the interdifference matrices it is difficult to select and justify either solution ahead of the other for further analysis and profiling. However, validation by comparison to K-means solutions by unseeded analysis (see tables 9-10 and 9-11) would suggest rejecting the 4-cluster solution in favour of the 3-cluster solution. The profiling that follows will therefore be based on the 3-cluster solution specified by refined K-means analysis of the Ward's method solution.

9.11 Cluster profiles

Cluster analysis has identified three discrete innovation types. Each type is populated by empirical instances each of which share a set of characteristics in common. The profiles of the types (and by extension members of the population) may be described in two ways. The first is according to differences in the expression of the variables that were used as a basis for the clustering. The second method is according to variables not used in the process of clustering. These two profiling techniques will be addressed in turn, first profiling according to characteristics of clusters from variable data.

9.11.1 Profiling by cluster variables

Cluster analysis has generated a cluster solution of 3 clusters. These clusters are not concepts, or constructs, or theories but remain for the moment simple empirical groupings, one containing 65 items, one containing 55 items and the final cluster containing 51 items. Each of the clusters forms a polythetic class, in that membership is based on the occurrence and value of more than one characteristic (variable).

Table 9-14 presents cluster membership by item for the preferred 3-cluster solution. Data from the interdifference matrix (table 9-12) describes cluster 2, with the lowest value within-cluster variation (0.820), as the tightest cluster. Furthermore, it is the most distinct of the three cluster solutions with a between-cluster variation of 3.367 from cluster 1 and 3.652 from cluster 3. Clusters 1 and 3 are separated by a between-cluster variation of 3.095.

	Cluster 1 (n=65)	Cluster 2 (n=55)	Cluster 3 (n=51)
Respondent identity number	1, 4, 7, 8, 10, 11, 12, 20, 27, 39, 45, 47, 51, 52, 56, 60, 64, 65, 70, 72, 75, 77, 79, 86, 88, 89, 90, 92, 93, 95, 96, 99, 100, 101, 103, 109, 110, 115, 116, 118, 121, 124, 126, 131, 132, 135, 136, 139, 150, 151, 152, 154, 155, 157, 159, 160, 163, 168, 170, 171, 177, 178, 181, 186, 189.	2, 3, 6, 15, 21, 22, 30, 34, 35, 36, 40, 44, 48, 49, 50, 55, 57, 59, 66, 67, 68, 69, 71, 84, 87, 91, 97, 98, 104, 106, 108, 111, 120, 122, 123, 125, 127, 129, 134, 137, 143, 153, 161, 165, 166, 169, 173, 174, 175, 179, 188, 190, 191, 195, 196.	5, 14, 16, 17, 19, 23, 24, 25, 26, 29, 31, 32, 33, 38, 41, 42, 43, 53, 54, 62, 63, 78, 80, 81, 82, 83, 94, 102, 112, 117, 130, 138, 141, 142, 144, 145, 146, 147, 149, 156, 158, 162, 172, 176, 180, 182, 184, 187, 192, 193, 194.

Table 9-14: Cluster membership, 3-cluster solution

Figure 9-8 is a graphical representation of the data in table 9-15. Inspection of both immediately reveals that none of the clusters can be differentiated from the others by dint of all high or all low values, rather they differ on the basis of high or low values on individual variables. That is, some variables are more responsible for differentiating between clusters than others (these are the shaded cells in table 9-15). Scope, departure, ideation and novelty were demonstrated not to be significant as a basis for distinguishing between clusters and so are discounted from the following description of the three clusters.

	Cluster 1 (n=65)	Cluster 2 (n=55)	Cluster 3 (n=51)	Grand Mean (n=171)
Novelty	3.935	3.695	3.847	3.826
Departure	4.290	3.955	3.939	4.062
Disruption	1.744	4.479	2.262	2.828
Risk	3.157	4.495	3.761	3.804
Ideation	3.658	3.945	3.949	3.851
Adaptability	6.385	5.718	5.647	5.917
Uncertainty	5.228	5.327	4.620	5.058
Scope	4.127	4.441	3.775	4.114
Complexity	3.662	4.704	3.596	3.987
Actual Operation	6.354	6.100	5.422	5.958
Relative Advantage	6.285	6.182	5.647	6.038
Profile	4.762	4.623	3.574	4.319
Observability	5.677	5.400	3.441	4.839
See text for explanation of shaded cells (those which differentiate the types)				

Table 9-15: Final cluster centres for 3-cluster solution (after K-Means refinement)

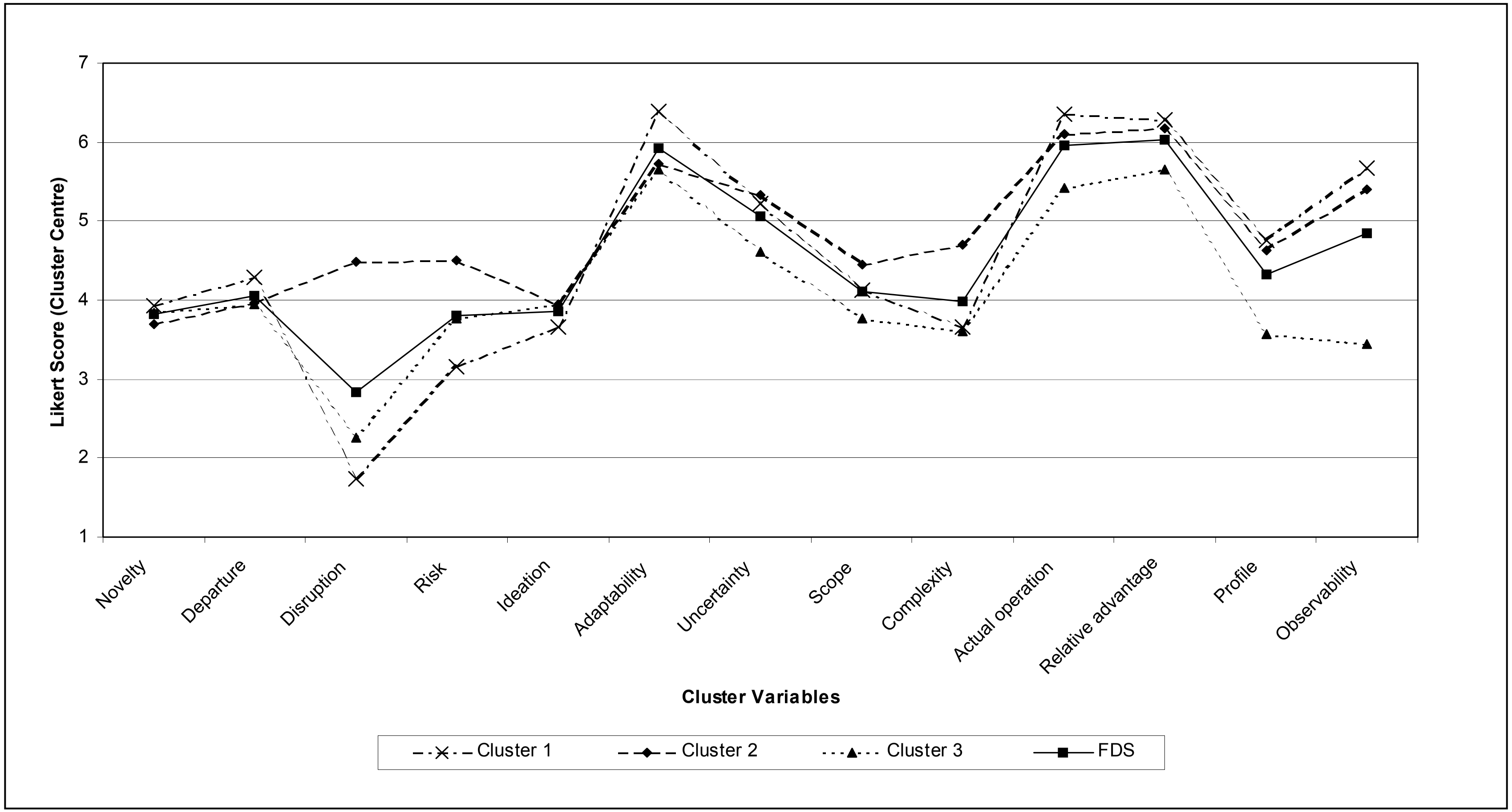

Figure 9-8: Cluster profiles by variable means

This is confirmed by the 'f-ratio' statistic (see table 9-16). With larger values for the f-ratio indicating greater importance of that variable as a discriminating factor between variables. 'Disruption' and 'observability' are the most significant differentiating variables with f-ratios of 135.089 and 65.438 respectively. The variables 'profile', 'actual operation', 'uncertainty', 'risk', 'adaptability' and 'complexity' each have f-ratios greater than 10 and can, too, be considered as significant in differentiating between clusters. The variables 'scope', 'relative advantage', 'departure', 'ideation' and 'novelty' are not seen as significant in differentiating between clusters given their relatively low f-ratios. It is interesting to note that the variable 'novelty' has the lowest f-ratio in table 9-16.

	Cluster Mean Square	df	Error Mean Square	Df	F	Sig.
Disruption	121.152	2	0.896	168	135.089	0.000
Observability	80.722	2	1.233	168	65.438	0.000
Profile	22.910	2	1.129	168	20.276	0.000
Risk	26.653	2	1.339	168	19.895	0.000
Uncertainty	7.795	2	0.489	168	15.931	0.000
Complexity	21.443	2	1.387	168	15.460	0.000
Actual operation	12.873	2	0.861	168	14.941	0.000
Adaptability	9.956	2	0.913	168	10.903	0.000
Scope	5.876	2	0.622	168	9.443	0.000
Relative advantage	6.395	2	0.769	168	8.3093	0.000
Departure	2.373	2	0.578	168	4.106	0.020
Ideation	1.679	2	0.564	168	2.977	0.053
Novelty	0.872	2	0.672	168	1.295	0.276

Table 9-16: ANOVA analysis, 3-cluster solution

Based on the data in tables 9-14 and 9-15, and figure 9-8, the three clusters can be described as follows:

Cluster 1 is characterised by relatively high values for 'adaptability', 'actual operation', and 'observability' (and marginally higher values for 'novelty', 'departure', 'profile' and 'relative advantage'), and relatively low values for 'risk' and 'disruption'.

Cluster 2 is characterised by relatively high values for 'risk', 'disruption', 'scope', 'complexity' and, marginally, 'uncertainty'. Cluster 2 innovations also have relatively low values for 'novelty'.

Cluster 3 is characterised by relatively low values for 'uncertainty', 'scope', 'actual operation', 'relative advantage', 'profile' and 'observability'.

9.11.2 Profiling by non-cluster (independent) variables

The final profiling task is to describe the clusters in terms of variables not included in the clustering procedure. The basis of this profiling is four further variables: innovation area of focus, item source, clinical type and functional type. Two further variables, five and six, based on conceptualisations of novelty are extracted from the framework. Novelty is a theoretically-based variable commonly used as a measure of innovation in a variety of studies.

The basis for the four non-clustering variables is as follows:

Innovation area of focus: The sample (n=171) was divided amongst four categories: technical, administrative/process, product/service and hybrid[14] innovations (see Chapter four, table 4-4).

Item source: The items in the sample were drawn from five different sources. Arguably each of these sources has unique characteristics. 'Hospital Doctor' and 'Doctor' magazines cater for discrete readerships in secondary and primary care. The 'British Journal of Renal Medicine' has a clinical specialist readership whereas the 'British Association of Medical Managers' (BAMM) has a focus on health management and the role of clinicians in health care management. Finally, the 'British Medical Association' (BMA) publication *Pioneers in patient care: consultants leading change* (BMA, 2001) profiles the work of medical consultants. Given the different focuses of each of these sources, it might be argued that items originating from each might share certain characteristics in common. However, the boundaries between the constituencies that each of these sources serve are grey. Some innovators have submitted applications to more than one of the sources and so the results must be interpreted with caution.

Clinical type: the distinction between primary and secondary care is one of the most fundamental in health care provision in the UK. Items from the sample were categorised as primary, secondary or, in boundary-spanning cases, hybrid.

Functional type: the final categorisation derives from the functional application of the innovations construed in the context of health care delivery. The 171 usable returns were synthesised into a list of eight functional types of innovation, these are described below in table 9-17.

Device	Physical medical apparatus or device introduced to effect a specific purpose. N=9
Facility	The establishment of a unit for the delivery of care regimen to niche users. Might be bricks and mortar or the reallocation of resources to form an integrated approach. Includes improved pathway management. N=54
Appeal	Fundraising and profile raising, communication to patients. N=5
Cyber-Medicine	Provision of remote healthcare support and consultation facilitated by the use of ICT. N=6
Clinic	Establishing a clinic dedicated to a defined condition. N=46
Nurse-led	Delegation of aspects of clinical responsibilities to empowered nurses. N=11
Education / training	Training for staff and for patients. N=19
Treatment	A treatment previously unavailable in the local context. N=21

Table 9-17: Innovation functional types

[14] The category hybrid was developed to accommodate those innovations that had blurred boundaries.

Novelty: the fifth and sixth variables employed were conceptualisations of novelty. Both were derived from aggregating and averaging responses to the survey instrument statements. Firstly, novelty is construed narrowly, simply in terms magnitude of change represented by the innovation. Variable values for this conceptualisation are derived from items 1.1 to 1.5 of the survey instrument. The sixth variable is a broader conceptualisation of newness comprising the dimensions novelty, disruption, departure and risk. Variable values for this broad conceptualisation are drawn from the items attached to statement groups 1, 2, 3 and 4 in the survey instrument. The response possibilities on the Likert scale range from 1 (strongly disagree) to 7 (strongly agree). Dividing the range of possible responses into three equal sets generates three possible degrees of novelty. Thus responses that fall into the 1.0 to 2.3 range are categorised as low, from 2.4 to 4.7 as medium and from 4.8 to 7.0 as high.

A chi-squared test was run on data from variables not used for clustering in order to ascertain the significance of association between the non-clustering variables and cluster membership. The chi-squared test is mainly used to investigate whether proportions of certain categories are different in different groups. The chi-squared test compares the extent to which observed values differ from expected values, and is a 'measure of association' (Norman and Streiner, 2000). The results of this test are detailed in tables 9-18 to 9-23, below.

9.12 Results and discussion

In this section the results of the cluster analysis and profiling are discussed.

Innovation area of focus: The chi-square value for the association between 'Innovation area of focus' and 'Cluster Membership' was obtained as 2.303 with 6 degrees of freedom and a significance probability of 0.889 (not significant). On the basis of this data there would appear not to be an association between 'Innovation area of focus' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. None of the clusters appear to have a distinctive profile based on the distribution of innovation types. Cluster 3, though, contains fewer product/service innovations than do clusters 1 and 2, and cluster 2 relatively fewer administrative/process innovations than clusters 1 and 3.

Variable	**Cluster Membership**						**N=**	**Chi-Square**	**Sig.**
	1		**2**		**3**				
Innovation type									
Technical	**14**		**11**		**12**		37		
	21	*39*	*20*	*28*	*24*	*32*			
Administrative/process	**25**		**18**		**22**		65		
	38	*38*	*33*	*28*	*43*	*51*			
Product/service	**25**		**25**		**16**		66		
	38	*38*	*45*	*38*	*31*	*24*			
Hybrid	**1**		**1**		**1**		3		
	2	*33*	*2*	*33*	*2*	*33*			
N=	65		55		51		171	**2.303**	**0.889**
(numerals in *italics* are percentages, vertical and horizontal)									

Table 9-18: Chi squared test, association between cluster membership and innovation area of focus.

Source: The chi-square value for the association between 'Source' and 'Cluster Membership' was obtained as 12.307 with 8 degrees of freedom and a significance probability of 0.138 (not significant). On the basis of this data there would appear not to be an association between 'Source' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. Notwithstanding the caveat made above, and although no strikingly distinctive profiles are evident, some features do emerge. Clusters 1 and 3 can be characterised as drawing relatively low proportions (16% each) of the total BAMM population and relatively high proportions (46% and 32% respectively) of the BMA population. Conversely, cluster 2 can be characterised as drawing a relatively high proportion (66%) of the total BAMM population and relatively low proportion (21%) of the BMA population. Cluster 2 is further differentiated from clusters 1 and 3 by the relatively low proportion (25%) originating from 'Doctor' magazine.

Variable	**Cluster Membership**						**N=**	**Chi-Square**	**Sig.**
	1		**2**		**3**				
Source									
BAMM	**2**		**8**		**4**		12		
	3	*17*	*15*	*66*	*4*	*17*			
BJRM	**1**		**1**		**1**		3		
	2	*33*	*2*	*33*	*2*	*33*			
BMA	**22**		**10**		**15**		47		
	39	*47*	*18*	*21*	*29*	*32*			
Hospital Doctor	**31**		**27**		**20**		78		
	48	*40*	*49*	*35*	*39*	*26*			
Doctor	**9**		**9**		**13**		31	**12.307**	**0.138**
	13	*29*	*16*	*29*	*25*	*42*			
N=	65		55		51		171		
(figures in *italics* are %ages vertically and horizontally)									

Table 9-19: Chi squared test, association between cluster membership and source.

Clinical type: The chi-square value for the association between 'Clinical type' and 'Cluster Membership' was obtained as 4.973 with 4 degrees of freedom and a significance probability of 0.290 (not significant). On the basis of this data there would appear not to be an association between 'Clinical type' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. No distinctive profiles emerge. However, a high proportion (55%) of primary care innovations are found in cluster 1.

Variable	Cluster Membership						N=	Chi-Square	Sig.
	1		2		3				
Clinical type									
Primary care	**16**		**6**		**7**		29		
	25	*55*	*11*	*21*	*14*	*24*			
Secondary care	**45**		**43**		**39**		127		
	69	*35*	*78*	*34*	*76*	*31*			
Cross-boundary hybrid	**4**		**6**		**5**		15	**4.973**	**0.290**
	6	*27*	*11*	*40*	*10*	*33*			
N=	65		55		51		171		
(figures in *italics* are %ages vertically and horizontally)									

Table 9-20: Chi squared test, association between cluster membership and clinical type.

Functional type: The chi-square value for the association between 'Functional type' and 'Cluster Membership' was obtained as 14.216 with 14 degrees of freedom and a significance probability of 0.433 (not significant). On the basis of this data there would appear not to be an association between 'Functional type' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. No distinctive profiles emerge. However, cluster 1 contains 46% of facility innovations, cluster 2 23% of clinic innovations and cluster 3, 63% of nurse-led innovations.

Variable	Cluster Membership						N=	Chi-Square	Sig.
	1		2		3				
Function									
Device	**2**		**4**		**3**		9		
	3	*22*	*7*	*44*	*6*	*34*			
Facility	**25**		**17**		**12**		54		
	38	*46*	*31*	*32*	*24*	*22*			
Appeal	**1**		**2**		**2**		5		
	2	*20*	*2*	*40*	*4*	*40*			
Cyber-medicine	**2**		**3**		**1**		6		
	3	*33*	*5*	*50*	*2*	*17*			
Clinic	**19**		**11**		**16**		46		
	29	*41*	*20*	*24*	*31*	*35*			
Nurse-led	**1**		**3**		**7**		11		
	2	*9*	*5*	*27*	*14*	*64*			
Education / training	**6**		**8**		**5**		19		
	9	*32*	*15*	*42*	*10*	*26*			
Treatment	**9**		**7**		**5**		21	**14.216**	**0.433**
	13	*43*	*13*	*33*	*10*	*24*			
N=	65		55		51		171		
(figures in *italics* are %ages vertically and horizontally)									

Table 9-21: Chi squared test, association between cluster membership and functional type.

Novelty: The chi-square value for the association between 'Novelty' and 'Cluster Membership' was obtained as 3.788 with 4 degrees of freedom and a significance probability of 0.435 (not significant). On the basis of this data there would appear not to be an association between 'Novelty' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. No distinctive profiles emerge.

Variable	Cluster Membership 1	Cluster Membership 2	Cluster Membership 3	N=	Chi-Square	Sig.
Novelty (narrow)						
High (4.8 - 7)	**7** (*11* / *41*)	**3** (*5* / *18*)	**7** (*14* / *41*)	17		
Medium (2.4 – 4.7)	**57** (*88* / *39*)	**50** (*91* / *34*)	**41** (*80* / *28*)	148		
Low (1- 2.3)	**1** (*1* / *17*)	**2** (*4* / *33*)	**3** (*6* / *50*)	6	**3.788**	**0.435**
N=	65	55	51	171		
(figures in *italics* are %ages vertically and horizontally)						

Table 9-22: Chi squared test, association between cluster membership and novelty.

Newness: The chi-square value for the association between 'Newness' and 'Cluster Membership 'was obtained as 12.313 with 4 degrees of freedom and a significance probability of 0.015 (significant). On the basis of this data there would appear to be an association between 'Newness' and 'Cluster Membership' in the population from which this sample of 171 respondents was drawn. However, 6 of the 9 cells on which the chi-squared analysis is based have an expected frequency of less than 5 thereby jeopardising the reliability of the test. The most striking observation is that all those innovations ranked as high in terms of a broad conceptualisation are found in cluster 2.

Variable	Cluster Membership 1	Cluster Membership 2	Cluster Membership 3	N=	Chi-Square	Sig.
Newness (4 dimensions)						
High (4.8 - 7)	**0** (*0* / *0*)	**5** (*9* / *100*)	**0** (*0* / *0*)	5		
Medium (2.4 – 4.7)	**63** (*97* / *39*)	**49** (*89* / *40*)	**51** (*100* / *31*)	163		
Low (1- 2.3)	**2** (*3* / *67*)	**1** (*2* / *33*)	**0** (*0* / *0*)	3	**12.313**	**0.015**
N=	65	55	51	171		
(figures in *italics* are %ages vertically and horizontally)						

Table 9-23: Chi squared test, association between cluster membership and newness.

This analysis would suggest that there is no pattern of relationship between alternative approaches to classification of innovation ('Innovation area of focus', 'source', 'clinical type', 'functional area' or 'novelty') and classification based on attributes. There is a weak suggestion that a relationship might exist between classification based on attributes and a wider conceptualisation of newness.

There are two caveats on this last point. First, the relatively large number of low value (<5) cells weakens the statistical process. Second, some relationship might be expected as the values on which chi-squared testing have been drawn from four of the 13 statement groups that form the survey instrument and on which cluster analysis was based.

Cluster variables		**Non cluster variables**
High	Low	
Adaptability Actual operation Observability	Risk Disruption	High proportion of primary care (55%) and facility (46%) innovations. Low proportion of members originating from BAMM evident in the cluster (17%), but accounts for a high proportion of members originating from BMA (47%). Relatively even distribution of innovation type within the cluster. Only 1 of 11 nurse-led innovations is found in this cluster.

Table 9-24: Overview of type 1 innovations

Cluster variables		**Non cluster variables**
High	Low	
Risk Disruption Scope Complexity	Novelty (marginal)	Contains the highest proportion of members originating from BAMM (66%) and lowest (21%) from BMA. Relatively high proportion (40%) of hybrid clinical type. A high proportion of the following functional innovations are found in cluster 2 devices (44%), cyber-medicine (50%) and education/training 42%. However, has only a small proportion of clinic innovations (24%). Where newness is conceptualised broadly, in terms of 4 dimensions, all high scoring innovations are found in cluster 2, consistent with the attributes in the adjoining columns.

Table 9-25: Overview of type 2 innovations

Cluster variables		**Non cluster variables**
High	Low	
-	Uncertainty Scope Actual operation Relative advantage Profile Observability	Cluster 3 appears to occupy a middle ground between clusters 1 and 2 and has few distinguishing characteristics based on non-cluster variables. Innovations in this cluster are mostly administrative/process innovations and account for the largest proportion originating from Doctor magazine. Cluster 3 accounts for 64% of all nurse-led innovations and 50% of those innovations characterised as low novelty according to the narrow conceptualisation.

Table 9-26: Overview of type 3 innovations

The absence of strong relationships would suggest that the innovation framework operationalised in its current form describes innovation in a different way from previous approaches. As a means of classification a framework based on attributes generates a taxonomy constituted differently from more conventional approaches. Ketchen and Shook (1996) argue that emergent clusters should be examined for their degree of concurrence with theory-based typologies in order to provide evidence of a cluster-solution's descriptive validity. By this measure the descriptive validity of the 3-cluster solution would be low. It neither supports nor is supported by existing typological approaches.

It does, however, indicate that the taxonomy that has been produced based on configurations of attributes presents a series of categories the contents of which differ from extant classifications. This research is underpinned by the argument that existing approaches are under-specified and so it is to be expected that the results of the cluster analysis will not be congruent with existing typologies. The attribute-based approach has generated an alternative taxonomy of innovation. To that extent this part of the research has achieved a useful result in the context of its underpinning research questions. The effect is that a classification based on attributes provides an alternate perspective in thinking about innovations.

The innovations under examination in this study are conferred with attributes by innovators to the extent that three discrete types of innovation, differentiated by configurations of the presence, absence or value of the attributes, appear to exist. Although the analysis has shown that 'departure', 'ideation' and 'novelty' were not significant in this study, that is not to suggest that as factors they should be discounted in future studies. Indeed Phase I of this research established that they are attributes held by innovators, and this is supported by a long history of published research (particularly in support of 'novelty').

9.13 Summary

A sample of 171 innovations in the UK NHS, drawn from five different sources, was subjected to a range of cluster analysis procedures. Innovations were clustered according to configurations of attributes as specified in the framework. Specifically cluster analysis has made possible the inclusion of multiple variables as sources of configuration definition (Ketchen and Shook, 1996) and permitted a holistic conceptualisation of innovation artefact.

Of the clustering procedures employed Ward's method was shown to best satisfy the criteria laid down in Chapter eight for selecting cluster solutions and to provide the most stable and valid cluster solutions. Two cluster solutions, a 3-cluster solution and 4-cluster solution derived from Ward's method, were then subject to non-hierarchical refinement in order to select the optimum solution. From this analysis a 3-cluster solution, based on innovators' perceptions of their innovations, was selected as the preferred solution.

The 3-cluster solution was then characterised in terms of variables used as a basis for cluster analysis and, also, in terms of a second set of variables not used as a basis for cluster analysis. Profiling according to variables not used as a basis for cluster analysis is important in assessing both the practical significance and theoretical basis of the cluster solution (Hair et al., 1998). By profiling by non-cluster variables two things have been demonstrated. First, that an approach based on the perceived attributes of innovation recovers clusters with internal configurations of members that differ from those which may be generated by the conventional approaches to innovation typologising, namely by area of focus and novelty. Second, non-cluster variable profiling has demonstrated a weak relationship between a theoretically broad construct of novelty and the 3-cluster solution.

In sum, innovation attributes provide an alternative framework for describing the properties of innovations in this particular sample. Meyer et al. (1997) argue that it is not enough to study the attributes of only one innovation within an organisation. There is a need to look at the nature of contrasting innovations in the context of the larger organisation to understand the extent and nature of innovation within that organisation. That is, we need knowledge about the fit between organisational processes of innovation and, members' perceptions of innovations in order to advance theory and begin to understand the sorts of management environments in which innovations are initiated and implemented. The following chapter explores briefly some of the process characteristics associated with exemplars drawn from each of the three clusters.

10 PHASE III, THE TAXONOMY IN THE CONTEXT OF INNOVATION PROCESS

10.1 Section 1 - Introduction

A case has been made for the conceptualisation of innovation based on attributes described by innovators' and users' perceptions. A framework composed of 13 discrete factors has been devised as a measure of these attributes and operationalised in a 56-item survey instrument. Following the application of the instrument to a sample of 310 innovations in the NHS and investigation by cluster analysis, three distinct clusters or types of innovation (type 1, type 2 and type 3) have been identified.

It has been argued that the merit of any classification scheme is in its utility, in its contribution to help better understand a phenomenon, explain it or predict future behaviour (Everitt and Dunn, 2001). This chapter, in two sections, assesses the utility of the taxonomy in the context of an exploration of innovation processes. Innovation processes are chosen as the context for this exploration because, as the following review demonstrates, previous research has uncovered relationships between aspects of process and innovation outcomes. In the first section and, on the basis of a review of the literature and corroborating evidence from Phase I of this study, three perspectives of process are considered. First, process as a series of events that occur in more or less discrete, linear sequences. Second the individual activities of process. Third, process within the context of climate or enabling conditions. These three perspectives form the basis of a theoretical framework for the investigation of a sample of innovations drawn from each of the three types of the taxonomy.

The second section of this chapter describes the data, analysis and results for Phase III. A study of process characteristics amongst a sample of innovations drawn from each of the clusters is evaluated and the chapter concludes with a discussion of process in the context of the new taxonomy. Again, the exploratory nature of the research drives the enquiry. The objective of this chapter is to seek new insights into the innovation process by regarding it through the lens of the new taxonomy.

10.2 Process Research

Increasingly it has become the generally accepted position that innovation is not simply the serendipitous happenstance of the conjunction of new ideas and customer needs. It is, instead, regarded as a process that can be managed and improved, made better in terms of its effectiveness and efficiency. Studies of the success of innovations therefore tend to assume some sort of relationship between the process of innovation and the degree of successful outcome. These studies are notable by their focus on the presence or absence of process activities.

Several major research studies have been undertaken to explore process factors associated with success: Project SAPPHO (Rothwell et al. 1974; Rothwell, 1974; Rothwell, 1985), project NewProd (Cooper, 1979b; Cooper, 1980; Cooper, 1986; Cooper and Kleinschmidt, 1987a; Cooper and Kleinschmidt, 1987b) and the Project Development Management Association studies on new product development practices

(Griffin and Page, 1996; Griffin, 1997b). There have also been numerous other studies that replicate or confirm much of this previous work (for example Maidique and Zirger, 1984; Balachandra and Friar, 1997; Lynn and Akgün, 2001; Danneels and Kleinschmidt, 2001; Storey and Easingwood, 1998; de Brentani and Ragot, 1996; Loch et al., 1996). There is broad agreement across these studies with regards to the correlates of success. Innovators must understand user needs, pay attention to market factors, make use of external advice and technology, use technology and scientific advice that is connected to experience, be efficient in development work and, assign senior individuals with authority.

Chapter three describes two distinct perspectives on innovation process, the activity perspective (which sub-divides to studies of individual, discrete activities, such as idea generation and, holistic studies of the whole process as a sequence of activities) and enabling conditions. Processes, at the most fundamental level, can be thought of as that collection of tasks or activities which, together, and only together, transform inputs into outputs (Garvin, 1993). Lofland and Lofland (1995) describe process as a time-ordered sequence of steps or phases, a set of discrete, linear events. However, while individual, sequential events might be recognisable, in and of themselves, they are incomplete as process theories. To be considered as process theories, lists of activities must be supplemented by detailed description of the interaction of activities. Further, process theories obtain their fullest meaning when the richness of the process is captured and the range of interlinked activities and reciprocal impacts felt throughout the group are elucidated (Garvin, 1993).

This is a view of process as a series of activities that take place in the context of an enabling environment, one which Pentland (1995) illustrates with the metaphor of grammar. While individual actions ('words' in the metaphor) can be recognised and have meaning in and of themselves, they give only the vaguest of clues to the outcome of their aggregation (the sentence). It is in the aggregation of the actions (words) into a unitary phenomenon (the sentence) that their sum, enabled and constrained by the environment (syntax), come to deliver a particular outcome (meaning) not evident from analysis of individual actions (words) in and of themselves.

The metaphor is illuminating. There are three ways in which meaning can be derived from actions and events (words in the grammar metaphor). The first is by the inherent meaning of each activity (word). Second, by the aggregation of activities into processes (the sentence). Third, by understanding activities and processes in terms of their context (the syntax employed to construct the sentence).

Extending the metaphor into the study of innovation process it could be argued that individual actions and events aggregate to compose the core process of innovating, activities central to the process of innovating. These activities and events can be understood to take place within the context of an enabling or constraining environment. Phase I of this research, in which data were also collected on teams' processes (see Appendix four), confirmed the duality of activity and enabling climate, see table 10-1.

Perspective	Category	Factor
Activity	Triggers	Serendipity Critical moments Conjunctions Opportunism Problem recognition
	Idea management	Information gathering Sifting Integration/combination Selection, Proliferation
	Process formality	Degree of planning Existing process Sequence of events
	Testing	Piloting
	Implementation	Launch Foisted implementation
Enabling conditions	Managerial commitment	Top management support Resource availability
	Group factors	Visions and guiding principles Champions and leadership Safety Challenge the orthodoxy Innovators tolerated/supported Making space Risk taking Empowerment/autonomy Tolerance of uncertainty Mutual support Peer group credibility

Table 10-1: Process factors uncovered in Phase I

The notion of duality also finds support in the literature, not least of all Chiesa et al.'s (1996) technical innovation audit that discriminates between core and enabling processes. Other authors make similar distinctions, some taking an holistic approach, others disaggregating to studies of enabling climate, activity sequencing or individual activities. Rothwell (1992) describes five generations of perspectives on process (see table 10-2). Implicit within the later models is the notion of enabling conditions, in which factors such as collaboration, flexibility, integration and speed are increasingly emphasised.

Rothwell's (1992) review moves, across the decades, from 'first generation' linear and sequential technological push and needs-pull models to third, fourth and fifth generation integrated and networked models of innovation process. Technological-push and need-pull models, are essentially simple linear, sequential models with an emphasis respectively on research and development push or the market as a source of ideas. The third generation 'coupling model' reflects a view of process as being more interactive, characterised by feedback loops and push/pull combinations. The fourth generation marks a shift in thinking about innovation in strictly sequential terms to one in which process is conceived as a parallel phenomenon where activities may occur simultaneously. Schroeder et al.'s (1989) model, for example (see figure 10-1), can be thought of as representative of this transitional phase in thinking about innovation process. Rothwell (1992; 236) describes his fifth generation model as a "*somewhat idealised model of the integrated (fourth generation) model*" in which innovators develop strategic integration in the form of inter company collaborations. The corollary of this increasingly complex

First generation: *Technology push:* Simple linear sequential process, emphasis on research and development. The market is the passive receiver of fruits of research and development **Second generation:** *Need-pull:* Simple linear sequential process, emphasis on marketing. Research and development is reactive. **Third generation:** *Coupling model:* sequential but with feedback loops, research and development and marketing more in balance. Integration at the research and development and marketing interface. **Fourth generation:** *Integrated model:* Parallel development with integrated development teams. Strong upstream supplier linkages. Close coupling with leading edge customers. Emphasis on integration between research and development and manufacturing. **Fifth generation:** *Systems integration and networking models:* Fully integrated parallel development, strong linkages with leading edge customers, strategic integration with primary suppliers including co-development of new products. Horizontal linkages: joint ventures; collaborative research groupings; collaborative marketing arrangements. Emphasis on flexibility and speed of development.

Table 10-2: Five generations of innovation process (Source: Rothwell, 1992)

innovation process is that managing innovation is a conspicuously exacting task and that organisations need to be flexible and adaptable, in short *innovation friendly* if they are to succeed in enabling the processes of innovation to take place productively (Rothwell, 1992).

Whatever the actual sequence of events and the degree of feed-back and feed-forward cycles, it is clear that the path from initiation to implementation presents both managerial and research problems. Indeed, it is difficult to prescribe normatively a single set of activities or the order in which they occur as necessary in the fulfilment of the innovation process. The extent to which Rothwell's five generations reflect the actuality of process in both its temporal context and complexity, or is merely an artefact of the methodological approaches contemporaneous with each generational type, is unclear. Nevertheless, it is a useful map of the different perspectives of process.

Early research sought to establish the individual activities that comprise the innovation process and the order in which the activities appeared to occur, which would explain the linear simplicity of Rothwell's (1992) first and second generation models. Figure 10-1 summarises 50 years' of this research activity. Wolfe (1994) populated a similar map with seven 'stages models', figure 10-1 incorporates and extends this original work. This presents the models of process in a linear fashion, but it would be incorrect to assume that innovation process is as neat as the table might imply. It is clear from table 10-2 and figure 10-1that innovation processes may occur differently across innovating groups and that in the process of innovation multiple factors interact. The level and complexity of that interaction differs across cases (King, 1992), so not all innovators manifest a process that is identifiable as a fifth generation process. It is not inconceivable for some innovation to occur in a first generation fashion.

Three things are apparent from the tables: first, that process research has attracted considerable interest over the last five decades. Second, process is conceptualised in terms of two high level categories, innovation initiation and innovation implementation, for which Zaltman et al. (1973) are generally credited. Third, there would appear to be a high degree of consensus over the constituent parts, the discrete, individual activities that need to take place, of the innovation process. Further, these activities are variously labelled throughout the literature but several generic process models have been described.

In the first section of this chapter three process perspectives are reviewed, event sequences, process activities and enabling climate. Event sequences are divided into three sub-types: linear, recursive and chaotic. Linear models are characterised by their sequential nature and have been demonstrated to best describe less radical or complex innovations. Recursive models are discussed and demonstrated to display apparently random characteristics in which activity is multiple, concurrent, and divergent in which the process includes feed back and feed forward loops. Finally, chaotic models are introduced. Empirically these are reckoned to be hard to identify.

Clearly the process of innovation is a complex affair and, as figure 10-1 attests, consists of many activities. There would appear, however, to be relatively high level of consensus about the core process activities and, for the purposes of this study a simplified generic model of process activities is preferred. As the basis for the analysis of process activities a modified version of Avlonitis et al.'s (2001) generic process is used. It is preferred for this research for two reasons. First, in the absence of a model specific to the NHS a generic model is preferred to one that is oriented toward manufacturing industry. This model is less overtly product-oriented and techno-centric. Second, the model consists of four broadly defined categories idea generation and screening, business analysis, technical development and testing and, innovation launch. In terms of the objectives of Phase III, a broad exploration of the utility of the innovation taxonomy by its application in the context of innovation process, four activities were considered to be a manageable research proposition. Clearly, a generic model consisting of only four activities is a broad conceptualisation and may not be sensitive to idiosyncrasies of innovation processes in the health or service sector. There is, therefore, a trade-off between sensitivity of the model and research manageability which may limit the extent to which conclusions can be drawn from the study.

Finally, the first section reviews the literature with regard to enabling climate which is held to consist of management commitment and group factors. Climate is generally regarded as playing the part of an intervening variable which affects the results of the operations of the innovators (Cebon and Newton, 1999). Climates are socially constructed and change over time as the patterns of interactions amongst members change (Fahey and Prusak, 1998). It is the proximal work group that represents the primary medium through which shared climates will evolve through active social interaction and ultimately become embedded in the fabric of the group (Mir and

Watson, 2001). However, senior management set the conditions within which climate develops (West and Anderson, 1996) and need to accept the need for change in order that innovation may be facilitated (Johne and Snelson, 1988a).

These three perspectives form the basis for the investigation and analysis of the innovation processes underpinning the innovation types identified in Phase II.

10.3 Event sequence models

10.3.1 Linear

Innovation is clearly regarded as a temporal phenomenon in that it takes place over time. Early process models (for example Zaltman et al., 1973) strongly imply a sense of linearity to the events and activities that together make the process. That is, not only cannot event B happen until after event A has happened, but all events take place in a sequential, orderly, linear fashion.

Linear models tend to be built on the premise of the two high-level processes underpinning innovation. Firstly, 'initiation', this refers to those activities relating to issue identification and specification, information gathering, attitude formation and evaluation, resource attainment, and finally leading to a decision to adopt or reject the innovation. This may be an individual undertaking at first but gradually or rapidly becomes a multi-party activity as initiation develops and moves to the second stage, implementation (Damanpour, 1996). During implementation all events and actions pertaining to modification of both the innovation and the organisation occur, until the innovation becomes a routine feature of the organisation.

Zaltman et al. (1973) are generally credited with introducing the initiation/implementation concept. These they call the major stages of the innovation process. In their model initiation is composed of three sub-stages (knowledge awareness, formation of attitudes and decision), the latter of two sub-stages (initial and then continued/sustained innovation). The major stages therefore are seen to consist of sets of temporally-linked, sequential, reciprocal, dependent phases or events. From this rather generic model of the innovation process other studies have developed variants reflecting context specific factors.

The earliest process research tended to focus on the implementation (adoption and diffusion) of innovations and paid scant regard to the processes of creativity or invention. Innovation and invention and creativity were kept separate, the assumption being that innovations were largely 'imported' into an organisation. Little attention was paid to the emergence of novelty or generative processes by which social units initiated and then implemented 'home-grown' innovations. The first phase of Rogers and Shoemaker's (1971; 100) 4-phase model, for example, is 'awareness' which they describe as "*The individual learns of the existence of the new idea but lacks information about it*". The assumption here is clear, that they are considering only those innovations that are imported into the social unit.

	Initiation activities – Commencing with problem or opportunity awareness														Implementation activities - Culminates with widespread continued use
Usher, 1954	Perception of the problem	Setting the stage	Act of insight	Critical revision											
Wilson, 1966	Conception of the change	Proposing the change	Adoption and implementation												
Hage and Aiken, 1967	Evaluation	Initiation	Implementation	Routinisation											
Shepard, 1967	Idea generation	Adoption	Implementation												
Rogers and Shoemaker, 1971	Awareness	Interest	Evaluation	Trial	Adoption										
Milio, 1971	Conceptualisation	Tentative adoption	Resource getting	Implementation	Institutionalisation										
Zaltman et al., 1973	Knowledge or awareness	Formation of attitudes	Decision	Initial implementation	Continued, sustained implementation										
Daft, 1978	Idea conception	Proposal	Adoption - rejection	Implementation											
Ettlie, 1980	Awareness	Evaluation	Trial	Adoption - rejection	Implementation										
Tornatzky, 1983	Awareness	Matching or selection	Adoption - rejection	Implementation	Routinisation/ commitment										
Rogers, 1983	Agenda setting	Matching	Redefine & restructure	Clarify	Routinise										
Pelz, 1983	Concern	Search	Appraisal	Select or reject	Commitment	Implementation	Incorporation	Diffusion							
Meyer and Goes, 1988	Knowledge or awareness	Evaluation or choice	Adoption	Implementation	Expansion										
Cooper, 1988a	Initial screening	Preliminary market assessment	Preliminary technical assessment	Detailed market study and marketing research	Business and financial analysis	Product development	In-house product testing	Customer tests of product	Test market or trial sell	Trial production	Pre-commercialisation business analysis	Production start-up	Market launch		
Johne and Snelson, 1988b	New product planning	Idea generation	Screening	Development	Concurrent technical and marketing prototyping evaluation	Launch									
Angle and Van de Ven, 1989	Start period	Middle period	End period												
Schroeder et al., 1989	Shocks	Idea proliferation	Setbacks & surprises	Degree of linking old and new	Restructuring	Hands-on top management									
Cooper and Zmud, 1990	Initiation (push or pull)	Adoption	Adapt, develop, install	Acceptance, usage	Incorporation/ routinisation	Infusion									

West, 1990	Recognition	Initiation								Implementation		Stabilisation	
Barclay, 1992	NPD strategy	Idea generation	Screening and evaluation	Business analysis	Development	Testing				Commercialisation			
Rothwell, 1992		Idea generation			Development	Prototype production			Manufacturing			Marketing and sales	Market place
Wolfe, 1994		Idea conception	Awareness	Matching	Appraisal	Persuasion				Implementation	Confirmation	Routinisation	Infusion
Chiesa et al., 1996		Concept generation			Product development	Process innovation	Technological acquisition						
Cheng and Van de Ven, 1996	Chaotic start-up period					Development period (periodicity)							
Cooper and Merrill, 1997		Research and development	Adoption and adaptation of new technology	Design	Training linked to innovation		Tooling up and start up activities		Marketing	Investment in machinery and equipment		Production engineering	
Veryzer, 1998				Concept evaluation	Concept refinement	Technical feasibility		Product design					
Song and Montoya-Weiss, 1998	Strategic planning	Idea development and screening			Business and market opportunity analysis		Technical development	Product commercialisation					
Rabson and DeMarco, 1999		Finding	Developing	Evaluating						Implementing			
Fernández, 2001			Proposal					Adoption	Development	Implementation			
Avlonitis et al., 2001		Idea generation and screening		Business analysis and marketing strategy	Technical development activities	Testing							Launch
Kim and Wilemon, 2002			Fuzzy front end										

Figure 10-1: 50 years of innovation process models, after Wolfe (1994)

Linear models depict innovation happening in a series of discrete, sequential stages (Zaltman et al., 1973). Each is characterised by the first activity/event being a form of evaluative awareness of both an existing problem and extant external solution. As they say, "*potential adopters must be aware that the innovation exists and that there is the opportunity to utilize the innovation within the organisation*" (Zaltman et al., 1973; 62). The approach is somewhat at odds with their stated view that "*the importance of new ideas cannot be overstated*" (Zaltman et al., 1973; 8), but would explain the conceptualisation of the innovation process as an exogenous search for potential solutions. However, it is around the 'idea' that collective action mobilises, it is the rallying point that "*provides the vehicle for otherwise isolated, disconnected, or competitive individuals to come together and [...] contribute to the innovation process*" (Van de Ven, 1986; 593). Both original and imported innovations are legitimate and should be included in any exploratory modelling.

Over the next two decades variants of the linear model were developed. Daft (1978) produced a framework of process in which organisations are conceptualised as having two cores (hence 'dual-core' model), one technical and one administrative. In his retrospective study of 13 high schools he found strong support for the conclusion that the process of innovation appears to be contingent upon both the type of innovation (technical or administrative) and the professional level of employees. That is, innovative ideas follow different paths from conception to approval depending on the origin of idea. For example, they may trickle down from top administrators or may trickle up from technical personnel.

Damanpour (1991) extended the initiation/implementation and dual-core models to produce the ambidextrous model. In doing so he provides further evidence of the contingent and contextual nature of innovation and the relationship between process and outcome. The ambidextrous model indicates that organic organisations[15] tend to facilitate the initiation of technical innovations and that mechanistic organisations facilitate the implementation of administrative innovations. Damanpour provides weaker evidence that organic and mechanistic companies are better able to implement and initiate (respectively) technical and administrative innovations.

Holbek (1988) called this split in innovation capability between organisational types the 'innovation design dilemma', and he proposed a solution. Holbek (1988) suggested that, although organisations can be characterised as organic or mechanistic, none is uniformly so across its whole range of activities, and so, administrative innovations can be initiated within mechanistic organisations but, the likelihood is that the initiating sub group will be characteristically organic. In Holbek's (1988) solution there is the early recognition of the role of groups to the innovation process and some sense of enabling conditions. Initiation and implementation, he argued, can take place within the same organisation but by different sub groups, and the major stages differentiated in time and space.

[15] After Burns and Stalker's (1961) mechanistic and organic organisations, see Chapter three.

Rabson and DeMarco (1999) developed Holbek's (1988) thesis. They envisage innovation taking place within a system or several systems. Still though, they adopt a sequential, linear model of process in which events and requisite activities are clearly identifiable. Organisations, they argue, face a predictable series of crises as they grow, and innovate, through the passage of time: revolutions interspersed with periods of relative calm evolution. Recognising these different events in the history of an organisation, they suggest a range of structural responses to deal with the different events. For example, they call for 'targeted innovation' systems for generating ideas (e.g. team brainstorming) or, 'venturing systems' for the commercial implementation of the innovation (e.g. independent start up businesses).

The merit of the linear model is in identifying the different activities that groups engage in when tasked with being innovative and the different tasks needed to be performed at each of the identified phases. Further, implicit in the models is the idea that as processes appear to differ across cases so do the resultant innovations. Clearly the approach has limitations, not least the view of process as a discrete and orderly sequence of activities. Nevertheless, the approach predominated in the literature until around the time of the seminal Minnesota Studies (Van de Ven et al., 1989), which recognised and mapped out some of the discrepancies between extant innovation theory and practice. Within this corpus, Schroeder et al. (1989) are amongst the first to include endogenous generative (creativity, invention, idea generation) processes as part of the innovation process, and they strongly challenge the idea of orderly sequences.

More recent literature suggests innovation is not the stable phenomenon that linear models imply (for example Wolfe, 1994); increasingly, the simple, unitary progression models have been discredited because of their lack of empirical validity. King (1992) demonstrates empirically that the Zaltman model is not well supported by the evidence. Such findings undermine, to some extent, the validity of all models built on the principle of linear, sequential stages. Linear models tend to be highly context specific and, useful in explaining only simple, incremental innovation. Whilst linear models provide a framework for understanding innovation their linear, sequential simplicity can deliver false hope in the attempt to understand what is increasingly regarded as a complex, iterative, recursive process. Non-linear perspectives of innovation describe a process that is fluid and dynamic, sometimes even random in which there is no apparent sequence of stages but is characterised by feed-back and feed-forward loops (Schroeder et al., 1989). The following sub-sections describe recursive and chaotic models of process, which are considered (the former, particularly) to be better representations of what actually happens.

10.3.2 Recursive

At best the linear models pay only cursory attention to turbulent creative activity, at worst the creative front end of the innovation process is ignored, thereby rendering linear process models incomplete representations of the innovation process. It is possibly the exclusion of generative activity from the conceptualisation of innovation that renders early models amenable to linear representation. However, although innovation has been cast as a process consisting of a collection of identifiable events or stages it is not always a simple linear process. The notion of necessary antecedents notwithstanding, evidence suggests that, at a fine-grained level of analysis, any of the identified events may happen at any time during the process of innovation (e.g. West, 1990). Later models include ideation, creativity and novelty generation in their purview and, characteristically, represent process as a more disorderly phenomenon, hence Kim and Wilemon's (2002) conceptualisation of a 'fuzzy front end'.

Two things are noticeable about these models, first, as a collection of models they present a more disorderly aggregation of activities in which boundaries between events are less clear. Second, they describe a process that appears to commence in an informal and fluid state to one that ultimately becomes more formal and rigid (Cheng and Van de Ven, 1996).

Pelz (1983) identified eight stages in his empirical study of the innovation process (see figure 10-1). In Pelz's study 2000 innovation episodes inducted from the study of 18 innovations were refined into 276 categories from which, ultimately the eight stages of the innovation process were identified. Pelz's answer to the question "are there innovating stages?" is contingent. For those innovations that are 'originated' (original) the sequence of events in the process overlap in time, is muddled and disorderly. For simple innovations that are borrowed, a moderately clear succession of stages appears.

In a later study Pelz (1985) concluded with a contingent view of process, in which innovations with medium originality and low complexity display the highest resolution of stage identification. That is the resolution of the boundaries between one stage of the process and another appeared to depend on the complexity and/or originality of the innovation. That is not to say that, a muddled or disorderly process will necessarily culminate in an original or complex innovation. Nor, indeed, that an orderly process, in which the stages are relatively clear, cannot culminate in an original innovation: "*apparently, an effective innovation could occur in either an orderly or muddled fashion, and so could an ineffective one*" (Pelz, 1983; 66). The data gave no support for a normative view that stages should occur in a certain fashion to assure a particular outcome. The conclusion is that there appears to be a relationship between process and artefact though the exact nature of that relationship remains to be answered (Smith, 1998). In 20 years though, innovation research has not moved much beyond Pelz's (1985) observation that technically simple innovations are installed with a more discrete succession of stages than are complex innovations.

Schroeder et al.'s (1989) view of innovation is that invention is the creation of ideas, but innovation is more encompassing and includes the process of developing and implementing the new idea. The organic model they describe comes close to a 'big bang' theory of innovation. A single large shock stimulates an innovative response from which many future outcomes are possible, which they describe as "*multiple, divergent, parallel and convergent progressions of activities over time*" (Schroeder et al., 1989; 132). The model comprises of six events, which are not discrete or linearly sequential (see figure 10-1). The principal benefit of Schroeder's model is that it recognises the untidy nature of the innovation process. The evidence of Schroeder et al suggests that back-tracking of the process and overlap of stages is likely to prove the norm not the exception.

In a separate and later study, using data from seven innovations in a hospital geriatric ward, King (1992) compared Schroeder et al.'s (1989) model with that of Zaltman et al. (1973). He suggests that neither model gives a wholly accurate representation of the data, though the Schroeder model is shown to outperform that of Zaltman. The Schroeder model is better able to offer an explanation of radical innovations than for relatively simple innovations, for which the Zaltman model performs better.

King argues that there is greater support for dynamic models that recognise the untidy nature of the innovation process and that stage-based models are probably not very useful as descriptions of how the innovation process proceeds in real world cases. The study confirms Pelz's (1983) observations that innovation process phases are most discernible in the least radical innovations. It is evident, King concludes, that further research exploring whether or not the descriptive model of process changes according to the type of innovation under consideration.

Recursive models stand up robustly against linear models (King, 1992), especially in understanding more complex or radical innovations (Schroeder et al., 1989). It would be wrong to assume *a priori* that innovation takes place in discrete stages even though it appears to comprise identifiable events. It seems safe to assume that the process is much more fluid than linear modelists have averred, but the extent of that fluidity is related to certain attributes of the innovation. The longitudinal, recursive modelists attempt to capture those factors in iterations of input-process-output models that generally adopt an individual or group cognition perspective. In doing so they recognise the holistic, social, path-dependant but untidy nature of innovating.

10.3.3 Chaotic

A recent theme in exploring the dynamic nature of the innovation process in the theoretical mode of enquiry is the idea of chaos (Cheng and Van de Ven, 1996; Koput, 1997). Cheng and Van de Ven (1996) conceptualise four principal temporal pattern types borrowed from dynamical systems theory: fixed, periodic, chaotic and random. Using time series longitudinal data for two biomedical innovations, they produce phase plots to examine whether or not the patterns produced conform to patterns produced by systems that are known to exhibit properties of the four temporal types.

Their study is limited by, amongst other things, sample size, short and 'noisy' time-series data and the ultimate failure of the innovations under study. However, that does not detract from their interesting observations on the innovation process, that it consists of a non-linear dynamic system which is neither orderly and predictable nor is it stochastic and random. Innovation process was found to exhibit a chaotic pattern in the initial developmental stages and an orderly, periodic pattern in the late and closing activities of development. The point at which behaviour shifts from chaotic to periodic, however, remains elusive. Indeed, we are no clearer, as a result of these studies, as to what a "*chaotic model of innovation would look like if it were instantiated in an organisation"*(Koput, 1997; 540).

For this research, at least, the concept of chaotic process appears not very useful nor, indeed, easy to operationalise in a cross-sectional study. The few empirical studies in which chaos has been 'discovered' have utilised a longitudinal methodology and time series data, this is an option that is not available in this study. Further, in the absence of a generic descriptive model of chaotic process (see Koput, 1997 in the previous paragraph) there is no referent against which the recollections of respondents can be assessed. Consequently, chaos is not included as part of the framework for analysis.

Regardless of whether or not the process of innovation occurs in a linear, recursive or chaotic fashion it comprises sets of identifiable activities. The following section reviews the activities of a modified version of Avlonitis et al.'s (2001) generic process.

10.4 Process activities

10.4.1 Idea generation and screening

Ideas are the raw materials for innovation and it is relatively inexpensive to generate and screen ideas (Smith, 1998). Song and Montoya-Weiss (1998) advocate an early cull of ideas in order to maintain control of costs. Successful idea generation is an important component of the process (Johne and Snelson, 1988b) and a variety of tools, techniques and procedures have been identified to encourage idea generation (Rochford, 1991; Smith, 1998; Thompson, 2003). An assumption appears to be that, through the use of generative tools, the objective is to generate as many ideas as possible yet, if it is done badly, it can have significant impact on ultimate success or failure (Cooper 1988). Formal techniques and procedures for screening tend to be invoked at the business analysis stage when the concepts and ideas are more fully developed (Cooper et al., 2001).

Further, a close connection with the organisation's marketplace is frequently cited as an important source of ideas (Cebon and Newton, 1999; Maylor, 2001; Parthasarthy and Hammond, 2002), with the clear implication that good innovation practice has some roots in being able to understand and assess customer needs. Similarly, external networks and linkages through participation in research projects or attendance at trade shows and so forth are important to idea generation (Cebon and Newton, 1999). Finally, close internal collaboration and communications have been positively associated with innovation (Damanpour, 1991; Lee and Xon, 1996; Anderson and West, 1998).

10.4.2 Business analysis

At the business analysis stage individual ideas, propositions for new products, are evaluated in the local context: for example, cost-benefit analysis of the project, analysis of customer needs and so forth. Most conventionally the evaluation is described as taking place within the context of a manufacturing organisation's product portfolio (Cooper et al., 1999, 2000, 2001). The importance of portfolio management to successful innovation has recently emerged as a key theme in the literature (Cooper et al., 1999) and is an important for the effectiveness of innovation process because of the rapidity at which resources are consumed during innovation and the need for this to be managed (Cebon and Newton, 1999).

The focus of portfolio management is about the effective use of resources for innovation, the relationship between some future expected value of the innovation and resource utilisation. It is about making strategic, technological and resource choices that will govern the future shape of the organisation (Cooper et al., 1999). Consequently, the effectiveness with which an organisation manages its research and development portfolio is often a key determinant of its competitive advantage (Bard et al., 1988) and a variety of tools and techniques have been developed to help in the process.

The problem of allocation of resources, project-evaluation, selection and termination to arrive at an optimal balanced product portfolio has been extensively investigated over the last 50 years. The earliest approaches used financial measures such as return on investment as the primary decision criteria (Bard et al., 1988). Subsequently, increasingly sophisticated mathematical tools were developed to resolve what Schmidt and Freeland (1992) describe as the constrained optimisation problem, that is, to maximise the output (according to specified criteria) from a subset of available inputs. Partly due to the inherent complexity of the methods many of these project selection models "*have been virtually ignored by industry*" (Schmidt and Freeland, 1992; 190).

This emphasis on quantitative methods failed to take into account qualitative aspects of the decision such as organisational (strategic, process, communication, climatic) factors. More recently models have tried to take account of more qualitative factors involved in decision processes. The range of methodological approaches to project selection is illustrated in table 10-3.

	Increasingly quantitative……………….....……………………………………………………increasingly qualitative							
Henriksen and Traynor, 1999	Mathematical programming	Economic models	Portfolio optimisation	Artificial intelligence	Decision analysis	Interactive methods	Scoring	Unstructured peer review
Cooley, Hehmeyer, et al., 1986		Economic models	Portfolio optimisation		Risk and decision analysis models		Scoring models	
Hall & Nauda, 1990	Mathematical programming	Economic benefit		Cognitive emulation		Comparative approaches	Scoring models	Ad hoc methods
Cooper, Edgett, et al., 1999		Financial	Strategic optimisation techniques			Bubble		Scoring
Cooper, Edgett, et al., 2001	Mathematical optimisation	Financial and economic	Probabilistic financial models		Decision support systems	Mapping	Behavioural approaches	Scoring and checklists

Table 10-3: Methodological approaches to project selection

In spite of the wide array of approaches to portfolio management in the literature there is little evidence of them having transferred into management practice (Henriksen and Traynor, 1999) and that there is a major gulf between theory and practice (Cooper et al., 1999). The most frequently used approaches they find are financial, but these are not associated with success (Cooper et al., 2000).

Veryzer (1998) and Guellec and Pattinson (2001) report that since the 1990s highly structured approaches for managing the new product development process have emerged. Included in this are stage gate systems that divide the innovation process into a pre-determined set of stages. The number of stages varies across models, Barth (1998) describes five, Cooper (1990) seven. Each stage is composed of a group of prescribed, related and often parallel activities. The “gates” function as quality control checkpoints at which stop/go decisions are made with regard to the progress of the project. Stage gates are really only a decision stage as opposed to an algorithm, though there is a history in the literature of algorithmic approaches to decision making in project evaluation and selection.

It is widely recommended that organisations seeking to innovate establish formal processes for innovating and make use of tools and techniques that may facilitate the endeavours (Cooper et al., 1999). However, many of the tools devised for portfolio management appear not to be widely used in the context (research and development and NPD in commercially oriented organisations) for which they were developed. It might, therefore, be unreasonable to expect to find much, if any, evidence of their use in the NHS. Indeed, the extent to which the concept or practice of portfolio management has relevance in the context of innovation in the NHS is not clear. However, it would not be unreasonable to expect to find innovators making use of some aids to decision-making (though how they might look is difficult to gauge) and some variance in the degree of formality of the process.

10.4.3 Technical development and testing

Avlonitis et al. (2001) describe this stage as relating to the design and development of process procedures and systems design. The stage is concerned with issues of designing both the innovation and also the means by which it will be brought to fruition. This is easier to conceptualise in product innovation processes where the product must be designed, as must the manufacturing and/or engineering processes that will make it, than it is in non-product sectors.

Testing or trialing is the application of the new idea on a small scale in order to determine its utility (Rogers and Shoemaker, 1971), test production processes (Cooper, 1988a) and provide for market and technological testing (Johne and Snelson, 1988b). These can be in-house or market tests of an innovation’s operational and market aspects (Avlonitis et al., 2001)

10.4.4 Innovation launch

The literature on launching innovations, possibly because it deals with the culmination of the innovation process, is rather thin. Activity at this stage tends to centre around post-launch analyses of the success or effectiveness of the process that brought about the innovation and/or evaluations of the contribution of the innovation to organisational performance. Infrequently issues with regard to the co-ordination and implementation of the launch get coverage.

10.5 Enabling climate

Several models of innovation process distinguish themselves from others by taking account of the internal organisational environment that pertains during innovation. These tend to be in the minority, but would include the studies synopsised in table 10-4. These studies share in common the conclusion that by creating a facilitating environment innovation can flourish.

Study	Enabling conditions
Corporate conditions (Rothwell, 1992)	Management commitment, long term strategy, long-term commitment to major projects, corporate flexibility and responsiveness to change, acceptance of risk, innovation accepting entrepreneurship-accommodating culture
Team Climate Inventory (West and Anderson, 1996; Anderson and West, 1998; Anderson and West, 1998)	Vision, participative safety, task orientation, support for innovation
Enabling Processes (Chiesa et al., 1996)	Leadership, deployment of resources, use of appropriate systems and tools
Organisational Climate (Ekvall, 1996)	Challenge, freedom, idea support, trust/openness, dynamism/liveliness, playfulness/humour, debates, conflicts, risk-taking, idea time
Group Climate for Creativity (Amabile et al., 1996)	Encouragement, autonomy, resources, pressures, organisational impediments
Norms for Innovation and Change (O'Reilly and Tushman, 1997).	Norms for creativity: support for risk-taking and change, tolerance of mistakes. Norms for implementation: effective team functioning, speed of action

Table 10-4: Enabling conditions of innovative organisations

Every group occupies some setting that affects the behaviour of its occupants in some way. No group can be fully understood unless its setting is analysed, this setting has been called 'climate' and 'climate' is the commonly used metaphor to describe these facilitating conditions. Both Ekvall (1996) and Anderson and West (1998) provide useful discussions of the use of climate as a construct. Climate is different from culture and context, it is more specific than either of these constructs. Hatch (1997; 205) provides several definitions of culture one of which suggests it to be "*the glue that holds an organisation together through the sharing of patterns of meanings…*[it] *focuses on the values, beliefs and expectations that members come to share*". Climate is not glue, it is more like lubricant. It describes perceptions within a context. In effect climate is a construct which describes a range of variables that collectively contribute to melding an individual's beliefs about the permissibility of (in this case) innovation in an organisation (Evangelista et al. 1998).

To allow for innovation, Leonard and Sensiper (1998) demand a climate conducive to producing a wide and healthy proliferation of ideas and a successful divergent and convergent process. Abbey and Dickson (1983) suggest that innovative organisations are characterised by an organisational willingness to experiment with new ideas; an orientation toward creativity and innovative change; support for members in functioning independently in the pursuit of new ideas; a tolerance of diversity among members; and adequate supplies of resources and equipment.

Whilst the components of climate would seem to relatively widely agreed upon it is in the nature of climate to be hard to access in measurement terms other than through people's perceptions. Behaviour and sense-making are predicated on perceptions (Reger and Huff, 1993) and, it is evident that the perceived and experienced work environment does make a difference to levels of innovation and creativity in organisations (Amabile et al., 1996).

For the purposes of analysis in this research, to permit re-engagement with the sample, a simplified conceptualisation of climate is adopted: management commitment, consisting of top management support, allocation of resources and norms, and group factors consisting of champions & leadership, autonomy, social factors and group orientation.

10.6 Management commitment

Management commitment, tolerance and lacking fear of change can create a climate conducive to innovation. This is especially important at the implementation stage of innovation, where conflict resolution might be necessary (Damanpour, 1991). It has been shown elsewhere that supportive attitudes are also necessary at the initiation stage. Dougherty and Cohen (1995) found the behaviour of senior managers to be influential. A culture of managing for efficiency presented itself as a barrier to being able to behave innovatively. Core 'efficiency' competencies can become core rigidities when the need to change behaviour and innovate was recognised (Leonard, 1998).

10.6.1 Norms

Managerial commitment is reflected in norms or support for innovation. These are influenced by expectations, approval and practical support for the introduction of new and improved ways of doing things in the work environment. West (1990) distinguishes between articulated and enacted support for innovation, where there are high levels of both, in combination, attempts to introduce significant innovations are more likely. Indicators include: verbal support (in and outside group meetings); co-operation (group and interpersonal) in the development and application of new ideas; time and resource provision; tolerance of error; top management's (outside the group) support for innovation.

10.6.2 Top management support

Implicit in studies of top management support is the distinctness of senior or top management and the innovating group, a distinction that was echoed in Phase I of this research. Top management sets the internal context for innovation or, the organisation's strategic orientation. Ramanujam and Mensch (1985) defined innovation strategy as a timed sequence of internally consistent and conditional resource allocation decisions that are designed to fulfil an organisation's objectives. Strategy, therefore, defines the parameters within which innovation takes place and is made manifest: the setting of innovation goals and objectives, the marshalling and apportionment of resources, the initiation and supervision of activities, management leadership, attitude and support.

10.6.3 Resource allocation

Brown and Svenson (1988; 30) describe the inputs into the research and development system as "*the raw materials or stimuli a system receives and processes*", these include people, information, ideas, equipment, facilities, specific requests and funds. Other authors appear to be in agreement with this list of items, though use different labels and/or focus on particular items within the list. The broad range of inputs into the innovation process are illustrated in table 10-5.

Study	Input factors
Brown and Svenson, 1988	People, information, ideas, equipment, facilities, funds, specific requests
Ekvall, 1996	People, buildings, machinery, know-how, patents, funds and material concepts.
Lee et al., 1996	Research and development investment and facilities Research and development personnel
Chiesa et al., 1996	Resourcing, systems and tools
Bontis, 2001	Structural capital, hardware, software, databases, organisational structure, patents, trademarks, buildings, machinery
Geisler, 2002	People and skills, funding, guidance and gain, other resources and restraints

Table 10-5: Inputs to the innovation process

Chiesa et al.'s (1996) notion of 'resourcing' combines adequacy of funding and people, specifically people with a range of experience in more than one function. This implicitly suggests that a range of skills and experience is an important input to the innovation process. Other studies endorse these observations. Clearly, adequate funding is important for innovation (Kerssens-van Drongelen and Bilderbeek, 1999; Geisler, 1995) as are the skills and experience of individuals (Merrill and McGeary, 2002; Kraft, 1990).

10.7 Group factors

Scott and Bruce (1994) report that the nature of social relationships is important in developing an environment conducive for innovation. West and Anderson (1996) argue that team climate, characterised by levels of trust, autonomy, safety, discretion and group orientation, facilitate the establishment of a benign and supportive climate from which it is perceived possible for innovation to emerge. The importance of innovation champions whose role includes the promotion of the innovation both within the group and externally is also considered an important factor to group innovation processes (Dougherty and Hardy, 1996; Kleinschmidt and Cooper, 1991).

10.7.1 Champions and leadership

According to Shane et al. (1995) a champion is an individual who promotes the development of an innovation within an organisation, particularly where organisational resistance to innovation exists. Champions can adopt different strategies to overcome resistance, these might include overcoming inertia by violating organisational norms, rules and procedures or, by making cross-functional appeals for support from organisational members (Shane et al., 1995).

There is general agreement on the positive influence of leadership on innovation (Scott and Bruce, 1994; Amabile, 1998). The literature identifies two roles for leaders in the innovation process. The first might be defined as the leader-to-innovation role, a participative and collaborative style allowing for autonomy and latitude and, also, direction and control. Control though must be moderate and balance absolute freedom with support (King and Anderson, 1990). In a cross cultural study of innovation in the scientific instrument industry, Madhavan and Grover (1998) found the role of the leader, particularly leaders with A-shaped skills[16], to be important and conducive to innovation. Centralised leadership or low degrees of participation in decision making inhibits initiation of innovation but will facilitate implementation (West, 1990), Feldman's (1988) study provides evidence of this. Zien and Buckler (1997) found successful leaders using story telling of innovative experiences and exploits as a useful motivational and climate setting tool.

The second role of the leader could be defined as leader-to-environment role in which the leader is representative of the innovation project to the external environment, for example champions act as advocates to overcome organisational resistance, sell the project, get resources, motivate participants, co-ordinate and communicate (Kessler and Chakrabarti, 1996).

10.7.2 Autonomy

There is general agreement on the importance of individual and group autonomy in the innovation process (Amabile 1998). Zien and Buckler (1997) assert the need for the freedom to experiment and, the creation of centres of safe havens without which innovation might be constrained. Different degrees of autonomy may be required at different phases through the innovation process. Whilst Autonomy is important for keeping innovative spirit alive (Zien and Buckler, 1997), it must be in balance with control. Feldman (1989) argued that autonomy is needed during the formulation phase of innovation, and control is needed during the implementation phase. This view requires that autonomy and control exist independently of each other within an organisation. For Feldman (1989) neither autonomy nor innovation can exist without the other. In the same way that day needs night to define it, so autonomy needs control: autonomy assumes independence from something, control assumes restrictions on liberty. In order to meet organisational goals the relation between autonomy and control must be properly balanced (see also Holbek's (1988) resolution of the innovation design dilemma). Too great a level of autonomy can impact negatively on the implementation stage of an innovation though high levels of autonomy may have a positive impact on innovativeness. However, Feldman showed that this level of innovativeness was unusable by other departments in the organisation and, that greater levels of control exercised during initiation would have constrained the innovation process within the operational parameters of the organisation.

Discretion, or empowerment for decision making is important too, and has been construed as existing on a continuum from none to self-management (de Leede et al., 1999). Fully empowered groups can challenge any extant status quo, be fully involved in the project and have strong commitment to it. High levels of empowerment limit the number of bureaucratic approvals that can change the shape of the innovation which can be demotivating (Gold, 2002).

The view is supported by Dougherty and Cohen's (1995) case study of Machco. The two innovations from which senior management remained operationally distant performed better, in terms of team satisfaction, time to market, project and product

[16] Depth of expertise in two different disciplines enabling combinations of insights from multiple knowledge sets.

cost, customer acceptance and overall project success, than did those with a high level of senior management intervention.

10.7.3 Social factors

Involvement in decision-making is encouraged, motivated and reinforced while occurring in an environment which is perceived as inter-personally non-threatening. The environment is characterised by non-judgemental, supportive, socio-emotional cohesiveness (West, 1990). This view is widely held in the literature. Pelz (1983) sees supportive climates as those encouraging interaction, autonomy, and the production of knowledge-generated achievement. Cohesiveness facilitates innovation because it enables high degrees of participative safety (Anderson and West, 1996), which permits the uncovering and articulation of personal, experiential, difficult to articulate tacit knowledge, which Nonaka (1995), amongst others (Leonard and Sensiper, 1998: Pitt and Clarke, 1999), argue is key to innovation. Networks of relationships constitute a valuable resource for the conduct of social affairs providing members with collectively owned social capital (Nahapiet and Ghoshal, 1998), much of which is embedded within networks of mutual acquaintance and recognition. Social capital is the "*sum of the actual and potential resources embedded within, available through, and derived from the network of relationships*" (Nahapiet and Ghoshal, 1998; 243) and is argued to be central to encouraging co-operative behaviour the enactment of which is important to innovation.

Social interaction is important for collectives of individuals responsible for delivering new products, services and organisational processes (Leonard and Sensiper, 1998). Collaborative structures and processes provide the framework for the combination and exchange of knowledge and the creative solving of problems. In mature organisations structures and practices are frequently not designed for organisation-wide collaboration and problem solving (Cooper, 1979a), thereby hindering innovation. Rather, mature organisations are designed for co-ordination and efficiency: for example, reward systems that punish people for stepping outside established work roles and organisational routines that limit inter-functional interaction (Cooper, 1979a). Perry-Smith and Shalley (2003) argue that weaker social ties are generally, but not always, beneficial for creativity.

While open communication between individuals helps develop trust, it is the organisational form and management philosophies that influence the openness of such communications. Trust is the reciprocal faith team members have in one another to complete the tasks in their areas of expertise successfully and, is important for cross functional team working (Madhavan and Grover, 1998). Trust allows for questioning, that may normally be perceived as aggressive or hostile, to be accepted with relative equanimity and, is an important lubricant in the social system (Nonaka, 1990). In a study of four Fortune 500 companies, Madhavan and Grover (1998) propose two types of team trust, trust in team orientation and trust in technical competence. Trust in team orientation being the reciprocal faith in others' intentions and behaviour. Trust in technical competence, a cognitive variant of trust, is the extent to which team members are trusted to be competent to handle the challenges. Trust is a time-earned feature of relationships. Ruppel and Harrington (2000) suggest it evolves over time through the development of shared perceptions and, eventually leads to commitment, effort and ultimately creativity and innovation. In short-lived groups an individual's history, for example prior record of publications or record of successful projects completed, may serve as a proxy for trust.

10.7.4 Group orientation

Anderson and West (1996) describe group orientation as climate for excellence, the shared concern with excellence of quality of task performance in relation to shared vision or outcomes, characterised by evaluations, modifications, control systems and critical appraisals. It allows for divergent thinking and competing perspectives particularly important for generation of creativity.

Indicators of climate for excellence include: individual and team accountability; critical approaches to quality of task performance; inter-team advice, feedback and co-operation; mutual monitoring; appraisal of performance and ideas; clear outcome criteria; exploration of opposing opinions and constructive controversy. Where participants are in a co-operative context of emphasising mutually beneficial goals and, groups with a climate for excellence will demonstrate the kind of tolerance for diversity which "group think" disallows (West, 1990).

10.7.5 Vision

Vision is an idea of a valued outcome which represents a higher order goal and motivating force at work (West, 1990). Pinto and Prescott (1988), in a study of 418 research teams, found a clearly stated vision to be the only factor having predictive power in terms of potential for success at all stages of the innovation process (conception, planning, execution & termination). To facilitate innovation successful visions must be clearly communicated, and understood collectively. They must also be valued and attainable (West, 1990).

It has been argued that the clearer the vision (defined, shared, attainable, and valued team's objectives) the more effective it is as a facilitator of innovation, as it enables focused development of new ideas that can be assessed more precisely (West, 1990). However, Leonard and Sensiper (1998) suggest that the more innovative the new product the less likely it is that the objectives have been spelled out in detailed specifications in advance. This is because it is more difficult to anticipate all needs and possible interactions in a radically new product or process. Therefore, the more clear and specific the explication of purpose the less likely the innovation is to score highly in terms of radicalness. Ambiguous project concepts allow for more speculation and creative abrasion (e.g. unsatisfactory understanding of the task, early misunderstandings) about what is to be produced but allow greater autonomy to exploit the cognitive processes that lead to radical innovation. For Kessler and Chakrabarti (1996) clarity of goals (clear specific time based objectives and clear specific product concept) is positively related to innovation speed. However, the need to balance specification of purpose with autonomy of cognitive processes suggests that there might be a curvilinear relationship between the explicitness of clarity of purpose and innovation outcome.

10.8 Section 2 - Investigating process amongst exemplar teams

The objective of this section is to report on the short empirical investigation of process for each of the three innovation types identified in Phase II. This study provides the context for an evaluation of the taxonomy developed from Phases I and II. It is not an exhaustive study, rather it aims to identify which of the factors described in section one of this chapter are reported by innovators to have been important to their innovation process. First, the approach to research method, data collection and analysis are described. The presentation of a series of brief case histories and a discussion of the findings follow this. Finally, the section and chapter conclude with a discussion of the findings within the wider context of this research.

10.9 Research method

Overall, the objective was briefly to explore the utility of the taxonomy of three clusters in the context of innovation processes. Choice of research strategy was limited by the historical nature of the phenomenon, as the innovation process had already been completed. Consequently, the recall of team leaders was relied upon. A semi-structured interview protocol, based on the review of process literature (above), was developed to guide this research (see Appendix ten). The interview protocol was designed to allow specific process issues, as described in the previous section, to be investigated.

Rapidity was a significant issue partly because of time constraints on both the researcher and respondents' sides and, as this was the second approach to respondents, it was important not to test respondents' tolerance with a request for too long an interview. Respondents were asked to allocate approximately half an hour for the interview, some of which took place by telephone and others face-to-face. Some interviews (telephone and face-to-face) lasted for longer than half an hour, where respondents became particularly engaged in the topic. This allowed for more extensive data to be gathered and finer-grained exploration of some of the process issues. Two interviews lasted less than half an hour, where respondents were particularly pressed for time. The data collection exercise was closed with personal letters to each respondent thanking them for their co-operation. A number of requests have been received at each Phase of this research to keep respondents informed of the progress and outcomes of the study.

10.9.1 Data collection and sample

The sampling frame consisted of nine innovations. The objective was to recruit an exemplar and a contrasting innovation from each cluster. To maximise the chances of this, three exemplars from each innovation type (the three innovations with least distance from cluster centres) and a further three, selected by random number generation, were selected and approached. The justification of the selection of exemplars is found in their tendency to generate unusual or amplified manifestations of the phenomenon of interest. Non-exemplar cases were sought in order to provide contrast to, and therefore help understand, the exemplar cases (Miles and Huberman, 1994).

Team leaders were approached by post with a letter requesting a short interview. Included with the letter was a brief outline of the focus of the enquiry (See Appendix eleven). Of the 18 team leaders approached, nine responded positively, six chose not to participate and three were unavailable. The nine who positively responded are unevenly distributed across the three clusters (see table 10-6). Exemplar innovations were recruited for types two and three, but none responded positively from type one. The characteristics of the sample are described in table 10-6 (the number in brackets indicates the distance of each innovation from its cluster centre).

Type 1 (distance) Exemplar = 1.492	**Type 2 (distance) Exemplar = 1.892**	**Type 3 (distance) Exemplar = 1.606**
126 (2.099) Technological Mental health Newness: 3.02	6 (1.892) Technological Mental health Newness: 4.47	180 (1.606) Technological Communication with patients Newness: 3.59
178 (2.415) Product/Service Mental health Newness: 3.33	22 (2.306) Administrative Staff recruitment and retention Newness: 3.54	32 (2.268) Technological Mental health Newness: 3.68
	122 (2.934) Administrative Accident and emergency Newness: 4.30	
	108 (3.029) Technological Mentoring network Newness: 3.79	
	188 (3.200) Administrative Interventional radiology Newness: 3.81	

Table 10-6: Phase III sample, characteristics

10.9.2 Data analysis

Data were analysed according to the broad categories identified in the first section of this chapter. In Phase I of this research NVivo® software was used to facilitate document management and to facilitate the coding process. In Phase III documents were fewer in number and shorter in length than in Phase I. Consequently, interview transcripts were manually coded.

The objective was to get a 'feel' for significant process issues and, subsequently, to look for patterns of significant process issues within and across clusters. Respondents were invited to tell the story of the process by which the innovation was developed and implemented in terms of the three categories of process already described. They were particularly requested to reflect on any significant moments or relationships with regard to the process that they felt were notable.

10.10 Results

Short case histories are presented below for each of the nine innovations investigated. Each case is introduced by a selected quote from the respondent that the researcher considers reasonable to summarise the history. An analysis and discussion follow these histories.

10.10.1 Type 1 Innovations

Type 1 innovations have been characterised by relatively low values for 'disruption' and 'risk' and, high values for 'adaptability', 'actual operation' and 'observability'.

10.10.1.1 Innovation 126

"*I cannot say it was because of the people that were around us who were supporting us – that was not the case really*".

Innovation 126 is a psychiatric rehabilitation unit, established following the closure of a traditional mental hospital that provided patients suffering from severe mental illness with 24-hour residential care. In order to provide this service, resources within the region were redistributed. This required the development of a service that enabled people currently benefiting from, but who did not need, 24-hour care to have a more independent lifestyle in the community. Resources were therefore freed to be targeted to younger, less chronic patients, but requiring 24-hour care, in order to ensure that they do not become chronic.

The innovation was triggered by the conjunction of several events. First, the arrival of a new consultant. Second, a review of 24-hour rehabilitation care driven by the realisation that the wrong people (patients) were occupying a facility that was needed to meet the needs of younger people who needed 24-hour care. Finally, the development of a partnership with a housing association able to provide buildings development expertise.

The innovation represented a challenge to the existing configuration of treatment of mentally ill patients that came from a newly appointed consultant. The consultant was able rapidly to construct a reasonably close-knit multi-disciplinary team around the idea of reorganisation of mental health care provision, but received little support from outside this team.

Although guided by a vision of the mentally ill being better engaged into a good quality of life, the project had no clear vision of how this might be achieved or of the final outcome. No clearly discernible process could be identified other than one characterised by adaptability and flexibility, in being able to change direction and modify plans and expectations as the exigencies of resources and infrastructure demanded.

10.10.1.2 Innovation 178

"*…a response to an area of need, and done in the form of a small pilot and adapted all the time and reviewed regularly*".

Innovation 178 was developed and implemented by a team with an impressive track record of local innovation in community mental health. This particular innovation enabled the provision of targeted care to a population of dementia sufferers whose needs had, for some time, been inadequately catered for. Although the existing system of care was widely recognised as being problematic the trigger for some sort of resolution did not appear until after the abnormally unsatisfactory experience of one patient. A series of inter-disciplinary and inter-institutional meetings scoped the problem. The lack of availability of long stay beds and limited financial resources necessitated an unorthodox solution to the problem.

Following a feasibility study and small-scale piloting of the concept, over a two-year period, a new specialist service for dementia care became operational in 2000. Not only is the service reportedly distinct in terms of the nature of the service offered but also because in its operation it cuts across the boundaries of two NHS Trusts and draws funding from both health and social services.

No clearly discernible sequence of activities was derived from the data. Certainly there appeared to be no formulaic or algorithmic approach to the management of the process of the innovation. Clearly discernible activities though, could be identified, notably: problem-scoping, idea generation, extensive internal and external collaboration and a market (patient) focused orientation. One process activity stood apart from the rest by dint of its embeddedness in the practice of the group: 6-weekly review meetings to assess the state of service provision and care performance. This is suggestive of a team oriented to a state of continuous improvement. Indeed, factors relating to enabling climate are repeatedly emphasised in the data.

Significant amongst these factors are support within the innovating group and championing. Longevity and familiarity appear to have endowed the team with requisite levels of trust and individual professional credibility that created an enabling climate. Not that the original concept did not have to be ‘sold-in’ to the team at the start of the process as some felt the idea to be infeasible because of the demands that would be placed on it from patients suffering from similar but ineligible (in terms of the remit of the service) conditions. A strong champion with significant professional clinical credibility steered the innovation to its point of implementation at which point operational personnel took over responsibility. However, the champion built protective boundaries around the service to prevent it from becoming dissipated into the general provision of psychiatric and mental health services, thus ensuring continuity of care for the population of young dementia sufferers.

10.10.2 Type 2 Innovations

Type 2 innovations have been characterised by relatively high values for ‘disruption’, ‘risk’, ‘scope’ and ‘complexity’.

10.10.2.1 Innovation 6

“*It was a simple process of actually binding people and getting things done*”.

Innovation 6 is an IT-based register of treatment of mental illness for patients with a learning disability. The treatment has a narrow therapeutic range and blood monitoring is essential to ensure levels are appropriate. Although not wilfully neglectful of their health, patients with learning disability could not be relied upon to attend monitoring clinics. This sub-optimal level of monitoring was revealed in an audit of service delivery. Creating safe and effective systems, which enhance co-operation and communication between health care professionals that result in improved patient monitoring is therefore important.

Several process activities are clearly identifiable which appear to have occurred in a sequence. The use of formal idea generation techniques (brainstorming) led to further information gathering and idea generation to resolve the problem in the context of limited resources. As a result of resource limitations a clear process of options appraisal with business type criteria (cost, time, performance, IT resource availability) was undertaken. Concurrently options were reviewed in the context of the customer (patient with mental health problems) and the extent to which each option would meet their requirements. Ultimately the team was able to modify an existing IT system to satisfy its and its users' requirements.

The process appears to have occurred in a generally supportive environment, multidisciplinary team-working characterised by high levels of internal collaboration. Indeed, the team formally constitutes meetings on a regular basis to scan their operating environment and highlight gaps in their practice. However, the initiation and implementation of the innovation was largely an extramural activity that took place "*…in the spaces between the day job*".

10.10.2.2 Innovation 22
"*We took a stand and wanted to do this for ourselves*"

Innovation 22 is a recruitment and retention strategy devised and implemented at the level of the directorate[17] that was a challenge to and in contrast to that which prevailed at the level of the Hospital Trust.

In order to achieve its recruitment and retention objectives, this critical care directorate usurped the authority of the Trust's personnel department. Indeed, part of the trigger for the innovation had been the slow turnaround of job applicants, from enquiry to job offer. So slow that it had frequently been the case that the applicant had found employment elsewhere by the time an offer had been made.

The trigger for the innovation was the need to address the issue of staff retention and recruitment following the merger of two hospitals. A clinically trained member of the directorate staff had recently completed an MBA degree and was able to conceptualise the problem in terms of change management. With the professional assistance of an external clinical psychologist the directorate management team galvanised around the criticality of the issue and "*provided massive support for the initiative*". Conversely, little support was received from the Trust's management where the attitude toward the innovation appears to be one that conceived it as a threat to the due process of recruitment. The initiative also created tensions at a regional level where the sense of competition for recruitment of staff to critical care posts intensified.

[17] Clinical directorates are management models in health care that aspire to involve clinicians in management, give a patient-centred approach to management with a business overview and tend to be organised around clinical specialities – for example palliative care (See section 7.3.2, Team A) (Rea, 1993).

The tension was managed by an open communications policy, the innovating team going to some lengths to keep stakeholders informed of what they were doing and why they were doing it. In no sense did the respondent consider the team to have been engaged in a process, rather there was a series of different problems for which solutions needed to be found. What followed, then, was a series of incremental innovations (for example raising the profile of the critical care directorate by branding and merchandising and, running recruitment stalls at national conferences) which together resolved the recruitment and retention problems. Success was attributed to the backing of directorate management, which consisted of individuals with clinical training. And the clinical psychologist who focused on team building amongst both clinical directorate management and directorate staff.

10.10.2.3 Innovation 108

"*We felt that if we had gone up to the medical director and asked him if he wanted a mentoring network it would have been like asking him if he would like some bizarre south Indian dish that he had never heard of...so it was a process of looking and watching and influencing*"

Innovation 108 is the development and implementation of a mentoring network to support newly appointed consultants in one Hospital Trust. The role of consultant has historically brought with it a sense of machismo, according to the respondent, and consultants participating in mentoring schemes could potentially be seen as a sign of weakness. Mentoring had a stigma attached to it. Nevertheless, a small group had trained in mentoring skills and acted for each other in the manner of an informal network.

In the year 2000, when the appraisal of consultants became a legislative requirement, senior management of the Hospital Trust were faced with a problem. What was an appraisal and who was going to do it? It was evident that medical consultants did not want to be appraised by (non-medically trained) managers. The mentoring group recognised that some of the skills they had developed as mentors were directly transferable to the appraisal process. Thus it was that the benefits of mentoring were introduced to consultants with the sanction of senior management. As the quote at the top of this section illustrates, the respondent considered it unlikely that any formal proposal for a mentoring scheme would have been well received. There was no senior management support (initially), though implementation was facilitated after the buy-in of one senior manager. However, implementation was only possible after opportunely demonstrating mentoring as a valuable tool for the Trust.

Clearly the success of the innovation owes much to this opportunism. Indeed, there was no plan for the active promotion and dissemination of mentoring through the Trust. However, success was also attributed to the long period of trialing (since 1994) and piloting the process of mentoring and the use of external support (organisational psychologists and academics) to help the users of mentoring devise an approach that was adapted to fit their particular context.

10.10.2.4 Innovation 122

"*…one of the factors that made setting up this group easier was that things were more in place here and I felt more in a position of permanence*".

Innovation 122 was a community-wide, multi-agency violence prevention group, this was the initiative of a senior consultant, with its genesis in research he had conducted some 20 years previously.

The traditional clinical 'envelope' begins with patient admission and ends with discharge. This innovation significantly expanded the boundaries of that envelope into the wider community. Following an epidemiological study of "*…why people end up on my operating table with busted jaws, cut faces and all the rest*" it became apparent that only about one quarter of (violent) offences that resulted in NHS casualty treatment appeared in police records. There was the realisation that there were perpetrators putting casualties on the operating table every day of the week who were not being investigated and were left free to re-offend, and the concomitant psychological distress of the victims that triggered this innovation.

In the same way that the epidemiological studies of cancer have identified smoking as a risk factor, so innovation 122 sought to identify and reduce the risk factors associated with this form of injury. The innovation was clearly driven by the joint goals of reducing violence in the community and providing an integrated service for the victims. Understanding the histories of violence required a multi-agency approach, which included the police, judiciary and local authorities. Interested parties began to be recruited in 1996.

This clinician had trialed a multi-agency approach to the reduction of violence in a previous geographical location. That initiative had not been sustained, it was suggested, because the organisational goals had been directed elsewhere at the time. A greater degree of independence in a subsequent post and the combination of academic and clinical roles allowed greater attention to be focused on its development and implementation.

Trust senior management were reportedly very supportive of the innovation, but this was not felt (by the respondent) to be a significant factor in the process of the innovation. The significant factors were: collaborating with external agencies, A-shaped skills and hands-on involvement of the champion. Further, the Crime and Disorder Act was enacted in 1998 in which tackling crime became a multi-agency responsibility. Within this legislation health is included as a statutory partner. Innovation 122 was instrumental in helping to shape this legislation and, once enacted, a legislative framework for a multi-agency approach legitimised and helped embed the practice in the local community.

10.10.2.5 Innovation 188

"*We never thought that we would be quite in the position that we are now. It was quite unintended*"

Innovation 188 is described as an interdisciplinary communication strategy that has ultimately resulted in the development of a care procedure that is unique in the country. The label ‘interdisciplinary communication strategy’ masks the significant consequence of the innovation in that the team responsible devised a new protocol for the insertion and management of lines[18] that predates, by two years, the guidelines issued by NICE (the National Institute for Clinical Excellence).

The innovation is characterised, not by a clearly identifiable process as described above, but by a sequence of problem or issue awareness-issue resolution (see table 10-7). There was no apparent guiding vision apart from the “*natural instincts*” of one senior nurse who asked to take on the responsibility of line insertion and management for the patients under her care. Whilst this type of nurse responsibility was not practised in this particular unit it was, reportedly, not uncommon in hospitals in the UK. Indeed, before responsibility was delegated to the nurse (and training given etc.) literature reviews were undertaken to identify current best practice.

As each subsequent issue became apparent then again best practice would be identified and implemented within the context of the unit. Each individual step of what was done had been carried out in other hospitals. For each change that was made supportive evidence of it having been done successfully and beneficially nationally or internationally was found. The result of this series of small innovations was a line insertion and management protocol unique in the UK.

Issue	Solution
Need to check that central lines are appropriately positioned	Rapid radiological reporting
Lines need to be inserted into jugular	Use of ultrasound to guide insertion
Volume of line insertions per year using too much radiological resource	Delegation to nurses
Nurses lack appropriate training	Training course developed for nurse and other non-specialist personnel
District nurses unfamiliar with management of lines (e.g. flushing)	Training of district nurses
Different lines and procedures used in different departments of same hospital	Reduce number of different types of line to 4 or 5

Table 10-7: Innovation 188, issue-solution cycle

Principal contributory factor to the success was attributed to the informal nature of cross-disciplinary communication (radiology, oncology, nursing staff, external suppliers), accessibility of specialist personnel, all team members considered to be on a par and each knows what the others can do and, top management support. The Trust was supportive, in as much as what was being proposed by the team was felt to be

[18] ‘Lines’ are the tubes inserted into the vascular system for the administration of, amongst other things, blood products and drugs. They can be inserted peripherally (e.g. hand), centrally (chest) or centrally via peripheral access. The latter alternative offers many advantages over the other two and is often the preferred method. However, radiological (x-ray, ultrasound) support is necessary in order to ensure that the line is correctly placed.

congruent with the criteria the Trust had established to streamline services and use the skill mix more effectively.

10.10.3 Type 3 Innovations

Type 3 is characterised by relatively low values for ‘uncertainty’, ‘actual operation’, ‘relative advantage’, ‘profile’, ‘scope’ and, ‘observability’.

10.10.3.1 Innovation 32

“*As always happens in the health service the true innovative processes are not at all related to the bureaucratic services*”

Prior to the publication of NICE guidelines some anti-dementia drugs had not been available nationally. These drugs were ‘post-code prescribed’, which meant that decisions were taken at a local level as to whether or not they should be made available to patients on the NHS. Criteria for this decision included affordability, perceived efficacy and availability of local expertise to administer the drugs. Innovation 32 is a service that was developed to facilitate the introduction of these drugs into practice in an effective and efficient way into an area covered by one NHS Trust with no experience of using the drugs, in accordance with NICE guidelines.

At the request of the public health physician at the Health Authority the respondent, who had had experience of prescribing the drugs in a previous position, was asked to develop a protocol for their use. There followed a systematic approach of evidence gathering, review of alternative methods and local consultation that is suggestive of process as a linear sequence of activities. The protocol achieved early buy-in from potential users (prescribing clinicians) in primary and secondary care.

At the time considerable reorganisation was taking place at an institutional level, Health Authorities were being replaced by NHS Trusts. In two and a half years the respondent’s employer changed three times as institutions merged, de-merged and then re-merged. As a consequence of the institutional instability, the adoption of the innovation in the region overtook the committee review due process procedure that existed to implement NICE guidelines. The development of the innovation and its implementation took place, therefore, out of the sight of senior management. In fairness it was not the sort of innovation that would normally require an unusual level of attention from the Health Authority chief executive, but the instability created a difficult environment in which to innovate.

There was a confused period of business analysis (likely resource consumption implications resulting from prescription) due to changes at the institutional level in terms of commissioning arrangements and, lack of clarity about the availability of supplementary resources. This ambiguity and absence of extra resources required a flexible implementation from the multi-disciplinary team. Resources had to be cannibalised from other parts of the service (e.g. seconding nurses) and pharmacy “*...just had to cope with any extra cost*”. Two process factors were highlighted as being significant in successfully implementing innovation 32. The first was management support at the local level, management that was prepared to tolerate the ambiguity and sanction explorations of the unorthodox. The second was the preparedness of the multi-disciplinary steering group to take the risk of avoiding due process "*…if we had gone through all the due processes and followed the proper lines and so on we might well have not started using these drugs yet*".

10.10.3.2 Innovation 180

"*… and I distinctly remember the occasional patient saying to me 'Did you say I had an 80% chance of living or of dying?'*".

In discussions of life and death in oncology clinics it became apparent, in this case, that there was a high tendency amongst patients to forget what had been said during consultations. This can be understandable in terms of distress felt because of the condition, complexity of the issues being discussed, possible range of alternatives, alien environment and so forth. At best this meant that the consultant had to repeat himself at a later date, at worst patients' decision-making could be based only on partial remembrance. Innovation 180 is a simple patient communications strategy consisting of audio-tape recording and documentation of consultations developed to ensure that patients are able to reflect, at a later time, on the substance of the consultation and be appraised of potential future outcomes.

Although the issue of patient consultation recollection might be supposed to be quite widespread anecdotal evidence suggests that taped records are infrequently used. Anecdotal evidence, again, suggests also that this may be because of issues of risk management and potential for litigation against clinicians. So it was that this inexpensive approach to solving patient consultation recollection found little support in the Trust in which it was being implemented (by a single user).

However, experience had taught this innovator that soliciting institutional approval for behavioural or practice change was a cumbersome and ineffective approach. Consequently the innovation occurred within the user's consulting rooms and, on occasion, funded by the user. Amongst the patient and primary care community the innovation has been readily accepted: patients, their families and GPs remain fully informed with regard to the patient's condition and better placed to discuss and make decisions. Some clinicians were, reportedly, horrified at the notion but, following support from the Trust Chief Executive the innovation has become a routinised practice for at least one consultant.

10.11 Findings

Visual inspection of table 10-8 reveals only a moderate degree of patterning of process factors between the three innovation types.

Type 1 innovations are characterised by their relatively low values for 'disruption', 'risk' and 'ideation' and high values for 'adaptability', 'actual operation' and 'observability'. Internally, type 1 innovations (items 126 and 178) do not appear to share very much in common in terms of process factors. Both though, report on the presence of idea generation and analysis activities, which distinguishes them from type 2 and type 3 innovations. In contrast to type 2 and type 3 innovations there does appear to be a greater emphasis on the front end of the innovation process. For type 1 innovations, fewer factors are remarked to be notable (either by their presence or absence) than is the case for types 2 and 3.

Type 2 innovations are characterised by relatively high values for ‘disruption’, ‘risk’, ‘scope’ and ‘complexity’. Internally, there is some patterning of process factors for type 2 innovations. However, type 2 innovations reportedly emphasise group factors, particularly autonomy, Social factors and orientation. One notable exception is item 108 where ‘hospital machismo’ reportedly generated a climate in which it was felt unsafe to innovate. To a lesser extent, type 2 innovations exhibit some commonality of activity, reporting little emphasis on initiation activities (ideas and analysis) and some focus on implementation activities (technical development and launch). A final notable observation regarding the internal patterning of process factors related to type 2 innovations is the dissimilarity of factors related to management commitment. Norms and top management support were notably absent for items 22 and 108 as was resource allocation for item 188. The absence of a pattern suggests that each item is underpinned by different manifestations of management commitment.

Type 3 innovations are characterised by relatively low values for ‘uncertainty’, ‘scope’, ‘actual operation’, ‘relative advantage’, ‘profile’ and ‘observability’. Internally, there is little obvious patterning immediately evident from visual inspection. Whilst there is no clear pattern of group factors, the activities and sequence of the innovation process are, reportedly, not notable and, there is a notable absence of management commitment (specifically norms and resource allocation).

Visual inspection also fails to identify any strong external patterning of process factors that would clearly discriminate between types. The sequence in which activities occur appears not to be notable or to discriminate between innovation types. Two innovations (188 and 32) exhibit linear characteristics and two (126 and 108) exhibit recursive characteristics. For five of the innovations sequence of events was not considered a notable factor (either by its presence or absence). The two innovations that noted the presence of a linear sequence of events (32 and 188) do not noticeably share other characteristics. The two that reported a recursive sequence (126 and 108) share little in common, other than a noted absence of there being any formal or planned process.

Group factors are notable across each of the clusters. Several studies have demonstrated that enabling climates are associated with successful innovation (West, 1990; Ekvall, 1996; Chiesa et al., 1996) and so, it is perhaps not surprising to find that group factors are notably present rather than absent or not mentioned given that each of these innovations can be considered in some sense a success (an assumption on the researcher’s part based on entry to awards). Five dimensions of group factors were investigated (champion, vision, autonomy, Social factors and orientation), none appears to be more significant than any other.

The internal consistency of pattern configuration of each of the innovation types appears, on visual inspection, to be only moderate. This is also the case for external patterning. Visual inspection, therefore, provides modest support for the notion of the

			Innovations								
			Type 1		Type 2					Type 3	
Process Factors			126	178	6#	22	108	122	188	32	180#
Activity and sequence	Activity	Idea	Conjunction of events triggers ideas	Formal exploration of potential solutions to trigger issue	Formal techniques	External stimuli	N/A	Academic research	N/A	N/A	N/A
		Analysis	With external partner	Feasibility studies and piloting	Options appraisal	N/A	N/A	N/A	N/A	Piloting	N/A
		Technical development	N/A	N/A	Modification of resources	Testing potential solutions	Long period of informal development	Piloting	N/A	N/A	N/A
		Launch	N/A	N/A	N/A	Profile building	Formally applied to mainstream activities	Formal high profile launch	N/A	N/A	N/A
		Formality	No formal process in existence	Formal initiation	Formally constituted reviews	N/A	No formal process in existence	Multiple partners	No formal process in existence	Regularised steering group	N/A
	Sequence	Linear	N/A	N/A	N/A	N/A	N/A	N/A	Series of discrete activities (but not formalised)	Series of discrete activities (but not formalised)	N/A
		Recursive	Adaptable, flexible and able to modify	N/A	N/A	N/A	Adaptable, flexible and able to modify	N/A	N/A	N/A	N/A

Contd/…

			Innovations								
			Type 1		Type 2					Type 3	
Process Factors			126	178	6#	22	108	122	188	32	180#
Enabling climate	Management commitment	Norms	N/A	N/A	N/A	Not encouraged	Not encouraged	N/A	N/A	Not encouraged	Not encouraged
		Resource allocation	Diverted from existing resources	N/A	N/A	Diverted from existing resources	N/A	Diverted from existing resources	Diverted from existing resources	Lack of clarity	Self-funded
		Top management support	N/A	N/A	N/A	Moderately hostile	Passive	Supportive	Supportive	Supportive	N/A
	Group factors	Champion	New consultant champions the innovation	Consultant-led	Consultant-led	N/A	Consultant-led	Consultant-led	N/A	Consultant-led	Consultant-led
		Vision	Vision of destination but not of the journey	N/A	N/A	N/A	Yes	Yes	Yes	N/A	Yes
		Autonomy	N/A	N/A	Independent decision making	Departmental autonomy	Yes	Yes	Yes	Yes	Yes
		Social factors	N/A	Longevity and familiarity	Multi disciplinary collaborative team	Familiarity	Hospital machismo	Permanence	Informal and cross-disciplinary	N/A	Yes
		Orientation	N/A	N/A	Regular reviews	Shared objectives	Shared objectives	Shared objectives	Flexibility	Tolerance of ambiguity	Challenge to orthodoxy

Table 10-8: Comparison of innovations' process characteristics

# Denotes type exemplars

Factor is notably absent
Factor is notably present
Factor is not applicable (N/A)

three different innovation types being underpinned by different process factors. In order to test this conclusion cluster analysis was applied to the data, using Ward's method and squared Euclidean distance[19]. The results of this analysis are presented in figure 10-2.

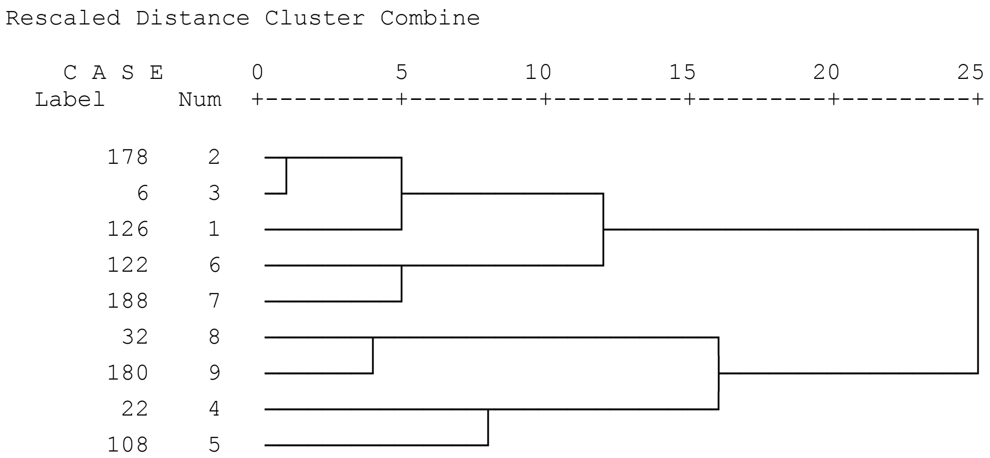

Figure 10-2: Dendrogram showing clusters of innovation types according to process factors

The cluster analysis confirms the conclusion of the visual inspection that patterning according to process factors is moderate. It is evident that the process of cluster analysis has not generated 3 clusters comprised of items that make up the three innovation types. However, three clusters do appear to have been generated:

- Cluster 1: items 6, 122, 126, 178 and 188
- Cluster 2: items 32 and 180
- Cluster 3: items 22 and 108

The membership of items according to their innovation type and the process cluster to which they belong, is illustrated in table 10-9.

Innovation type	Type 1		Type 2					Type 3	
Item	126	178	6	122	188	22	108	32	180
Process cluster	Cluster 1					Cluster 2		Cluster 3	

Table 10-9: Item process and type membership

The items in process cluster 1 (126, 178, 6, 122, and 188) are items that are drawn from both type 1 and type 2 innovations. Process cluster 2 contains only two items (22 and 108), both type 2 innovations. Finally, process cluster 3 contains two items (32 and 180), these are both type 3 innovations. There would appear to be some support,

[19] See Chapter eight for full discussion of cluster analysis.

therefore for the distinctness of type 3 innovations on the basis of process factors. However, the degree of overlap between type 1 and type 2 innovations suggests that the two types may not be clearly discriminated in terms of their underlying processes. It is notable that the exemplar from type 2 (item 6) clusters with items from type 1 innovations.

Using process factors as the cluster variables, the two items that comprise the sample of type 1 innovations cluster together as do the two items that comprise the type 3 sample. This suggests that there is some pattern of process that is common to type 1 innovations and is different from type 3 innovations. However, given that items comprising the sample drawn from type 2 innovations do not all cluster together weakens the claim of process separability. Three type 2 items (6, 122 and 188) cluster with items from type 1 innovations, and two items (22 and 108) form a separate cluster of which they are the only members.

Cluster analysis, therefore, provides moderate support for the notion that innovations, distinguished from each other according to configurations of user perceptions, can be discriminated from each other according to process factors underpinning their development.

10.12 Summary

Innovation is conceived of as a multi-stage process characterised by multiple concurrent and divergent activities that may or may not occur in discrete sequential stages (Schroeder et al., 1989) on which many social factors impinge (Scott and Bruce, 1994). The general conclusion of process theorists is that the fundamental components of the innovation process remain constant. However, there can be considerable variation across projects in terms of the nature and sequence of activities and the conditions in which innovation takes place, from which innovations that differ one from another in several respects may result. Empirical studies have suggested that innovation processes differ according to differences in selected attributes of the innovation (Pelz, 1983; Pelz, 1985; Schroeder et al., 1989; King, 1992). Although labels exist that describe the activities (processes) by which innovations are generated and implemented and, schemata that articulate the sequences of their occurrence, we know little and with little certainty, how different configurations of these activities might be associated with different types of innovation. Some authors suggest connections between processes and outcomes, Pelz (1983, 1985) connects disorderly processes with complexity and originality of outcome, Schroeder et al. (1989) and King (1992) connect disorderliness and the rated novelty of the outcome. It is on this basis that this chapter aims to build. On the basis of these observations this chapter has explored the utility of the innovation taxonomy developed in the previous chapter in terms of underlying process factors.

The chapter commenced with a review of process literature, identifying three key themes: sequence of events, activities and enabling climate. A sample consisting of nine innovations drawn from each of the innovation types (two exemplars and seven contrasting innovations) was interrogated on these key themes. Following content analysis of qualitative data visual inspection and cluster analysis were used to identify the extent to which the three innovation types exhibited internal homogeneity in terms of process factors and external heterogeneity between types.

These results could be interpreted in several ways and should be treated with caution. It was not the objective of this research to investigate the nature of any relationships between innovation processes and types of innovation as described by the novel taxonomy. Rather, the objective was to explore the potential utility of the taxonomy in generating new insights into the nature of innovation. In applying the taxonomy to an investigation of process there appears to be moderate support for the proposition that innovation types 1, 2 and 3 can be discriminated according to underlying process factors.

Type 1 innovations appear to be associated with an emphasis on factors relating to initiation and innovation championing, type 2 with factors relating to implementation and notably dissimilar instances of management commitment and, types 2 and 3 with enabling group factors. This research does not attempt to explain why this might be the case, that must be left for future research. However, it does demonstrate the utility of the taxonomy.

Further, these results come with a *caveat* attached. First, the sample of innovations drawn from each of the types is not representative. Consequently it is difficult to generalise from the results of Phase III to the whole population of innovations that comprised the sample for Phase III. Second, the sample is unevenly distributed across the three innovation types, two items come from each of type 1 and type 3 and five items from type 2. Third, it is difficult to draw any firm conclusions with regard to the nature of internal patterning in a group when that group consists of only two items.

Notwithstanding these limitations the results indicate that the taxonomy may provide a useful alternative perspective on the classification of innovations. The following chapter addresses this in greater detail.

11 CONCLUSION

11.1 Introduction

The concept of innovation is complex and is not adequately explored in unidimensional studies. Slow progress in the development of innovation theory has been attributed to inconsistencies in the labelling of innovations (Garcia and Calantone, 2002). Consequently, innovation studies lack a shared set of concepts and definitions that, to an extent, promulgates context dependent, contingent theorising. The consequence is that opportunities for a cumulative tradition based on well-defined constructs and the operationalisation of these constructs are restricted (Moore and Benbasat, 1991).

Past authors have chosen to distinguish between innovations according to different criteria such as newness or 'radicalness' (for example Damanpour, 1988), or innovation type such as technical, administrative…and so forth (for example Subramanian and Nilakanta, 1996). However, it cannot be assumed that all radical innovations are equal in their 'radicalness', or that one organisation's administrative innovation would be similarly construed by another, though these are assumptions that underpin many previous studies. Extant classification systems can therefore be criticised for their tendency to assume that entities within a category of the classification system are identical on all dimensions (of the variables) that define that category. They may also be criticised for failing to take account of the mutability of innovations.

Extant classification systems often lack generalisability because they fail to take account of the different ways in which innovations are perceived in different contexts and their labels are inconsistently defined and applied (Afuah and Bahram, 1995). This observation reflects Whitley's (1984) wider critique of management research in which problems and approaches are selected in an *ad hoc* and opportunistic fashion. Without a clear specification of concepts and constructs it is unlikely that theory development in innovation studies could develop beyond Pinder and Moore's (1979) notion of low level theory.

There have been calls for a change of emphasis in the unit of analysis that places the innovation artefact at the centre of innovation studies. Wolfe (1994) argues for a move away from organisational innovation to 'innovation-in-an-organisation'. This would help in the analysis of organisation specific innovation attributes and in investigating the nature of, and factors that influence, innovation processes within organisations. Calvert et al. (2002) argue for a more holistic approach to the study of innovation and the development of instruments that allow wider generalisability and comparative research. Such perspectives permit greater sensitivity to the multi-dimensionality of innovation.

This research addresses the issue of non-comparability due to the absence of a scientifically grounded formal framework of innovation. The importance of scientifically determined classifications, as a basis for the advancement of knowledge, is well established (Bailey, 1994). At the heart of this research is the objective of developing a generalisable formal framework of innovation, enabling the comparison of innovations across cases. This research conceives of innovations as consisting of diverse bundles of attributes. The notion of configurations provides a conceptual and theoretical starting point for operationalising a multi-attribute framework of innovation. Configurations are used to describe broad, natural bundles of the different elements that comprise an innovation, so that distinct types can be identified. Importantly, configurations do not specify direct causal relationships among the individual elements (Manu and Sriram, 1996) and the contribution of this research is not in explaining relationships but exploring aspects of their existence.

A discussion of the three dominant approaches to the classification of innovations based on newness, area of focus and attributes is presented and their limitations are discussed. A novel system of classification of innovations based on a comprehensive conceptualisation of innovator and user perceptions of the innovation artefact is then proposed. In so doing, this research has drawn on the biological sciences' approach to classification, a discipline that has long struggled with its own 'species problem', the problem of classifying diversity (Hey, 2001).

Innovation researchers are required, at some point in their studies, to make a choice between breadth and depth of study. Straddling the two presents significant challenges within the context of a PhD. This research consists of three empirical phases, the first two are in-depth and the third broad.

The research commenced with in-depth inductive empirical and literature studies designed to generate both a framework and a survey instrument to provide a sensitive measure of innovation, with high potential for general application. In Phase II, the survey instrument was distributed to a sample of 310 innovations from the NHS, drawn from examples of best practice and entrants to competitions. The framework and survey tool were designed as formal instruments (Blaikie, 1993) and may be generalised to other studies.

From the survey, 171 usable returns were subjected to cluster analysis from which three clusters of innovation type emerged. The utility of this taxonomy is subsequently examined in Phase III by means of a brief exploration of process factors in a sample drawn from each of the three categories of innovation. The taxonomy provides a useful abstraction of the empirical observations of 171 innovations and identifies key variables describing the artefact/process relationship. In focusing on concepts of interest to innovators (in a single sector) the research contributes a synthesis of a wide variety of NHS innovating situations, and is consequently readily applicable in the context of practice. The triad of this study's conceptual analysis, abstraction and the field of practice helps to close the theory-practice gap.

However, the study is limited by its exploratory nature. Consequently, from its final phase it is difficult to draw widely generalisable conclusions. Analysis in this phase has been based on interpretations of the significance attributed by respondents to different parts of the process underpinning their innovations. Future studies might consider operationalising more robust measures of process in order that a more objective understanding of the significance of process factors might be elucidated. However, in spite of these limitations, the findings provide a useful basis for discussion and future research and it is to these that this chapter now turns, first with a consideration of contribution.

11.2 <u>Research contribution</u>

This research contributes to the existing body of knowledge in three areas: to academic theory, to the methodology of innovation research, and to the theory of practice. These contributions are reviewed below.

11.2.1 Contribution to academic theory

The overarching objective of this research was to develop and investigate the utility of a classification of innovation based on a more sensitive and robust measure of the innovation artefact. Implicit within this objective was the requirement to address and overcome the conceptual and methodological limitations of previous research. Specifically, six major issues were identified in the literature:

- The narrow conceptualisation of innovation artefact.
- The empirical indefensibility of Rogers' (1983) framework, on which a large proportion of subsequent studies have been based.
- The absence of systematic quantitative comparative analysis of the attributes of different innovations.
- The narrow scope of previous applications of multi-dimensional instruments.
- Class homogeneity within existing typologies.
- The problem of panel members 'assigning' attributes to others' innovations (see section: Contribution to the methodology of innovation research).

Each of these issues is fully addressed below.

The first issue identified was the problem of the narrow conceptualisation of innovation artefact. There have been relatively few empirical studies of attributes of innovation not least of all because of the conceptual and methodological complexity that such an approach implies (Fliegel and Kivlin, 1966). One contribution of this study is to that developing body of theory that adopts the innovation artefact as the unit of analysis and, importantly, attempts to treat it holistically rather than disaggregating it into its component parts. The argument for an holistic approach in organisational studies was laid down by the work of the Aston Group in the 1960s (Pugh and Hickson, 1996). They argued that the complexity and changing nature of organisations could best be understood by consideration of the working whole. Miller and Mintzberg (1983) developed the argument by suggesting that the analysis of organisations by their disintegration into component parts has not helped the resolution of key issues in organisation theory. Indeed, configurational thinking extends the tendency of contingency theorists to make disaggregated, one-to-one comparisons of variables to more holistic and aggregated comparisons of whole types (Pettigrew et al. 2001). The benefit of the holistic approach in innovation research is that it enables those items that have traditionally been viewed as discrete (i.e. multiple attributes) to be meshed in a powerful integrating device. In this instance that device is the framework of innovation attributes.

Through the exploration of attributes in the empirical study, this research addresses the second issue identified from the literature, the empirical indefensibility of Rogers' (1983) framework, on which a large proportion of subsequent studies have been based. The role of attributes in innovation research is well-established (see Chapter five). The results of Phase II of this research suggest that ten of the 13 attributes operationalised appear significant to innovators in discriminating between innovations. Seven of these feature prominently in previous studies and so the results support earlier findings that 'observability' (Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982), 'risk' (Tornatzky and Klein, 1982), 'uncertainty' (Zaltman et al. 1973), 'complexity' (Rogers and Shoemaker, 1971; Rogers, 1983), 'adaptability' (Rogers and Shoemaker, 1971; Rogers, 1983), 'scope' (Goodman, 1981) and 'relative advantage' (Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982) play an important role in understanding innovation. 'Departure', 'novelty' (a narrow conceptualisation based on degree of change from pre-existing conditions) and ideation did not find wide support as distinguishing factors.

This research offers the attributes 'disruption', 'profile' and 'actual operation' as salient in the perceptions of innovators as characteristics according to which they distinguish between innovations. These three attributes have little in the way of empirical or theoretical history in the innovation literature. It is further interesting to note the absence from the framework of factors significant in previous studies. Notable amongst these are 'trialability' and 'cost' (Rogers and Shoemaker, 1971; Rogers, 1983; Tornatzky and Klein, 1982).

The absence of 'trialability' is a reflection of the selection criteria for the inclusion of attributes in the framework laid down in Phase I of the study. The absence, too, of an economic or financial perspective in the framework of attributes is notable. Downs and Mohr (1976) describe 'cost' as a primary attribute, one that is invariant across cases, though it is argued in Chapter 5 that the attribute 'cost' might be differentially reified according to individuals' perceptions in different contexts. That is, it might be construed as expensive in one context and inexpensive in another. Nevertheless, Downs and Mohr note it to be a significant attribute. Frequently economic and financial factors are subsumed within the construct 'relative advantage' which comes to reflect social and financial benefits (Tornatzky and Klein, 1982). The absence of 'cost' from the framework of attributes can be explained by the rigidity of the selection criteria.

The strict criteria were instrumental in helping to develop a rigorous and parsimonious framework and were important in addressing the third identified issue, the problem of the absence of systematic quantitative comparative analysis of the attributes of different innovations. This was addressed by the development of an instrument to measure individuals' perceptions of innovations. It was developed from a general/formal framework and thus distinguishes itself from other instruments that measure perceptions. It contrasts with the innovation specificity of other multi-attribute research (for example, Moore and Benbasat (1991), Meyer et al. (1997), Agarwal and Prasad (1997), and Dearing and Meyer (1994)). Dearing and Meyer (1994) develop a conceptual tool to aid the prediction of which innovations, amongst a set of functionally similar innovations, are most likely to be adopted, based on innovator and adopter perceptions. This research extends previous work by suggesting that a configuration based on attributes offers potentially richer opportunities for understanding than do classifications based on functionally similar innovations. By investigating a broad range of innovations, this research addresses the fourth key issue to be identified in the literature, the narrow scope of previous applications of multi-dimensional instruments. Importantly, this research moves attributes research away from narrow studies of single innovations in an organisation to a study of a range of contrasting innovations within the context of arguably the largest employer in western Europe.

It is evident from the case histories in Phase III of the research that 'piloting' and 'trialing' and financial factors (in terms of resource allocation) were prominent features of some innovators' processes (and not for others). This is the perennial problem of operationalising constraining frameworks, that one finds what one is looking for. As Rogers (1983; 177) notes, "*when investigations are designed with the concept of re-invention in mind, a certain degree of reinvention is usually found*".

One consequence of the strict selection criteria was that some attributes, potentially significant from the point of view of classification variables, were excluded. These selection criteria stipulated that, to be included in the framework, evidence of the attribute must be present in the majority of responses and in each of the case studies. The output of cluster analysis is immediately constrained by the selection of variables used to characterise the item, any derived structures are therefore only reflections the structure of the data that has been defined by the initial variables (Hair et al., 1998).

The consequence is that variables with value as a discriminating factor may have been excluded, clearly this will have to be tested in future research. Therefore, it might be argued that the conceptualisation remains narrow and therefore the patterns identified within the data are incomplete because (important) dimensions may have been excluded. It may be that the absence of these partly contributes to the only modest relationships found between innovation and process in Phase III. Further, it limits any claims regarding the formal and generalisable qualities of the framework.

The framework, its operationalisation and the subsequent emerging innovation types address the fifth issue identified in the literature, that of class homogeneity within existing typologies. This research has contributed to a finer-grained, 'nuanced' investigation of innovation process than other classifications of innovation permit. The finding that innovators' perceptions vary is not original. What is new is the discovery that these variations configure into three discrete types of innovation. This extends Meyer et al.'s (1993) observation in strategic management research that there is a tendency of multiple attributes to fall into coherent patterns, into the domain of innovation.

The finding that a narrow conceptualisation of novelty was not a useful factor in the perceptions of innovators to discriminate between innovations may represent something of a challenge to the orthodox approach to the classification of innovations. It may be the case that the borders between innovation types are blurred, and that they cannot easily be classified. But, the value of this analysis has not been to assert the existence of 'natural' types of innovation but the provision of an approach and nascent framework that is a useful tool for communication and exploration. That is, attributes provide a useful framework for examining the properties of innovations and as a basis for their classification.

This study also makes a contribution to innovation process research. The utility of the new taxonomy was explored in the context of innovation processes. Phase III considered three aspects of process: activities, sequencing and enabling climate. The framework for the analysis of process was drawn from existing theory and was broadly scoped. On the basis of the analysis of data, drawn from nine cases from the three innovation types discovered in Phase II, no new elements of process were unearthed, which confirms the completeness and endurance of extant models. However, different process elements were found to be emphasised in each of the three innovation types.

Innovation types 1 and 2 were distinguished from each other in terms of their emphasis on activities associated with the initiation and implementation of innovations. The requisite group and organisational characteristics appropriate for initiating and implementing innovations have long been considered to be different (Burns and Stalker, 1961; Holbek, 1988; Rabson and DeMarco, 1999). This research provides empirical support for that dichotomisation but, for the first time, relates it to the characteristics of the artefact, not of the organisation.

The high relative value for 'adaptability' that characterises type 1 innovations may reflect the focus on initiation activities, particularly idea screening and business analysis, where solutions that have the potential to be moulded to specific local circumstances are selected. Type 2 innovations, on the other hand, are characterised by high values for 'disruption', 'risk', 'scope' and 'complexity', which may explain the apparent focus on implementation activities. Type 3 innovations did not exhibit any clear activity patterns.

Type 3 innovations were notable for the reported absence of management commitment (that is, senior management external to the management within the innovating group). Management commitment has been positively associated with innovation success (Amabile, 1983; West and Anderson, 1996). Arguably, all the innovations in the Phase III sample are 'successes', an assumption based on the fact that each was an applicant for an award. It is interesting, therefore, to notice the absence of management commitment in these successful innovations.

For innovation types 2 and 3 group factors were reportedly notable and appear to confirm the work of Anderson and West (1996; 1998), West and Anderson (1992; 1996) and Ekvall (1996). Why it is that type 1 innovations do not report either the notable presence or absence of group factors is unclear. Both type 1 innovations report the notable presence of a champion. Presence of a single product champion differentiates successful innovations from failures. The champion is the individual whose presence differentiates most strongly for success. They are generally individuals who are enthusiastic towards the innovation, but who also have sufficient authority and power to affect the course of the innovation. The role is one of communication and co-ordination, to organise the marketing, production and research and development functions and to integrate them into a continuous innovation process (Rothwell et al., 1974). This may suggest the presence of an heroic, lone innovator for type 1 innovations, supporting the work of Schon (1963). This was a plausible explanation for innovation 126, but innovation 178 was clearly a group effort.

Innovation 22 represents an interesting contrast to Daft's (1978) dual-core model of innovation. Ostensibly recruitment and retention would be considered to be administrative innovations, originating in the administrative core of the organisation. This was not the case in this instance. The administrative core had reportedly failed to innovate and it was this failure that stimulates the technical core to develop its own innovation in response to the perceived failures of the administrative system. The administrative core then proceeded to try and claim the innovation for its own with the resultant consequence that once taken away from the technical core, from which it originated, the innovation failed to deliver any of its earlier benefits.

Finally, this research makes a contribution to that body of research that investigates organisational climates for innovation. The predominant theme in this body of literature is to identify optimum or ideal characteristics of innovation climate (Anderson and West, 1998; Ekvall, 1996). Whilst these studies describe climates that managers might strive to emulate or promulgate, this research describes the lived-experiences of clinicians and managers in the NHS. As such it provides them with a road map of issues to be alert to in undertaking the process of innovation.

11.2.2 Contribution to the methodology of innovation research

In the preceding chapters much has been made of the need for methodologies and conceptual frameworks that will enable innovation research to be broadened and shared across cases and across studies. The diversity of operational definitions and different disciplines' analytical and methodological assumptions has created richness in innovation studies but makes comparison problematic. This issue of unstable frameworks has been addressed through the systematic quantitative comparative analysis of the different attributes of innovations facilitated by cluster analysis.

One objective of this research was to develop a taxonomy of innovation based on users' and innovators' perceptions. No studies with this objective, either in the NHS, or indeed any other sector, have been discovered. In order to achieve this objective, principles and methods of numerical taxonomy elucidated by Sneath and Sokal (1973), see table 11-1 have been employed.

This approach marks something of a departure in innovation research. The introduction into the management sciences of statistical tools for systematic classification has provided the opportunity to explore the existence of types based on configurations of their attributes. It is uncommon for innovators and users to rate innovations according to their perceptions, in this case elicited by the use of Likert scales. More commonly, panels of judges assign scores to an innovation or series of innovations, (for example (Wilson et al., 1999; West and Anderson, 1996), and these scores are then held to be constant across adopting organisations. This seems a rather remote way of assessing

Practice of numerical taxonomy	Research question and objective	Research method
Organisms and characters are chosen and recorded.	How do users and innovators perceive their innovations? Identify and catalogue attributes from previous research and validate them in the context of empirical study.	Inductive empirical (4 case studies combining interview, repertory grid technique and analysis of documentary data) and literature studies.
The resemblances between organisms are calculated. Taxa are based upon these.	Do attributes configure into discrete taxa? Create parsimonious framework based on strict selection criteria. Explore whether or not innovations can be clustered according to different configurations of attributes.	Utilise Churchill's (1973) paradigm as a guide for synthesis and instrument development. Apply survey instrument to sample of innovations and calculate degrees of similarity through cluster analysis. Stopping rules establish number of taxa (i.e. number of innovation types).
Generalisations are made about the taxa (such as inferences about their phylogeny, choice of discriminatory characters etc).	To what extent can differences in process be recognised for each of the types of innovation? Explore utility of the taxonomy in the context of innovation process.	Cross-sectional exploration of process in sample drawn from each taxa (innovation type) by telephone interview. Content analysis for identification of process factors.

Table 11-1: Sequence of operations in numerical taxonomy developed in biological sciences and applied in innovation research (after Sneath and Sokal, 1973; 5)

perceptions that are normally assumed to change across individuals. The problem of panel members 'assigning' attributes to innovations was held to be the sixth issue identified in the literature. The method employed in this research accommodates the variation of perceptions across individuals and permits a method of comparison of innovations that share and have in common configurations of attributes. Arguably, this creates an analytically more relevant dimensionalisation of innovation than those based on judges' assessments (Warner, 1974). As such, the research design adds to earlier research into perceptions in innovation by developing and operationalising the multi-dimensional configurational approach.

11.2.3 Contribution to the theory of practice

The issue of innovation is currently significant in the NHS, and this research makes a contribution to those involved in the tasks associated with it. The NHS is characterised as a political and politicised organisation, influenced by multiple and often conflicting interest groups and stakeholders. Further, attempts to bridge the often tense power relation dynamics between clinicians and managers have been made with the development of the hybrid clinician-as-manager (Fitzgerald and Dufour, 1998). McNulty and Ferlie (2002) draw attention to the changing context of the UK health care sector and argue that change cannot and should not be abstracted from the context from the context in which it occurs. Thus, the characteristics of the milieu are likely to be important to an understanding of the processes of innovation. Shifts in political ideologies since the 1980s have led to processes of managerialisation and marketisation of the health service, but not fully to the extent that the NHS has converged with private sector organisations in terms of behaviours, drivers, and practices. Individual clinicians are increasingly being asked to take on managerial roles in the NHS for which they have little training. This research exposes, for the first time, the ways in which they perceive one aspect of that role.

One interesting outcome of this research is that, although the innovation artefact was specified as the unit of analysis, respondents seemed unable easily to distinguish the artefact from arguably contextual or environmental factors. That is, they did not perceive their innovations as existing independently from the context of their development and ultimate application. Consequently, the framework developed as the empirical survey instrument for this research cannot be accurately described as a framework describing output or outcome in the conventional uses of the terms. Thus confirming Dearing and Meyer's (1994) conclusion that when answering questions about innovation attributes, respondents do consider broader contextual issues.

It is apparent from this study that innovators in the NHS are not well informed of the output of several decades worth of innovation research. In recent years some attempt has been made to inform change agents, increasingly clinicians tasked with management responsibilities, with some of the output of this research (for example Iles and Sutherland (2001). However, the development of management skills is not prioritised in the general education of clinicians. Consequently, this research offers a useful contribution to the education of innovators in the NHS.

In narrow terms, a number of innovators who participated in the research found the process educative and informative, for example:

> "*…the* (innovation) *process we are going through is not working* (because of the debate initiated by repertory grid technique) *I am really beginning to understand why some of our projects are going better than others... the methodology we are using in that is really not going very well... we haven't really got the methodology … the problem is that there isn't really a defined methodology and it is becoming evident*" **[B1]**.

More widely, by synthesising the perceptions of 171 innovators into three innovation types, the research contributes by elucidating innovation environments in which, in this single sector, innovators may potentially find themselves operating.

Unique process profiles have been suggested for each of the three types of innovation developed in this research. This may provide a valuable framework for generating additional insights into management needs and techniques necessary for different innovation types. For example, type 2 innovations are characterised by relatively high values for 'risk', 'disruption', 'scope' and, 'complexity'. There are echoes in the type 2 processes of discontinuous innovation. Veryzer (1998) described discontinuous innovation as being characterised by high levels of uncertainty, an exploratory less-customer-driven process that, because of its uneven iterative nature, is less well-suited to formalised highly-structured processes or systems. As Veryzer (1998; 318) notes "*It is important…that the development process for these types of* [innovations] *allows for* *the 'unconventional' progression of activities inherent in discontinuous innovation*". It may be that innovations occur without the commitment of senior management and that, under such conditions, innovating is inherently risky, disruptive and uncertain. Case study A in Phase I suggested that this may particularly be the case where innovations are confrontational.

Clinicians engaged in the dual role of clinical care and management process can struggle with the complexity of conflicting demands (Weight, 2001). The three emergent innovation types and the associated processes imply different innovation contexts across organisations. By recognising differences between them it may be possible to describe generic management responses to each of these conditions. This would be particularly important in the case of clinicians with little managerial experience. Consequently the research makes a contribution to enabling more prudent and better-informed management decisions, with regard to innovation, amongst a community that is now encouraged to solve problems and work in ways for which it has no particular training.

Further, a taxonomy based on attributes offers a more plausible basis for comparison and generalisation because it does not rely on the assumption of constancy as do typologies based on area of focus. As Meyer et al. (1997) note, managers need to be aware that contextual factors impact the ways in which innovation attributes affect innovation outcomes. Within the context of the NHS such an understanding of the different ways in which innovations are perceived can help managers be more prepared for the issues that they may encounter when tasked with being innovative. Such an approach to measurement may possibly be extended to other sectors. Through its Beacon Status programme the NHS tends to encourage organisational learning on a functional basis, that is palliative care teams will learn from other palliative care teams. This is clearly a legacy of the clinical prioritisation that has characterised health care. This research has demonstrated that an innovation in palliative care may have more in common with an innovation in, say accident and emergency or primary care than with another innovation in palliative care (expressed in terms of configurations of attributes). A final contribution of this research then, is to ease this complexity through the articulation of the process-artefact relationship. This broadens the scope for organisational learning in the NHS.

11.3 Validity, limitations and future research

This alternative approach to classification of innovations supplements the more orthodox views based on newness and area of focus and offers a more sensitive facility to investigate the nuances and complexities of innovation. Nevertheless, the study does have some limitations. The overall research objective of this study has been accomplished through a series of projects, described as phases, each following a different research strategy. The principal contribution of this research lies in the first two phases in which the taxonomy is developed. The third phase offers a brief exploration of process, and illustrates a potential application of the taxonomy.

Each of the three phases can be conceived to stand alone as a discrete project. They are all, however, underpinned by a realist perspective, justified in terms of facilitating the exploration of people's difficult to articulate perceptions. The notion of reproductive compatibility appears to be a natural basis on which to ground the species concept in the biological sciences. The equivalent in innovation research appears to be the notion of newness. The sufficiency of newness has been challenged in this research and an alternative scheme based on innovators' perceptions has been proposed. This has provided some utility for generating insights into the artefact-process relationship. Ultimately, however all classification schemes might be described as arbitrary, the products of people's linguistic or epistemic predilections and measurement efforts too often create boundaries where none apparently exist (Gold, 2002).

Whilst these are credible positions to maintain from the realist standpoint, the issues of validity and reliability are sensitive ones for research orientations that reject positivism's implied methodological correctness. The positivistic preoccupations of validity and reliability are argued to be inappropriate in qualitative research (Kincheloe and McLaren, 1994). Consequently, Schwandt (1994) wonders 'in what sense can knowledge that is socially constructed (as realism allows) and residing in the minds of individuals reasonably be said to be verifiable or testable?' That is not to say though, that the confidence that validity and reliability impart to a piece of research is inconsequential. Alternative criteria for qualitative and interpretive research, against which levels of confidence can be appraised, have been suggested (Yin, 1994; Mark and Lynch, 2000; Kincheloe and McLaren, 1994).

Case studies underpin Phase I of the research and Yin (1994) recommends three tactics to ensure construct validity in support of this strategy. The findings of this stage are based on multiple sources of evidence, there is a clear and auditable chain of evidence and informants have been involved in reviewing the analysis. Component parts for the framework were drawn from 23 semi-structured interviews, 16 applications of repertory grid technique and archival data from four cases of successful innovation. These data were subject to content analysis and reduced by the method of constant comparison as elaborated by Glaser and Strauss (1980) and Miles and Huberman (1994). The data were synthesised with that drawn from the extensive, systematic and ongoing thematic investigation of the literature.

The practice of 'systematic review' is relatively long-established in disciplines such as medicine where it has been described as a "*fundamental scientific activity*" (Mulrow, 1994; 597). One objective of systematic review is to provide a synthesis of otherwise unmanageable volumes of research studies which, through the use of explicit methods, aims to limit bias and improve the reliability and accuracy of conclusions (Mulrow, 1994). In management research, however, it is relatively untried and a methodology has only recently been proposed (Tranfield et al., 2003).

This research pre-dates Tranfield et al.'s (2003) process and some of the features of systematic review were not adopted. In particular, the review was not driven by a review panel and was not pre-planned. However, in all other respects, the principles of systematic review were adhered to. This review employed a comprehensive search to locate all relevant studies, the relevance and quality of these studies was appraised and key descriptive findings presented. Key attributes of innovations were then extracted from individual studies and, by identifying patterns and making connections, these were synthesised into a framework of innovations based on attributes. As Campbell et al. (2003; 672) suggest, the aim of any synthesis is to "*achieve a greater level of understanding and attain a level of conceptual or theoretical development beyond that achieved in any individual empirical study*". This review represents a theoretical development and formed the basis for the formal framework of innovation used in the empirical study.

Subsequently, the framework was drawn up subject to specified criteria and, as the research moved from a qualitative to quantitative approach the survey instrument was developed according to Churchill's (1973) paradigm. The framework is developed from high quality underlying data characterised by a rich and elaborate dialogue between cases and attributes derived from the literature that allowed for a meaningful analysis and interpretation of innovations. It goes someway to achieving its objective of a standardised tool generalisable across fields and disciplines but remains in need of further development.

A further component of instilling confidence in research results is 'trustworthiness' (Lincoln and Guba, 1985). Trustworthiness is argued to be a more appropriate construct in qualitative research than internal validity (are the researcher's observations and measurements a true description of a particular reality?) and external validity (the generalisability of results to other domains). One criterion for critical trustworthiness involves the credibility of portrayals of constructed realities (Kincheloe and McLaren, 1994). The nature of the PhD process demands that a single individual conduct the research and analysis. There are of course opportunities for validating and ensuring the reliability of the research or, for qualitative approaches, ensuring the credibility, transferability, dependability and confirmability of the research (Lincoln and Guba, 1985). The credibility of the portrayals can, therefore, be assessed in these terms: by their plausibility to those who constructed them (respondents); by peer review from domain relevant experts in learned journals and at conferences; by the use of multiple coders; by testing and developing instruments in the context of their application; and, the support infrastructure (supervisors, seminars, discussion groups and so forth) that exists at the researcher's institution to air and test ideas. Trustworthiness may also be achieved through the rigorous application of procedures designed to combat common method and same source bias (Howell and Shea, 2001). In this research, these include use of different sources of data and the use of mixed data gathering tools. Whilst all these have been utilised in this research it remains the case that a single objective 'truth' is unlikely ever to be the outcome of qualitative research and there is space in the approach for disagreements to exist. As such, whilst the approach might be considered a limitation of this research it is also responsible for generating the richness of perspective.

A significant limitation is one of generalisability. The research was conducted in a single national context (Great Britain) and in a single sector (health). Furthermore the research was exploratory and, legitimately, compromises were made with regard to sampling in each of the three phases. A further issue is that the samples in each of the phases might be considered to consist of only successful innovations. There are no examples of failure. Cases of failure would have generated a useful sample against which to contrast the observations made of successful innovations, a method that was adopted to particularly good effect in the pair-wise sampling of Project SAPPHO (Rothwell, 1985).

The survey instrument was then made available to accessible and elite informants (Miles and Huberman, 1984). By choosing to comply with the request to participate in the research, the sample consisted of self-selected groups. Consequently, each sample is representative only of itself, and so opportunities for generalisation to other contexts is limited. Within the context of exploratory research this is felt to be legitimate. Clearly paths for future research are opened up and the approach could be repeated in other national contexts and industrial sectors. Additionally, future research could usefully explore the extent, if any, to which less successful innovations configure differently from successful ones.

The framework has been developed based on the mature perceptions of innovators and users. This means the research was conducted at a point when innovations had been adopted and were in regular use. The cross-sectional nature of the research enables a constancy of perspective (all respondents respond from a position of post-adoption), but the framework fails to take account of the changeable quality of perceptions over time. That is, in the development or pre-adoption stages innovations may be perceived more favourably because they will not have been applied in a normal work situation (Dearing et al., 1994). Similarly, Phase III is limited by its cross-sectional nature. Longitudinal strategies are commonly recommended for process research because of the necessity of capturing event sequence data (Poole et al. 2000; Pettigrew, 1990). Future research should consider longitudinal measurement of attributes in order that data may be compared and contrasted for different stages of the innovation process in order to provide further insights into the nature of the relations between the two.

Table 7-3 indicates values for reliability for several attributes which would be unacceptably low in studies other than exploratory research. There is clearly scope for improvement of the instrument. This could be achieved in future studies by the addition of further items and testing in samples before doing the main survey. The framework variables have though, been partly derived from an empirical study of innovators' perceptions of innovations. This method, where the expert not the researcher is the arbiter of importance (notwithstanding the constraints of the definition of innovation that specified the initial dimensions of the framework), is recommended as a means of enhancing confidence that the variables in a particular data set are important (Ketchen and Shook, 1996). Indeed, requisite degrees of reliability differ according to the needs of different research objectives. For the purposes of this exploratory research reliability levels were felt to be tolerable (Moore and Benbasat, 1991).

This research has, ultimately, identified three types of innovation described by configurations of attributes according to an individual's evaluation of the presence, absence, or degree of those attributes. Chapter four described Sneath and Sokal's (1973) seven principles guiding the operation of a classification exercise (see page 55). The degree to which any classification exercise complies with these will vary across studies; it may be that some of the guidelines are inappropriate or even impossible to comply with given the context of any particular study. In this thesis, for example, it has not been possible to draw any phylogenetic inferences from the emergent classification given the cross-sectional nature of the study. The notion of types of innovations, distinguished from one another on the basis of attributes, having an evolutionary ancestry is problematic. Conceptually, it is not difficult to envisage ancestral lineages for individual entities such as submarines and helicopters (Griffin, 2002) or manufacturing systems (McCarthy et al., 1997) etc. However, where innovations in a manufacturing system and a helicopter belong to the same category, as defined by innovator- and user-perceptions, common ancestry is less discernible. However, it is only on the basis that phylogenetic inference cannot be drawn that this study significantly deviates from Sneath and Sokal's (1973) guidelines.

The taxonomy emerging from this study has been deliberately pursued as an empirical science. More properly the resultant classification scheme might be described as a hybrid of typology and taxonomy (see table 4-1, page 51). The first-order categories that formed the organising framework were drawn from the West and Farr (1990) definition of innovation and were populated with data drawn, in part, from the rigorous thematic analysis of the literature. Subsequently, the framework, in which a balance between comprehensiveness and parsimony was sought, was developed and validated in an empirical context. The subsequent identification of three types of innovation, in which types are recognised by internal similarities between the variables that form the basis for classification and external heterogeneity between configurations, further demonstrates the empirical grounding of this study's classification.

An interesting question, then, would be with regard to the extent and nature of configurations based on the evaluations of multiple innovators within a single or multiple innovating groups. The emergence from such a study of three types, broadly similar to those described in this research, would lend some validation to the results of this study. Additionally, these discovered types would be the embodiment of multiple innovators' perceptions, and as such might be construed as archetypes.

The concept of archetypes has been developed by Hinings and Greenwood (1988), building on the work of Miller and Friesen (1980), as a heuristic device for understanding organisational phenomena. At its core is the idea that an archetype is a set of structures and systems that consistently embodies a single interpretive scheme. It is a reflection of a set of beliefs and values (Greenwood and Hinings, 1993), and as such is important for understanding change. By reflecting beliefs, archetypes adequately accommodate the notion of perceptions as drivers of behaviour (Rogers, 1983). Consequently, the notion of archetypes of innovation artefact would provide a useful device for focusing on key issues of its management.

Importantly, the notion of archetypes introduces the issue of giving names to types. McCarthy and Ridgway (2000) stress the importance of labelling the groups uncovered in classification exercises and that they should be labelled in accordance with the groups' defining characteristics. Labels, they argue, should not only provide a means of reference, but act as a "*vehicle for communication* [which is] *unambiguous and universal*" (McCarthy & Ridgway, 2000; 25), and a process for labelling is specified in McCarthy et al. (1997). Notwithstanding the communicative advantages of labelling, this research deliberately avoids developing labels based on the constitutive attributes that describe the emergent categories. The key reason for this is that formalised labelling implies some fixity of categories, this may be particularly so where the basis of classification is phenetic which, as opposed to phylogenic, is cross-sectional and takes no account of evolutionary mutability. In the light of this and the exploratory nature of the research reported here, its limitations and the possible instability of the emergent types any implied fixity was felt to be unwarranted. Considerable utility for the framework has been demonstrated, but its further development and validation in different contexts are considered to be the minimum requirements before useful descriptive, unambiguous and universal labels can confidently be applied. More research is required to further validate the perceptual approach to innovation research and perhaps modify the framework in the light of experience in other organisational sectors.

11.4 A final thought

This final chapter has reflected on the contribution of this research, the opportunities for further research that it has generated and, its limitations. In building the framework of innovation attributes, this work has drawn heavily on previous studies. These studies have been marked, not by any internal inadequacies but by a failure at the level of synthesis characterised by classification systems that limit opportunities for wider abstraction The legacy of those past studies is readily acknowledged, and the absence of synthesis has presented the opportunity for this research.

This research has achieved its objective of developing a new, useful and viable taxonomy predicated on innovation attributes. The limitations of the classical, narrow classifications based on a high-low dichotomisation of newness or area of focus asserted in previous studies (Wolfe, 1994; Downs and Mohr, 1976; Tornatzky and Klein, 1982) has been confirmed. A more "*realistically delicate*" (Shenhar et al., 1995; 195) or sensitive taxonomy better reflects the multi-dimensional diversity of innovation and widens the scope of innovation beyond its conventional categories. The research also offers additional theoretical insights into the relationship between types of innovations and their processual origins. Previous research has indicated that different innovation types are associated with different processes and outcomes (see Chapters three and four), this research extends these findings. The framework may usefully be used in theory-building, relating innovation types to process factors, and could be extended into other domains such as outcome and success.

As this has been an exploratory study, more research is needed to establish the validity of the framework. It is presumed that, for sector specific reasons, some attributes may be under-represented in the framework. However, the evidence does suggest that differences between innovations exist along the dimensions specified, thereby demonstrating the utility of the approach and warranting further study.

Researchers often believe that their work is new and important when instead it re-labels, redefines or reiterates findings from previous studies (Garcia and Calantone, 2002). Researchers in innovation are particularly susceptible to the danger of making exaggerated claims with regard to the output of their work because of the breadth and depth of previous studies emanating from a variety of disciplines. Indeed, there have been many studies of innovation, studies in which the sample comprised of award winners and studies operationalising attributes as the dependent or independent variable. This research has confirmed some of the findings from these previous studies. The results of this previous research have strongly suggested that innovation is context dependent and contingent. In order to make a contribution, new research must either replicate previous studies, discover new contexts and contingencies or, challenge the prevailing orthodoxy. This research has attempted the latter.

Replication studies and the discovery of new contexts and contingencies continue to build low level theory (Pinder and Moore, 1979). The development of a framework of innovation that is truly generalisable across studies, that will enable the identification of clearly, comprehensively specified and, more importantly, constant innovation types will contribute to the development of middle range theory. This research has delivered neither the framework nor the middle range theory. It has though begun the journey with the discovery of discrete clusters of innovations, described by configurations of attributes that is considered to be unprecedented in the literature. However, in the light of the limitations of this research the taxonomy cannot currently be regarded as stable. But, no matter, to complete the quote from Kierkegaard that began this thesis:

> "*... When a classification does not ideally exhaust its object, a haphazard classification is altogether preferable, because it sets imagination in motion*" (Kierkegaard, 1941; 56).

Classification has played a crucially important role in the history of innovation research. Knowledge about the relationships and fit between contrasting and different types of innovation and innovation inputs, processes and outputs is required if headway is to be made into the complex business of understanding and managing innovations more effectively. It seems that the possibilities of classification of innovation are not yet exhausted. By suggesting a classification of innovation based on a polythetic approach this research has provided for the first time a multi-dimensional classification based on empirical investigation and also provides a language for practitioners and academics to use. This research offers a supplement to the conventional class labels that have governed thinking in the past. This approach to the classification of innovation, according to innovators' perceptions, has been shown to be a stimulating perspective for the study of innovation. It is intended that this research complements and extends that which has preceded it and, sets imagination in motion.

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APPENDIX ONE: INNOVATION NEWNESS

Study	Focus	Classification system	Nature of study	Observations
1934, Schumpeter	Innovation, which is distinct from invention and imitation, is crucial to economic development.	5 different areas of newness: 1. introduction of a new good or of a new quality of a good, 2. Introduction of a new production process, 3. Opening up of a new market, 4. Development of a new source of input supplies, 5. Changes in industrial organisation.	Economic theorist using innovation to help explain business cycles.	Innovation causes cyclical fluctuations or waves. Introduced notion of 'creative destruction', the replacement of the old with the new through the testing and application of new ideas. Innovation is the fundamental impulse that starts and motivates the capitalist machine.
1961, Burns & Stalker	An exploration of the relationship between organisations and their environment. Suggest environmental change prompts realignment of the fit between strategy and structure.	Newness (radical, incremental).	Largely conceptual.	Challenged the view that there is 'one best way' to manage and offers the typology of organic vs mechanistic organisations. Organisational characteristics influence innovativeness. Mechanistic organisations are best suited to stable conditions and innovate incrementally. Organic organisations are appropriate for changing, unstable conditions and yield more radical innovations.
1978, White & Graham	Developing a framework to evaluate the merit of radical technological innovation.	Newness (radical).	Conceptual. *It is the discontinuous, revolutionary innovation that affects a company's fate* (pp. 147).	Framework constructed around issues of core technology (inventive merit and embodiment merit) and implications for business practice (operational merit and market merit). Forerunner of familiarity matrix (see Roberts & Berry, 1985).
1982, Booz-Allen et al.	New products management for the 1980s.	Newness (6 categories ranging from new-to-the-world products to simple cost reductions). Categorises new products on 2 dimensions of newness: to the developing firm and to the market.	Investigation into role and impact of product innovativeness. Findings suggest that innovative products are more successful and that firms should pursue such products.	More innovative categories yield a higher proportion of 'successes'.
1983, Heany	To re-examine some of the 'semantic inflation and distinctions' associated with product innovation.	Newness (style change, product-line extension, product improvement, new product, start-up business, major innovation).	Prescriptive practitioner-orientation. Product innovation focus. Suggests polar extremes of newness and populates the intermediate space with a further 4 categories of newness. Absence of justification for any of the labels - they must be taken as 'given'.	Plea for consistency of language and label. Links each of 6 types with different business strategy and tactics.

1985, Roberts & Berry	Framework designed to help select entry strategy for new business areas.	Newness: framework is based on a 2-dimensional "Familiarity matrix" based on corporate familiarity - namely market served and technology employed.	Practitioner-oriented prescriptive review and synthesis of literature.	Nature of opportunities will vary depending on "familiarity" concept, and so strategic responses need to vary: 1) step-out product development, 2) new business and new ventures, 3) new items in existing lines, 4) market development, 5) defend or penetrate, 6) market expansion through customer application projects). New business development new markets, new products or both. These areas may be familiar or unfamiliar.
1986, Tushman & Nadler	Exploration of organisational factors that enhance innovation.	Newness (incremental, synthetic, discontinuous) and type (product, process).	Prescriptive. *At the most basic level there are two kinds of innovation…*(pp. 75).	Sustained innovation requires stability and change, interplay of degree of novelty with strategy over course of product life cycle.
1986, Dewar & Dutton	Test of models for the adoption of two different types of innovation.	Newness (radical, incremental) and type (technical, process). Variables chosen that are widely regarded as being associated with innovation adoption and reviewed from a knowledge perspective.	6 technological innovations common to the footwear industry were rated as incremental or radical by 56 judges. Stratified random sample (n=40) US footwear manufacturers.	Adoption of radical and incremental innovation has different predictors. Research needs to acknowledge differences across different innovations.
1988, Johne & Snelson	Factors affecting success in product innovation.	Newness (new product lines where the organisation has no technological expertise, extensions to existing lines exploiting current technological expertise, developments of existing product lines).	Literature review. Focus on *bread-and-butter…the different types of product innovation open to a manufacturing business* (pp. 115) innovations: developments of existing product lines.	Analyses success factors in terms of McKinsey's 7S framework (skills, strategy, structure, shared values, staff, style, systems).
Damanpour 1988	Study of the impact of organisational factors on the adoption of innovations.	Newness (radical, incremental) and type (technical, administrative).	Meta-analysis of previous studies. Typological.	Organisations adopt innovations of various "types of radicalness" (sic p561, the expression is interesting because Damanpour does not identify types **of** radicalness at any point. Possibly "radicalness" is being used as a generic term for newness [which might be dichotomised radical/incremental] in this instance) to respond to changes in their environment. Clear distinction between categories of innovation help resolve inconsistencies in previous research. Innovations do not share identical attributes. Technical/administrative distinction well supported in the literature and, it reflects a more general distinction between social structures and technology.
1990, Henderson & Clark	Traditional categorisation based on radical/incremental argued to be incomplete or misleading. Develop an expanded conceptual framework of innovation type.	Newness (radical, incremental) and type (product, architectural, modular). R/I dichotomisation insufficient because apparently modest (incremental) innovations are reported to have had dramatic (radical) consequences. Product conceived of as a system comprising components, change can happen to the system or to individual components.	Case study of semiconductor photolithographic alignment equipment to test validity of framework that suggests important implications of concept of architectural innovation. 2-year field study in photolithographic alignment equipment industry.	Links architectural innovation to organisational learning. Innovations have the potential to enhance or destroy competence within a firm - architectural innovation has the capacity to do both. Learning about changes in architecture (new interactions across components [or boundaries]) may require explicit attention, new skills etc...

1991, Kleinschmidt & Cooper	The role and impact of product innovativeness on performance.	Newness (new-to-world, new-to-firm, additions to existing product lines, improvements to existing products, cost reductions to existing products, repositioning of existing products).	This study condensed this schema to 3 categories of high, moderate and low innovative products based on the principal of parsimony. 195 new products from 125 industrial product firms. Managers interviewed about a success and a failure and on measures of innovativeness.	Relationship between product innovativeness and commercial success is U-shaped. That is low and highly innovative products are more likely to be more successful than moderately innovative products. Product innovativeness based on the Booz, Allen & Hamilton (1982) schema that explicates 6 categories from new-to-the-world to repositionings.
Damanpour, 1991	Organisational adoption of multiple innovations.	Newness (radical, incremental) and type (administrative, technical, product, process).	Briefly reviews the literature and selects typologies *that have gained the most attention* (pp. 55). Meta analysis of the literature using a method reminiscent of systematic review. Sample consisted of 23 empirical studies, 21 articles and 2 books.	Types of innovation found not to be highly effective moderators of organisational innovation, rather organisational type accounts for much of the variance. Innovation type is secondary.
1992, King	Empirical test of models of innovation process.	Newness (radicalness - consisting of novelty and risk).	Longitudinal study of innovation in a single hospital ward. 17 innovations identified of which 7 form basis of the analysis. Innovations scored as high, medium or low on risk and novelty by the author and an independent rater. Risk difficult to determine retrospectively by the independent rater.	Less support for the rigid, linear stage-based model than for the model characterised by flexibility and disorderliness. Testing linear and recursive process models against radicalness and output. Measure of radical based on Zaltman's (1973) conceptualisation.
1993, Cooper & Kleinschmidt	What makes a new product a winner?	Newness (exists on a continuum polarised by "true innovations" and "fairly minor modifications": 1) true innovations - a totally new product that creates a totally new market, 2) totally new to the world products, but caters to an existing market, 3) totally new to the company products - new features vs competition/existing market, 4) new product lines to the company, 5) new items to an existing product line for the company, 6) significant modifications of existing company products, 7) fairly minor modifications of existing company products.	Empirical study of 103 chemical industry projects/ Comparison of winners and losers.298-variable questionnaire. New product performance measured predominantly by financial indicators. 7 categories of newness operationalised, a derivative of Booz et al.'s (1982) 6-category typology.	*Success rates do not depend all that dramatically on the nature of the product's innovativeness* (pp 100). However, type 4 innovations accounted for 26% of all failures (but were only 17% of all launches) and type 5 innovations accounted for 12 % of all launches and achieved an 83% success rate. Product differentiation based on a range of factors (performance, value for money, relative quality...) is a better predictor of performance.
1995, Atuahene-Gima	Exploratory analysis of impact of market orientation on new product performance.	Newness (radical, incremental - degree of product newness to customers and firm [the producer]).	Cross-sectional survey of 600 firms (service and manufacturing). 275 usable responses from a pre-tested and validated instrument. Newness measured by 7 items.	Influence of market orientation on success of new products moderated by newness. Grounded in a body of literature that is divided regarding the relationship between newness and market orientation's influence on performance.

1996, Manu & Sriram	To identify different types of businesses based on their innovation orientation and multiple dimensions of innovativeness. To compare each type on the basis of their environment, marketing strategy attributes and, performance level.	Newness (Composite measure of innovativeness based on: rate of new product introduction, timing of market entry, R&D expenditure).	Taxonomic. Cluster analysis based on the 3 dimensions of innovativeness. Stopping rules governed by practical usefulness and kinks in the curve. Random sample of 350 businesses from PIMS database.	4 types of innovation orientation identified, each associated with different kinds of environment and delivering different types of performance. Grounded in previous literature on innovation orientation.
1996, Damanpour	Test of theories that purport to explain the relationship between organisational complexity (size and structure) and innovation.	Newness (radical, incremental) and type (Administrative, technical, product, process).	Typological. Method of coding of innovation to type according to specification in the original article. 21 published studies relating structural complexity or size to organisational innovation.	Multiple observations on the structural complexity-innovation and size-innovation relationships based on dimensions of innovation. Innovation broadly conceptualised as a means of changing an organisation, hence breadth of types.
1996, Subramanian	Reconceptualisation of the theoretical construct of innovativeness.	Innovativeness, three dimensions measured: (1) Mean number of innovation adoptions (over 7 years - period varies across studies), (2) Mean time of innovation adoption, (3) Consistency of the time of adoption (were the firms consistently early or late?).	Many unidimensional studies (which renders studies incomplete), but contends that a valid measure of innovativeness must represent the temporal dimension - innovativeness is an enduring trait. Different measures of innovativeness lead to a variety of different outcomes but, by adopting innovations early and consistently competitive advantage might be gained.	164 usable responses (sample size n=600) to questionnaire-based survey in the banking industry. 8 banking industry innovations formed basis of questionnaire to assess rates of adoption etc.
1996, Cheng & Van de Ven	Pattern-seeking in the innovation process: orderly, random-chance or, random-chaotic? Propose that little research has been done on the emergence of novelty.	Newness (novelty).	Tracked 2 bio-medical innovations from start of funding to implementation (interviews, meetings, observation…longitudinal). No measures of novelty specified.	Innovation as a learning experience in which novelty derived from a starting position of profound ignorance. Non linear dynamical system, beginning in chaos ending in periodicity.
Bessant and Caffyn, 1997	Implementation issues in continuous improvement and increasing participation in the innovation process.	Newness (continuous improvement).	Longitudinal (5 year) action research project comprising approximately 100 companies. Synthesis of ideas from manufacturing management, organisational learning, R&D management etc.	Reports on diverse implementation experiences of project participants, but continuous improvement recognised to be about *behavioural change and involves both learning and unlearning* (pp. 26).

1997, Gallouj & Weinstein	Developing a framework for the exploration of innovation processes in services sector.	Newness (radical, improvement, incremental, ad hoc and recombinative innovations).	Theoretical paper and conceptual framework. Argues that both products and services can be construed in terms of their characteristics. Classification based on qualitative or quantitative variation in technical or service characteristics of the innovation. Formalisation innovation based on the visibility and standardisation of these characteristics.	Propose an integrative approach to the study of innovation based on characteristics of the innovation rather than its effect.
1997, Sundbo	Do service firms innovate? If yes, how do they organise for it?	Newness (radical, large incremental, small incremental, general acts of learning, individual acts of learning).	Multiple (n=21) case study. Survey and interview.	3 types of (service) innovation organisation identified. Innovation conceptualised as a process of organisational change and learning
1998, Rice et al.	Identification of mechanisms and practice to help manage the process for discontinuous innovation.	Newness (discontinuous, incremental).	In-depth interviews with key members of 11 project teams. Operationalises discontinuous innovation: 5-10 times performance improvement; or, 30-50% cost reduction; or, new-to-the-world features.	The process for discontinuous innovation is long, uncertain, sporadic, non-linear, stochastic and context dependent. To foster discontinuous innovation management must attempt to curb its natural tendency to reduce uncertainty. Because discontinuous innovations are critical for the renewal of a firm's competitive position it is important to understand how they differ from incremental innovations.
1998, O'Connor	Investigation of the role of market learning in NPD projects involving really new products.	Newness (discontinuous).	Case studies of 8 radical innovations. Survey, interviews and secondary sources.	Process for discontinuous innovation differs drastically from those associated with incremental innovations. Discontinuity defined in terms of artefact being new to both the firm and the marketplace and consisting of unprecedented performance features.
1998, Osborne	To develop a typology of organisational change.	Newness (existing service or new service, to the firm and to the client. Leading to 4 types of innovation - expansionary, total, developmental, evolutionary).	Postal survey of voluntary & non-profit sector (n=196).	Richer classification has *allowed the issues of service innovation and of service development to be more clearly specified, and hence has invited a more clear exploration of their management* (pp. 1150).
1998, Veryzer	Does the NPD process for discontinuous products differ from the process for incremental or continuous products?	Newness and characteristics (Radicality or discontinuity coupled with product and technological capability is the basis of a 4-element categorisation: continuous, commercially discontinuous, technologically discontinuous, technologically and commercially discontinuous).	Criteria and method for assignment of each of the innovations to any of the categories vague. Field studies of 8 discontinuous product development projects involving the development and application of a new technology. Multi-level, real time interviewing.	Processes of continuous and discontinuous innovation differ. Grounded in (the conventions of) the literature.

1998, Sirilli & Evangelista	An investigation of the role and nature of innovation activities in the service sector underpinned by a technological perspective of innovation.	Service innovations, notes 4 ways in which services differ from product innovations: (1) Co-terminality, close interaction between production and consumption, (2) intangibility, often due to high information/knowledge content, (3) important role of Human Resources as a key competitive factor, (4) critical role of organisational factors to firm performance (e.g. low capital equipment costs, non-continuous nature of production, role of the process of delivery, limited economies of scale,).	Classification based on asserted relevance of the two types to the analysis of innovative phenomena. Similarities exist between service and manufacturing sectors with respect to basic dimensions of process. Suggest economic criteria, with internal and external foci, to help distinguish between service and process innovations.	Respondents asked to specify type of innovation introduced. Also asked to indicate whether or not they had introduced innovations for which the distinction was not applicable. A number report that the distinction is inappropriate. Survey of 6,005 Italian market service companies employing >20 employees.
1999, Rabson & DeMarco	Relationship between psychological type and different innovation systems.	Newness (revolutionary, evolutionary) and type (product, process).	Propose a conceptual model.	Different behaviours required at different stages of the innovation process. Grounded in (the conventions of) the literature.
1999, Wilson et al.	Develop a fine-grained measure of innovation adoption, tested in exploration of relationship between organisational climate and adoption.	Newness (radical, incremental) and characteristic (relative advantage).	70 hospitals interrogated on list of 68 medical imaging innovations.	Finer-grained measure *can aid firms …to make more prudent and better informed adoption decision* (pp. 320). Grounded in (the conventions of) the literature, one measure is objective the other perceptual. Both with a significant history as differentiators of innovations.
2000, de Moerloose	Relationship between innovation, process and success.	Newness (technological newness, commercial newness, functional newness, customer group newness).	87 usable responses from survey of Belgian chemical industry.	11 factors that influence success identified which impact each of the 4 newness categories in different ways. Grounded *in many earlier studies* (pp. 29).
2001, de Brentani	The influence of innovativeness on the factors that impact success and failure in the development of business-to-business services	Newness (of the technology and to the marketplace).	Meta analysis of previous studies. Items and measures derived from literature review and personal interview. Sample of 276 projects from 115 Canadian firms. 104 item instrument (1-7 Likert scale) measuring 4 categories of success and failure and also some variables measuring degree of innovativeness.	Discontinuous and incremental innovation constitute substantially different development scenarios (e.g. variations in climate, systematisation of process, fit with strategy and so forth). Grounded in conceptual development of researchers addressing *really new* (pp. 170) versus incrementally new products.

2001, Avlonitis et al.	Develop an empirically-based typology of innovativeness for new financial services. To identify whether or not different innovativeness types are associated with different development and performance scenarios.	Newness (operating/delivery process newness, service modification, service newness to the market, service newness to the company).	Taxonomic. 17 item questionnaire, 5 point Likert scale. Cluster analysis (Ward's method), 6-cluster solution preferred. 80 businesses representing 80 successful and 52 failed financial services. Innovativeness – conceptualised in terms of newness measured across 4 dimensions by 17 items. Based on past research and a pilot study.	Identify 6 types of service innovativeness ranging from new-to-the-market services to service repositionings. Different types associated with different development patterns and levels of performance.
2001, Danneels & Kleinschmidt	Clarifying the meaning of product innovativeness with regard to stop/go decisions and firm performance.	5 dimensions of product innovativeness: (1) market familiarity, (2) technological familiarity, (3) marketing fit, (4) technological fit, (5) new marketing activities. Distinguishes between firm perceptions of innovativeness (based on familiarity and fit of technological and marketing aspects) and customer perceptions (based on innovation attributes, adoption risks and levels of behaviour change implied).	Need for a consistent, explicit and precise definition of product innovativeness. Different dimensions of product innovativeness have different relations with product performance. Fit with existing marketing and technological competencies more important to financial performance than market or technological familiarity.	Historical sample of 262 projects known as NewProd II. Five dimensions of innovativeness measured on a 19 item instrument.
2001, Cardinal	Examination of the impact of organisation-wide controls on innovativeness at the firm level.	Newness (radical, incremental).	Retrospective study in US pharmaceutical industry of 57 SBUs using archives and questionnaire to gather data.	Processes for radical and incremental innovation noted to be similar. Input and output controls important for incremental innovation. Input, behaviour and output controls important for radical innovation. Grounded in literature on project team research and innovation adoption research.
2001, Lynn & Akgün	Exploration of the impact of project visioning on successful new product development.	Newness (Radical, evolutionary market innovation, evolutionary technical innovation, incremental).	2 phase empirical study. Phase 1 exploratory, interviews and documentary triangulation. Phase 2 validation survey: scale items developed for questionnaire. Usable n=509.	Vision clarity associated with NP success for radical innovations, but not vision support or stability. Stability & support associated with success of incremental innovation. For evolutionary innovation clarity is positively associated with NPS. Grounded in the 'familiarity' literature, but conceives of newness in terms of uncertainty.
2001, Fernández	Exploratory research of innovation development patterns.	Newness (radical, routine) and type (technical, administrative).	Empirical. Innovations classified by panel of 3 experts. 15 innovations in a hospital A&E department monitored in situ.	Different innovations have different development profiles. Confirms view of relationship between incremental/linear and radical/disorderly processes.

2002, Garcia & Calantone	To clarify confusion surrounding multiple definitions of innovativeness and innovation and develop a method for classifying innovation.	Newness (radical, really new, really new, really new, really new, incremental, incremental, incremental).	Theory. Proposes innovations to be evaluated on a set of common dimensions. Wide-ranging literature review identifying conceptualisations of degrees of newness described on continua ranging from dichotomous to those with eight categories.	Slow progress in theory development ascribed to inconsistencies of labelling innovations. Provides a framework and operationalisation based on degree of newness. Propose a typology based on extant literature that results in a typology of 8 innovation types by degree of newness. Each type is elaborated by the presence or absence of macro and micro level marketing and technology discontinuity. Hence 4 types of 'really new' and 3 types of 'incremental' innovations.

APPENDIX TWO: INNOVATION AREA OF FOCUS

Study	Focus	Classification system	Nature of study	Observations
Daft, 1978	Study of processes leading to innovation adoption. Type is a significant determinant of process.	Type (administrative and technical). Dual core model - initiation of administrative innovations is facilitated by mechanistic rather than organic organisations. Definitions sourced from the literature.	Unit of analysis = school district. 68 innovations in 13 districts.	Notion of separate organisational cores equally capable of initiating and implementing innovations challenges Zaltman et al. (1973, above). Independent variable. The process of innovation appears to be contingent upon both the type of innovation (tech/admin) and, the professional level of employees.
1981, Kimberly & Evanisko	To examine the combined effect of individual, organisational and contextual variables on organisational adoption of innovations.	Type (technological and administrative). Technological and administrative innovations. Defined in relation to an (unspecified) 'external standard'. Adopts an item-oriented perspective in preference to perceptions of unit of adoption, suggesting, implicitly, that innovations have immutable characteristics that remain constant across organisations.	Innovations in US health sector from existing data set (details not specified). Data collected from hospital administrator and chief of medicine in each hospital. 15 experts identified 300 innovations from which 12 (technological) were chosen as focus for this research. Context was respiratory disease. A further 8 administrative innovations identified based on electronic data processing.	*It is not obvious that different types of innovation have the same organizational salience or engage in identical organizational process in the course of their adoption* (pp. 709). Supportive of Daft's (1976) dual-core model.
1988, Damanpour	Synthesis of empirical work on adoption in order to make aggregated statements about adoption behaviour	Technical and administrative (type), radical and incremental (newness).	Meta-analysis of previous studies. Aggregates previous research on 3 dimensions of organisational innovation that are felt to best explain adoption: type of innovation; innovation radicalness; stage of the adoption process.	Adoption is contingent upon company type.
1990, Henderson & Clark	Traditional categorisation based on radical/incremental argued to be incomplete or misleading. Develop an expanded conceptual framework of innovation type.	Type (product, architectural, modular) and newness (radical, incremental). R/I dichotomisation insufficient because apparently modest (incremental) innovations are reported to have had dramatic (radical) consequences. Product conceived of as a system comprising components, change can happen to the system or to individual components.	Case study of semiconductor photolithographic alignment equipment to test validity of framework that suggests important implications of concept of architectural innovation. 2-year field study in photolithographic alignment equipment industry.	Links architectural innovation to organisational learning. Innovations have the potential to enhance or destroy competence within a firm - architectural innovation has the capacity to do both. Learning about changes in architecture (new interactions across components [or boundaries]) may require explicit attention, new skills etc...

1990, Damanpour	Study of the consequences of adoption of innovation for organisations.	Type (technological, administrative, ancillary). Assumption appears to be that the range of types provides broad coverage of various types of innovation. Based on previous definitions of innovation type. Categorisation method undefined.	85 usable questionnaires returned from directors of libraries (US). List of library innovations developed from a literature search.	Technological innovations are more effective than administrative or ancillary innovations. Similarly, rate of adoption is higher. However, administrative innovations found to be a higher correlate of organisational performance than technological or ancillary.
1993, Cooper & Kleinschmidt	What makes new products winners?	7 new product types that exist on a continuum polarised by "true innovations" and "fairly minor modifications": 1) true innovations, 2) totally new to the world products, 3) totally new to the company products (new features vs competition/existing market), 4) new product lines to the company, 5) new items to an existing product line for the company, 6) significant modifications of existing company products, 7) fairly minor modifications of existing company products.	Empirical study of 103 projects in North America and Europe.	Typology has its origins in the Booz et al six category typology. Product differentiation an important factor in success, aspects of the external environment (market attractiveness and competitive situation) less so.
1994, Montoya-Weiss & Calantone	Meta-analysis of determinants of new product performance.	Type (High, moderate, low innovation).	Review of 47 studies (criteria specified), the *quantitative cumulation and analysis of statistics across studies* (pp. 404). Note that only 15% of studies provided information on type of innovation.	Type of innovation may be an important moderator variable on the relationship between determinants of performance (strategic factors, development process factors, market environment factors, organisational factors).
1995, Shenhar et al.	Conceptual development of classification to overcome simplistic models.	2 dimensional taxonomy: initial level of technological uncertainty and system scope (product level on a hierarchical ladder of systems and subsystems).	Exploratory study, mixed method: multiple case study (n=26) and questionnaire (n=127).	Typology exhibits the existence of substantial differences among product characteristics of various kinds and provides a basis for additional theoretical development of product innovations.
1996, Teece	Explores the properties of different types of firms with respect to the generation of new technology.	Autonomous, systemic.	Reviews alternative organisational forms suited to innovation having identified characteristics of technological development, the factors affecting firm-level innovation, and firm archetypes.	The formal and informal structures of firms and their external linkages have an important bearing on the rate and direction of innovation. Various archetypes are recognised and an effort is made to match organisation structure to the type of innovation. The framework broadens the framework economists use to identify environments that assist innovation.

1996, Subramanian & Nilakanta	Use a multidimensional conceptualisation of innovativeness in a study of determinants, types and performance to clarify conflicting results of previous studies.	Type (technical, administrative). Follows Daft's (1978) 'dual-core' dichotomisation between technical and administrative innovations. Conceptualisation based on quantity of innovations, time of adoption and consistency of adoption pattern.	List of 8 technical and 14 administrative innovations compiled with aid of domain relevant experts. These formed basis of questionnaire-based survey of bank innovations via single competent witness, 143 returned.	Organisational innovativeness positively impacts organisational performance which in turn is moderated by innovation type. Such observations dependent on multidimensional conceptualisation of innovation.
1996, Chesborough & Teece	How to organise for innovation - decentralised vs integrative strategies.	Type (autonomous, systemic). Asserts that the distinction between autonomous or systemic innovation is fundamental to the choice of organisational design.	Narrative case studies.	Type of innovation dictates organisational design.
1998, Sirilli & Evangelista	An investigation of the role and nature of innovation activities in the service sector underpinned by a technological perspective of innovation.	Type (service [aka product], process). Classification based on asserted relevance of the two types to the analysis of innovative phenomena.	Respondents asked to specify type of innovation introduced. Also asked to indicate whether or not they had introduced innovations for which the distinction was not applicable. A number report that the distinction is inappropriate. Survey of 6,005 Italian market service companies employing >20 employees.	Similarities exist between service and manufacturing sectors with respect to basic dimensions of process. Suggest economic criteria, with internal and external foci, to help distinguish between service and process innovations.
2001, Damanpour & Gopalakrishnan	Study of dynamics of adoption of product and process innovations.	Type (product, process). Grounded in the literature. Distinction is important because adoption of either requires different skills.	Empirical, based on previous definitions of innovation type panel of experts allocated different innovations to a priori categories. Secondary sources & questionnaire for 101 US banks.	Adoption of product innovations is emphasised, by companies in both service and manufacturing sectors, over that of process innovations.

APPENDIX THREE: INNOVATION ATTRIBUTES

Study	Focus	Classification system	Nature of study	Observations
Mohr 1969	To identify the determinants of innovation in public agencies.	Attribute: Slack , an innovation adopted in the quest of prestige rather than organisational profit or effectiveness.	94 health departments in 5 US and Canadian States. A possible explanation of propensity to adopt large numbers of innovative programmes.	Organisational size found to be a significant predictor of adoption, but only in as far as it implies the presence of motivation, obstacles and resources.
1973, Zaltman et al.	To integrate findings on innovation research from different perspectives on different types of organisation.	Attributes (Reversibility, Compatibility, Complexity, Cost, Newness, Divisibility, Disruptive, Visibility, Impact, Scope, Radical, Relative Advantage, Scientific Status, Efficiency, Risk and uncertainty, Communicability, Terminality, Status quo ante, Commitment, Interpersonal relationships, Publicness vs privateness, Gatekeepers, Susceptibility to successive modification).	Overview of innovation in organisations: nature of innovation, processes of innovation, organisational characteristics and innovation, and theoretical review. Integration of previous works, particularly March & Simon (1958), Burns & Stalker (1961), Harvey & Mills (1970), Wilson (1966), Hage & Aiken (1967).	Attributes of innovation influence adoption and rejection decisions. Organic structures would better facilitate initiation and mechanistic organisational structures implementation.
1974, Warner	Disciplinary parochialism has led to imprecision in use of language, incompatibility of methodologies, and conflicting results in innovation research. Aims to provoke debate about more integrative approaches.	Attributes (hard, soft, use, profitability).	Theoretical, drawing together strands of rational economics and sociological perspectives on innovation. Innovations have physical and non-physical properties.	Need for exploration of the 'analytically relevant dimensions of innovation'. Technological perspective on innovations, which can be hard (physical objects) or soft (organisational changes), but these do not suffice to define or bound the innovation. Multidimensionality of the innovation, based on its use (application) or profitability (value, worth or benefit) provide more sensitive analysis.
1976, Downs & Mohr	Authors attribute instability (variance in findings) in innovation research (partly) to inconsistent treatment of innovation characteristics and varying operationalisations of innovation. Propose move toward developing integrative theory.	Attributes (primary and secondary attributes). Primary attributes are constant across cases, secondary attributes vary according to local perceptions. They emphasis the importance of constancy across studies rather than whether or not primary or secondary attributes exist as natural or real types.	Theory. Proposed as a basis for multiple innovation research, but conceived only in terms of study of single attributes. No holistic approach.	Set of 7 prescriptions for innovation research. Acknowledge innovations vary according to different attributes and that different theories (about, say, adoption etc) will pertain to each different innovation.

1982, Tornatzky & Klein	Methodological profiling of Attributes' studies. Exploration of the relationship between Attributes of innovations and adoption.	Attributes (focused on compatibility, relative advantage, complexity, cost, communicability, divisibility, profitability, social approval, trialability, observability - the most frequently occurring in the review).	Meta-analysis of previous Attributes' studies. 30 Attributes in total uncovered, which begs questions about the independence of the dimensions. 75 articles reviewed. 46.7% of sample studied one Attribute only, 82% studied 5 Attributes or fewer.	Develop 7 criteria for the hypothetically 'ideal' innovation Attributes study, including: need for constancy in approach to Attributes' studies; measurement of innovation from a perceptions perspective.
1983, Rogers	Attributes of innovations and the rate of innovation adoption.	Attributes (trialability, relative advantage, compatibility, complexity, and observability).	To identify those attributes that influence the rate of innovation adoption.	Individual's perceptions of the characteristics of innovation not the characteristics of the innovation affect adoption. Proposed 5 attributes of innovation as those that explained innovation adoption. Derived from 12 previous empirical studies that studied between 1 and 50 innovations and measured between 2 and 16 different attributes.
Pelz, 1985	The relationship between properties of an innovation and time sequence (stages) of development.	Attributes (originality - idea origins of the innovation; complexity - comprising technical complexity and organisational complexity).	3 research staff assigned innovations to one of trichotomous categories for complexity and originality. 3 technically-based innovations investigated in 18 locations via unstructured telephone interviews.	Technically simple innovations are adopted with a more discrete succession of stages than are complex innovations. Selection of originality and complexity not justified in terms of other attributes but because the sequence of innovating stages in this study *appeared contingent on certain properties of the innovation itself* (pp. 262), that is, originality and complexity.
1988, Meyer & Goes	An examination of assimilation of innovations into organisations.	Attributes (complexity, risk and skill, observability, compatibility).	12 medical innovations in 25 hospitals, 206 informants. Innovation variables assessed by expert-panel judgement.	Advance a model of assimilation antecedents containing 3 classes including innovation attributes. Assimilation is highly dependent on an innovation's attributes. Innovations rarely have inherent attributes that can be ascertained unequivocally without reference to its context.
1990, West	A theory of group innovation.	Attributes (quantity and quality of innovations).	Theoretical. Postulate 'vision' and 'climate for excellence' contribute to quality of innovation, and 'participative safety' 'norms for innovation' to quantity of innovation.	Understanding innovation can be considerably enhanced by psychological analysis and theorising. I*nnovation can be measured in terms of both the quantity of innovations introduced and the quality* (pp. 310).

1991, Moore & Benbasat	Development of an instrument to measure perceived characteristics of an IT innovation.	Attributes (trialability, relative advantage, compatibility, result demonstrability, visibility, ease of use, voluntariness, image).	Commenced with set of initial characteristics which were refined, modified and relabelled in the light of additional data, including reviews of previously operationalised instruments. Instrument developed in a 3-stage process: item creation, scale development, instrument testing.	Existing classifications lacked validity and reliability. The classification ultimately developed derived from a retroductive approach based on theory and previous empirical work. Develop a *parsimonious, 34-item instrument, comprising 7 scales, all with acceptable levels of reliability* (pp. 210).
1992, Adams et al.	Evaluation of 'psychometric' properties of an IT innovation.	Attribute (perceived ease of use, perceived usefulness).	2 empirical studies. (1) 118 respondents, 10 organisations, questionnaire containing 60 items on usefulness, 45% response. (2) 73 users rate IT in terms of the two psychometric properties.	Replication of an earlier study that developed and validated the two psychometric constructs. Usefulness is an important determinant of (IT) system use.
1994, Wolfe	To specify a research design direction for more generalisable, cumulative and comparable research based on the complex, context-sensitive nature of innovation.	Attributes (Adaptability, architectural impact, centrality, compatibility, complexity, cost, divisibility, duration, magnitude, observability, organisational focus, pervasiveness, physical properties, radicalness, relative advantage, risk, status, uncertainty).	Conceptual review of the innovation literature (parameters undefined). There is no broadly accepted typology based on attributes. Presents a list of 18 groups of attribute types (and synonyms) derived from previous studies. Attributes, it is argued, are under-represented in innovation research which has led to confounded results in diffusion, process and organisational innovativeness research.	Identification of innovation by categorisation of attributes could contribute significantly to the generalisability of research. Need to determine empirical independence of attributes.
1995, Shenhar et al.	Conceptual development of classification to overcome simplistic models.	Attribute (4 levels of technological uncertainty, 3 levels of system scope).	Exploratory, mixed method case study and survey, 26 and 127 innovations respectively in various Israeli military and commercial industries. Empirical application of previously developed conceptual framework.	A more *realistically delicate typology* (pp. 195) provides additional theoretical insights into the nature of products and an evaluation of their success. Technological uncertainty has proved to be a viable variable for distinguishing between variables.
1996, West & Anderson	Examination of relationships between group and organisational factors and team innovation.	Attributes (magnitude, effectiveness) and newness (novelty, radical).	Longitudinal study of top management teams in 27 hospitals.	Clarity of and commitment to objectives, participation, task orientation, support for innovation influence the outcome. *More important than what teams decide to do…is what they actually implement…Innovativeness can then be judged by domain relevant experts on a number of dimensions such as magnitude, radicalness, novelty and influence on organizational effectiveness* (pp. 681).

1997, Agarwal & Prasad	User-perceptions of an innovation as an explanatory and predictor variable for acceptance behaviour.	Attributes (relative advantage, ease of use, compatibility, trialability, visibility, result demonstrability, image, voluntariness).	Grounded in (the conventions of) the literature (e.g. Rogers, 1983; Adams et al., 1992; Moore & Benbasat 1991). Empirical test of innovation Attributes research model in context of IT innovation. Surveyed 73 members of MBA class.	Perceptions influence rates of adoption, specifically relative advantage, compatibility, visibility, trialability, result demonstrability, voluntariness.
1997, Meyer et al.	Study of innovation in new organisational forms in order to understand organisational innovativeness.	Attributes (trialability, observability, relative advantage, complexity, compatibility, adaptability, riskiness, acceptance).	Typological. Study of three innovations across a single organisation. Three discrete projects. Self-report questionnaire, key decision makers N=89.	Different innovations have different (rated) attributes, which, in turn, impact adoption and implementation. 7 factor typology, adding adaptability and riskiness to Rogers' (1983) 5 attributes. Includes also 1 behavioural characteristic - acceptance.
2001, Mukherjee & Hoyer	Investigation of the presumed positive effect of the attribute novelty (or novel attributes) on product evaluation and sales.	Attributes (novelty, complexity). Grounded in (the conventions of) the literature.	Empirical. Sample of 140 undergraduates asked to read and evaluate product descriptions in which text had been manipulated to reflect complexity and novelty variables.	Novelty can have a negative effect and generate technophobia or consumer resistance.
2001, Danneels & Kleinschmidt	Clarifying the meaning of product innovativeness with regard to stop/go decisions and firm performance.	Attributes. Distinguishes between firm perceptions of innovativeness (based on familiarity and fit of technological and marketing aspects) and customer perceptions (based on innovation attributes, adoption risks and levels of behaviour change implied).	Historical sample of 262 projects known as NewProd II. Five dimensions of innovativeness measured on a 19-item instrument.	Different dimensions of product innovativeness have different relations with product performance. Fit with existing marketing and technological competencies more important to financial performance than market or technological familiarity. Need for a consistent, explicit and precise definition of product innovativeness.
2001, Biswas	Attempts to formulate indicators for classifying innovations in low technology rural industries by using composite criteria.	Composite (6 categories derived from the following criteria: innovation source, artisan participation, enterprise size, nature of promotional bodies, Attributes and effects of innovation).	Conceptual paper with empirical observations of rural industry in West Bengal.	Provides basis for developing a set of quantifiable indicators. Inadequacy of conventional classifications that derive from economics, NPD, innovation diffusion etc literature that originates in developed 'western' economies.

2001, Gopalakrishnan & Bierly	To develop a categorisation of innovation incorporating knowledge elements and explore impact of consequent types on organisational decisions and outcomes.	Knowledge (tacit/explicit, complex/simple and systemic/autonomous), type (technical, administrative, product, process), newness (radical, incremental). Classification based on the nature of the knowledge associated with the innovation process.	Empirical exploration of innovation source (internal or external), cost of implementation and effectiveness in sustaining competitive advantage. 101 usable questionnaires from survey of US banks, based on expert-derived list of 31 financial sector innovations categorised by their knowledge content. Innovation typology determined by 3 items for complexity and 4 items for tacitness and autonomy.	Sheds light on integration of different knowledge areas during the innovation process. The distinction between product and process innovations in explaining the 3 dependent (knowledge) variables associated with adoption held to be critical.

APPENDIX FOUR: PHASE 1 INTERVIEW PROTOCOL

Preamble

Introduction of self
Thanks for being available for interview
Introduction to research, the objective of which is to explore the connectedness of innovation processes and outcomes. That is what sort of processes have delivered what sort of outcomes. The interview will last no longer than 1 hour and will be a fairly free ranging discussion of **xxxxx** innovation during which time there are 4 key areas that I would like to discuss:

Team/innovation context
Develop a picture of time line and process
Identification of critical incidents
Understand the outcome

There is no judgemental aspect to the process. Answers cannot be right or wrong, good or bad. The objective is to establish what you (the team) did and what came out at the end of the process. Please do not feel abashed at mentioning something that might seem to you to be trivial or unimportant.

Understanding the background to the founding of the team
Prompts:

- Why was the team put together? With what objective in mind?
- Who was in the team and why?
- Why did you enter for team of the year – a function of the outcome?
- Level of respondent's involvement. Level of team socialisation, communication.
- Critical knowledge/individuals.

Identification of critical incidents
Prompts:

- What were the important events in the duration of the process? Why were they significant?
- Single or multiple triggers? Triggers along the time line?
- Criticality of incidents to the outcome
- How and where were key decisions made (directed vs autonomous), individual reactions to decisions

Building a picture and time line of process
Prompts:

- How did you start, what happened next, how did that come about? What were the activities in which you engaged in order to deliver the innovation?
- Was the process prescribed? Prescription vs discretionary, structure vs unstructure, degree of routinisation (effortful accomplishment vs automatic response).
- Negative and positive features of the process.
- What did you do and why did you do it.

- Progressive revisions along the time line.
- What would have made it better/worse?
- When it was working well what was happening?
- When it was not working well what was the block, was there an absence of something?
- Were there occasions when you did not know what to do next, what did you do?

Understanding the outcome
Prompts:
- Describe the innovation – what was special about it? What quality does the innovation have that, if it were absent, would render the innovation something other than it is?
- Newness, significance, effectiveness. An improvement, something completely new
- The absence of what element from the process would have made it better/worse?
- What were the key features of the process that enabled you to end up with what you got?
- What is it about your application to team of the year that made your application successful?
- Users' perspective?

Background documentation to informants

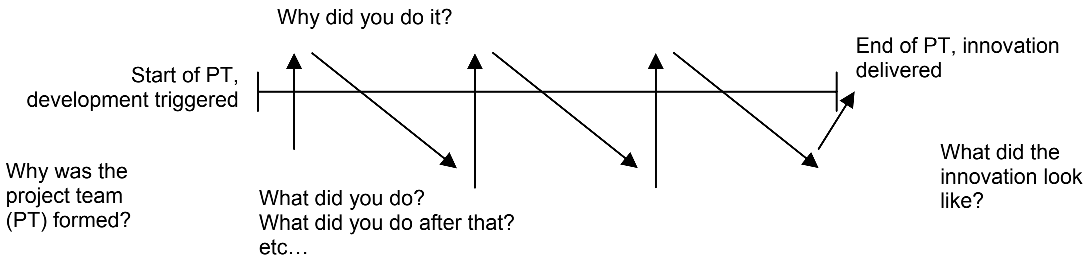
The importance of innovative problem solving to competitive advantage and organisational survival is largely undisputed. Partly as a consequence of hyper-turbulent competition and demand for improved services, organisational capacity to deliver innovative solutions has come to be regarded as a critical competence. Research across several domains suggests that teams play a significant role in stimulating innovation. However, despite the growing use of teams as a vehicle for organisational functioning there is still little understanding of the input factors and group processes that determine levels of team innovation.

The focus of management and academic attention appears largely to have been on making the processes of innovation more efficient (for example, faster or leaner through the application of tools such as TQM), or, understanding the impact on the organisation of introducing innovations from outside the organisation. Both of these approaches largely ignore the nature of the innovation itself. It is argued, for example, that the process for managing discontinuous (radical) innovation is different from that for managing incremental innovation. What is sound management practice for managing incremental innovation might actually hamper the process of radical innovation. In the absence of a critical understanding of the connection between process and outcome it is not clear how best, in successive projects, to organise for innovation.

Part of the difficulty in forging a connection between process and outcome is the inadequacy of our language for talking about innovation. Historically, we have been restricted to talking in generalities about radical or incremental, administrative or technical innovations, and so on. This framework fails to capture the richness of all that which contributes to an innovation, of all that that is embodied in the innovation. Our language simply fails to capture the essence of an innovation.

The proposed research confronts this difficulty. In posing the question 'What is it that makes the innovation outcome look like it does?' the research addresses two key issues. Firstly, it seeks to specify a robust framework for talking about innovations. Secondly it will map out and categorise the processes, which at the most fundamental level are that collection of tasks or activities which, together, and only together, transform inputs into outputs, of innovation in project and team working. The assumption of the proposed research is that the processes of innovation in project teams can be understood from a holistic perspective in which the process elements are tightly interdependent and mutually supportive.

Through the retrospective analysis of histories to discern commonalities (or not) in which the actors engage, which culminate (or not) in robustly specified innovation outcomes, the objective is to describe an innovation both in terms of its essential features and the process by which it came about. In the early stages of data collection three questions will be asked: 'Why was the project team started (issue identification)?' 'What was the innovative outcome (its essence)?' and, 'How did it come about (the process)?' along a time-line investigation (see below).



APPENDIX FIVE: SURVEY INSTRUMENT AND COVERING DOCUMENTATION

Dear [Name]

Based on your participation in the [Award], I would like to ask for your co-operation in a research programme being undertaken by my research student, Richard Adams, as part of his doctoral studies.

The research investigates the approaches NHS teams use to deliver different innovation outcomes in order to better understand the nature of the relationships between the two and the extent to which processes influence the nature of outcomes. Because existing research in this area is limited it is anticipated that the study will have significant learning applications in the current climate of change in the NHS.

Enclosed is a short questionnaire, developed from case work in the NHS, which in trials has taken approximately 15-20 minutes to complete. We would sincerely appreciate your participation in this survey that we feel sure will be of mutual benefit. As a token of this appreciation we are happy to provide you with the results of this study.

If you have any questions or would like to discuss the questionnaire further Richard can be contacted at the above address, via email (radams7109@aol.com) or by telephone (**********).

I do hope that you will feel able to participate.

Yours sincerely

Professor David Tranfield
Director of Research

Perceptions of Innovation Questionnaire

This questionnaire considers the nature of innovations as part of a wider study into connections between innovation processes and outcomes. It is designed to discover **your perceptions** about a recent innovation in which you were involved, [INNOVATION]

The questionnaire takes the form of a series of statements and should take between 15 and 20 minutes to complete. When considering these statements please:

Consider them with respect to [INNOVATION]
Evaluate each statement according to the extent to which you agree or disagree with it in relation to [INNOVATION]

Thank you for your co-operation

Richard Adams

Guidelines for completion:

Please answer all the statements by circling the appropriate number on the scale of 1 (you strongly disagree with the statement with regard to [INNOVATION]) to 7 (you strongly agree with the statement with regard to [INNOVATION])

Please return completed questionnaires to Richard Adams in the pre-paid envelope provided.

If you would like to receive a copy of the report emanating from this research please ensure that your contact details are correct and sign below
DETAILS
Yes, please send me a copy of the research report:……………………………………………….(signature)

Statement of Confidentiality Findings from this research will be presented in generalised form only and not in any way that would identify any specific individuals, teams or organisations.

Please circle the relevant number for ***each*** *statement*	**Strongly disagree**			**Neutral**			**Strongly agree**

1. Statements 1.1 – 1.5. How big was the change?

1.1 There is a high degree of similarity between the innovation and that which it replaces	1	2	3	4	5	6	7
1.2 The innovation has allowed the adopting unit* to provide (a) new service(s) for the first time	1	2	3	4	5	6	7
1.3 The innovation consists only of minor changes	1	2	3	4	5	6	7
1.4 The innovation supplemented, but did not replace, an existing service	1	2	3	4	5	6	7
1.5 The innovation represents a major change in what the adopting unit* is able to offer	1	2	3	4	5	6	7

***Adopting unit:** the team, specialism, or medical or organisational unit that has adopted and is the principal user of the innovation.

2. Statements 2.1 - 2.7. Did innovating lead to changes in existing routines and behaviour?

2.1 Staff were immediately familiar with how the innovation worked	1	2	3	4	5	6	7
2.2 The innovation represented a large departure from existing behaviour for the adopting unit	1	2	3	4	5	6	7
2.3 The innovation represented a large departure from existing behaviour across the whole organisation	1	2	3	4	5	6	7
2.4 The innovation represented a large departure from existing behaviour for the wider stakeholder* community	1	2	3	4	5	6	7
2.5 Pre-existing routines (i.e. pre-dating the innovation), in the adopting unit, remained unchanged after the innovation	1	2	3	4	5	6	7
2.6 Pre-existing routines (i.e. pre-dating the innovation), in the whole organisation+, remained unchanged after the innovation	1	2	3	4	5	6	7
2.7 Pre-existing routines (i.e. pre-dating the innovation), in the stakeholder community, remained unchanged after the innovation	1	2	3	4	5	6	7

***Stakeholder community:** the wider community that has an interest in the innovation, this might include patients, suppliers, government departments, charitable bodies etc

+Whole organisation: the local organisation to which the adopting unit belongs. This might be a Primary Care Trust, Hospital Trust, Charitable body, Health Authority

3. Statements 3.1 – 3.6. To what extent was the innovation disruptive?

3.1 **Developing*** the innovation caused disruption in the adopting unit	1	2	3	4	5	6	7
3.2 **Developing** the innovation caused disruption in the wider organisation	1	2	3	4	5	6	7

3.3 **Developing** the innovation caused disruption in the stakeholder community	1	2	3	4	5	6	7
3.4 **Implementing+** the innovation caused disruption in the adopting unit	1	2	3	4	5	6	7
3.5 **Implementing** the innovation caused disruption in the wider organisation	1	2	3	4	5	6	7
3.6 **Implementing** the innovation caused disruption in the stakeholder community	1	2	3	4	5	6	7

***Developing an innovation** – those activities pertaining to problem identification, information gathering, attitude formation and evaluation, resource attainment, leading to a decision to adopt and implement an innovation

+Implementing an innovation - the initial utilisation and then continued use of the innovation by the group or organisation until the innovation becomes a routine feature.

4. Statements 4.1 – 4.5 The extent of risk* to which individuals or the whole organisation were exposed in the development, implementation or use of the innovation.

4.1 The innovation is inherently risky	1	2	3	4	5	6	7
4.2 The innovation has been widely accepted as safe	1	2	3	4	5	6	7
4.3 Individuals took risks in **developing** the innovation	1	2	3	4	5	6	7
4.5 Individuals took risks in **implementing** the innovation	1	2	3	4	5	6	7
4.6 The innovation represents a risk for the organisation	1	2	3	4	5	6	7

***Risk:** covers a range of factors and can include: clinical failure, legal action, degraded reputation, diminished career expectations, technical failure, threats to established power bases and so on.

5. Statements 5.1 – 5.5 The idea origins of the innovation

5.1 The innovation was developed entirely in-house	1	2	3	4	5	6	7
5.2 The innovation required significant external input	1	2	3	4	5	6	7
5.3 The innovation required minimal external input	1	2	3	4	5	6	7
5.4 The innovation was copied from an external source.	1	2	3	4	5	6	7
5.5 The innovation was modified from external examples	1	2	3	4	5	6	7

6. Statements 6.1 – 6.2 The extent to which the innovation can be refined, elaborated and modified according to the needs of the adopting unit

6.1 The innovation fits comfortably with existing organisational values	1	2	3	4	5	6	7
6.2 Where necessary it has been possible to modify the innovation to suit local requirements	1	2	3	4	5	6	7

	Strongly disagree			Neutral			Strongly agree
7. Statements 7.1 – 7.4 Users' (those members of the adopting unit) understanding of the origins of the innovation and the use to which it is put							
7.1 Users are well informed about the origins of the innovation	1	2	3	4	5	6	7
7.2 Users are well informed about expectations of the innovation	1	2	3	4	5	6	7
7.3 The feasibility of the innovation was frequently called into question	1	2	3	4	5	6	7
7.4 We were not aware of appropriate external solutions to the initial problem	1	2	3	4	5	6	7
7.5 The innovation is effective in its use	1	2	3	4	5	6	7
8. Statements 8.1 – 8.4 Innovation scope. Does the innovation stand alone in the unit of adoption or does it have a wider reach?							
8.1 The innovation is self-contained within the adopting unit	1	2	3	4	5	6	7
8.2 The impact of the innovation has been limited to the whole organisation	1	2	3	4	5	6	7
8.3 The impact of the innovation has been widely felt beyond the whole organisation	1	2	3	4	5	6	7
8.4 The innovation has required changes to be made or accommodations sought in the wider stakeholder environment	1	2	3	4	5	6	7
9. Statements 9.1 – 9.7 Innovation complexity. The multiple inter-dependant, inter-relating components* necessary for the functioning of the innovation.							
9.1 The innovation consists of modified existing components*	1	2	3	4	5	6	7
9.2 A large number of specialists (clinical and/or non-clinical) were involved in **developing** the innovation	1	2	3	4	5	6	7
9.3 A large number of specialists (clinical and/or non-clinical) were involved in **implementing** the innovation	1	2	3	4	5	6	7
9.4 The innovation requires co-ordination amongst many units	1	2	3	4	5	6	7
9.5 The innovation has been highly customised for local use	1	2	3	4	5	6	7
9.6 A large number of organisational units were involved in developing the innovation	1	2	3	4	5	6	7
9.7 A large number of organisational units were involved in implementing the innovation	1	2	3	4	5	6	7

***Components:** might be physical items – say a piece of technology – equally they might be 'soft' items such as social relationships. So, is the innovation a reconfiguration of existing resources?

	Strongly disagree			Neutral			Strongly agree
10. Statements 10.1 – 10.2 Achievement of objectives							
10.1 The innovation has satisfied all the original objectives set for it at the start of its development	1	2	3	4	5	6	7
10.2 The innovation solves the problem that originally stimulated its development	1	2	3	4	5	6	7
11. Statements 11.1 – 11.2 Extent of improvement							
11.1 The innovation represents an improvement on the pre-existing situation	1	2	3	4	5	6	7
11.2 The innovation has achieved unplanned-for benefits	1	2	3	4	5	6	7
12. Statements 12.1 – 12.4 The extent to which the innovation raises personal, group or organisational profile							
The innovation was pursued for reasons of…							
12.1 …**organisational** prestige	1	2	3	4	5	6	7
12.2 …**personal** prestige	1	2	3	4	5	6	7
The innovation has raised the profile of…							
12.3 …the **organisation**	1	2	3	4	5	6	7
12.4 …**individuals**	1	2	3	4	5	6	7
13. Statements 13.1 – 13.2 The extent to which the innovation is observable by others							
The innovation has…							
…gained recognition **within** the NHS	1	2	3	4	5	6	7
…gained recognition **outside** the NHS	1	2	3	4	5	6	7

Many thanks for taking the time to complete this questionnaire.
If you have comments about any of the issues raised please note them in the box below. Please return completed questionnaire to Richard Adams in the pre-paid envelope provided.

APPENDIX SIX: CASE HISTORY SUMMARY SHEET

Interviewee name	Tape reference
Role title/responsibilities	Age
Interviewee code number	Sex
Interview number	Education
Date coded	Date/time of interview
	Place of interview

What were the main issues or themes that struck me in this contact:
Summary of data gathered (any notable gaps?)

Process	Outcome

What struck me as salient, interesting, illuminating or important in this interview:
As a result of this interview what new or alternative issues are raised for future contact at this site or, other sites?
Salient points emerging from coding:

Page	Point	Category/Theme

Reflections on the process of coding:

APPENDIX SEVEN: CONTENT ANALYSIS OF REPERTORY GRIDS, AN EXAMPLE FROM TEAM D

Informant Generated Construct, and Dimension	**Raw Data**	**Initial Reflections and Annotation**
improving existing activities - concrete, episodic	Involves improving existing services or existing activities or participating in existing activities and it is just if you like getting a new handle on them all getting a new approach or improving them in some way. Whereas (element) 1 seems to be a much more concrete, separate, episodic -- there seems to be a definite step involved as opposed to incremental change.	Degrees of newness, echoes of radical/incremental dichotomisation. In fact, appears to distinguish between existing services and services that are new to the hospital – located newness. Making the innovation a 'better place to be'. Captures and supports multiple dimensions.
medically led, nurse led	It is delegating previous medical responsibility to nursing staff.	Internal roles in the delivery of the new service. Internal location of impact. Indicative of innovation type and departure from pre-existing practices.
multidisciplinary, individual discipline	They tend really to be much more individual, all based on an activity by an individual or perhaps two people. 5 is more a single discipline....	Scope of impact, maybe suggesting departure from the way things were done before either for a small number or large number of people.
patient focus, organisation focus	I think to the patient those 2 (elements) are exceptionally significant. The multi-disciplinary teams are not interested in the patient and element 1 scores 1 – they don't care what is behind it. Element 2 scores 4 because a lot of that will have a knock on effect for patients – big time. They (elements 4&5) are highly patient focused, that one (3) isn't. Well, I am not saying nothing but, it doesn't affect the patient. As far as I am concerned 4&5 are very patient focused and score 5 – the service for the patient, that is what we are here for. At the end of the day the patient doesn't care who's managing what! I think when it comes to a patient the patient is interested in the service they get, not how they get it or who's up there governing it. I don't think they look above the consultant, and I don't put consultants in management. When I talk about management I mean people in their offices, not delivering medical services.	Various manifestations of this idea: patient focus contrasted against non-patient focus, organisational focus, dimensionalised high/low. Combines ideas of location of newness, and the extent to which the innovation is better than the situation which preceded it.

	Element one is more organisation focused if you like whereas four and six are really much more patient focused.	
single/holistic aspects of patient experience type of patient inpatient or outpatient	Elements 5 and 6 are much more about a single aspect of service or activity. A component if you like. They are much more about a component of the patient's experience. Whereas element 2 is much more about the whole service that the patients experience is rather than one single aspect of that service that the patient or the staff experience	Innovations are made up of elements, some more than others – different degrees of connectedness between the elements from one innovation to the next.
strategic, functional	Practical aspect of service delivery whereas in 1 and three involve a more strategic role -- that is thinking about the health service as a provider. So we are looking at strategic versus practicality.	Dimensions of solution to the initial problem? Multi-levels of solving. Components and complexity of some innovations.
benefit to patients, benefit to staff via streamlining	Element 2 seems to be more about the staff aspects of activity, in other words they would seem to me to benefit staff although they probably do benefit patients because we actually had to set up the community dental service in hospital to help out the community because they were having problem coping with it in the community. So that is how I would put it, number two would probably benefit staff working practices or types of working practices whereas numbers four and six would predominantly benefit patients…What I think I mean is they probably benefit smooth running of the organisation in the sense, if you like they probably do not directly benefit staff by giving them more time off -- I don't really mean that. So what they do is produce more streamlined organisational practices or streamlined organisational working.	Customer perspective vs internal perspective. A better place to be…
degree of personal involvement (lo-hi)	Elements 1&2 are something that I would potentially be involved in, that one (3) is something I wouldn't.	Roles and behaviours?

degree of nurse involvement at establishment (lo-hi) degree of consultant involvement (lo-hi) degree of management involvement (lo-hi) nurses/multidisciplinar y	That is a tricky one because they are all nurse led, they all depend on medical staff for help. I would say, in their setting up 5&4 are more nurse led and 6 is anaesthetic led. They are similar, although they are asked for by doctors they have really been introduced by nurses and they are rather more nurse orientated, whereas the acute pain service, although it is Sharon – she is the pain nurse – she has a team of anaesthetists that she always works with. So although a nurse is at the forefront of that (which one?) now I don't think she was when it was set up. I would say 2 are mainly either consultant or management led 1 is more nursing led. I am going to change my mind, I am going to say that that is more management led and that is more nursing led. So that is the degree of management Again mainly nurse led, mainly big nurse involvement. I think that that one relies on consultant input, consultant approval. Degree of consultant involvement. That is a clinic run by nurses primarily – even though it is a multi disciplinary it is mainly a nurse-led (5). Nurse-led (score 1) multi disciplinary (score 5)	In dimensionalising the scale one informant was eager to point out that it was at introduction of the service, not necessarily in the current running of the service – the setting up and introduction. In effect it is nurse involvement again, just the emphasis has changed and the scoring mirrors very closely that for construct 3. In fact I terminated repertory gridding with informant quite quickly – at least informant generated constructs – informant found it very difficult to generate more than one construct (which was in effect degree of nurse involvement).
effectiveness to Trust management (lo-hi) effectiveness/ineffectiv eness to the hospital	Patient orientated effectiveness. No, effectiveness to the management structure of the NHS, no within the Trust. So 2&1 score highly	Innovation evidently has impact in different domains, but informant appears to compare and contrast these impacts as part of the reflection process of repertory grid technique to determine a perspective of 'most and least'
significance to patient (lo-hi)	Significance? To the service, to the staff or to patients? OK, significance to staff and patients	I feel uneasy about this. Seems not to have any meaning for the informant and gives the impression of just 'playing the game'
incremental/radical	I think that's a new innovation for the hospital. I would say those things have perhaps already been there or certainly over the last 8 or 9 years. I would say that element 5 is a new initiative, a new innovation for us, I would say those (1&2) have been there – they may have been reinvented but I would say those two (1&2) have always been there and that (5) is a new one. Card 1 is about a 2, it has always been there, it is coming to the forefront now and we are changing the way the multi disciplinary team works together. The acute service is about 3, although it has always been here it has undergone a lot of change recently, or	In spite of the radical/incremental dimensionalisation, I think we are talking here about what has been done to existing knowledge, behaviours and so on, how they have been amended, developed, revitalised.

	since S came into post. I would say that (2) is about a 5 because I think that a lot of those are new. Card 3, middle of the road on that one because I think it has always been here, only now is it coming up to the forefront, that we are supposed to know about these things. 5, probably a 3, it has always been here but again it is undergoing change and the same for element 4.	
existing within/new to hospital	Elements 2&3 are the same, just because you participate in something, you are one of many and…they are multi disciplinary practice areas, something that are already established anyway, there was already something there. Setting up of a multi disciplinary day case management team that was setting up something from scratch – so you are beginning with a blank piece of paper, how you want to move forward… Element 2…about a 3 because even though you have got things existing you are improving your emphasis on future…you are trying to do change as well because there is something there.	The extent of the newness? Some start from nothing – the blank piece of paper – others develop on pre-existing things. Existing vs new? Not necessarily continuous improvement. Context local, domain of newness.
individual/team	I would say 2&3 are the same purely because they are different services, but we have had that one. Can we have introduction or is that the same as new? RA: what do you want to say about introduction? Well it is a new service but it is the introduction of…so maybe…all the groundwork has been done and we are just about to run with it whereas these are already ongoing. They can be done by one person and the other has to be done with many people - Individual (1) team (5).	Range of impact, numbers of people involved, behaviours affected?
impact of newness to patient/staff	RA: So, new to patients then? Newness to the patient because now that we have merged from 5 hospitals to 1 and we have also got the GPs with their ever changing roles and the inpatient care group, we are taking patients from further afield especially with the cataracts. RA: And what could we have at the other end? Can you not have, how do you word it, I want a word going from, could you have like patients and staff in the same thing? What I am trying to say is that that's new to patients that…But also from our point of view we have now got such a large area to deal with that we…	Politics and play. The junior partner in a trust that feels under-valued, ignored even bullied and coerced by a much larger partner. Seems a curious construct given the conversation that followed. Origin of the construct in new service for the patient, ends with a rant about the extent to which they are 'permitted' to develop their own ideas for service improvement. Their initiatives would seem, then, not to stand alone but be connected by 'invisible threads' throughout the trust – which makes the opportunity of innovating and

	RA: Are you talking about impact of newness on patients and impact of newness on staff? Yes, because I think in this Trust as well, which highlights the point actually of one of the things to epidurals: they had a problem down the road with epidurals, suddenly it's a Trust wide problem (i.e. because it is a problem for the *Hospital* the *Hospital* assumes it is a problem for the whole Trust) not the fact that we didn't have a problem, the *Hospital* did and suddenly "Oh my God, it is Trust-wide". Suddenly we had to have huge bloody working parties upstairs, like 30 odd people. And we were like "well hang on a minute, we are alright 25 miles down the road", but suddenly what they are trying to foist on us we have had to really say "well hang on, we are doing it, we've got best practice, use what we use" and that is what I want am trying to say here.	subsequent implementation very complex.
hospital specific, any Trust in UK	Could be any other area, nation-wide context – there are lots of services going on like that, all at different stages	It is not unique to this team – possibly sources of origination of ideas.
pre assessment, no pre assessment	Dimensionalised 1 or 5 – yes or no –	Not a helpful dimension other than to identify the construct? No discussion. Is about some sort of focus of the innovation – individual consciousness about the use to which it is put. What is special about pre-assessment? My feeling about this informant that at the centre of the informant's thinking is not the innovation but rather the individual.
inpatient/outpatient	These people…they are coming to be in patients…others are just being pre-assessed	Location of benefit of the innovation – different constituencies of beneficiary.

APPENDIX EIGHT: PRELIMINARY CODING TO THE INNOVATION FRAMEWORK, ILLUSTRATIVE EXTRACTS FROM TEAM A

Categories and Dimensions of framework	Literature and commentary	Raw data transcript
Newness		
Extent	The dichotomisation radical/incremental is that which is most commonly adopted in innovation literature to describe the extent of newness. Other similar labels include: discontinuous change(Lambe and Spekman, 1997), continuous improvement (Bessant and Caffyn, 1997) and revolutionary change Rabson and DeMarco (1999). The extent of an innovation is the degree of change represented by the innovation. Four sub-dimensions of extent have been uncovered in the empirical data: risk, departure, disruption, novelty.	
Risk	The innovation literature does not focus significantly on the concept of risk, Heany (Heany, 1983) is a rare example, for whom risk is at its least where market, product and process repercussions are non-existent or minimised.	I got warned by the health authority that I might get suspended and [that] if I was asked to go to a meeting with my chief executive and medical director [I should] say no and ring us. And I had a gagging letter from [senior manager] with whom my boats were burned really so I wrote back a brave letter… she said if I talked out of turn she would have to take it to the chief executive of the region**. (A1)**
Departure	The degree of change in the activities of an organisation and departure from existing practices (Lambe & Spekeman, 1997). Incremental innovations are those that result in a low degree of departure from existing practices (Damanpour, 1996). White and Graham (1978) consider the impact of the innovation on business practices. Tornatzky and Klein (1982) describe this as the degree of consistency with existing values, past experiences and needs of adopter. Beyer and Trice (1978) described this as 'pervasiveness', the proportion of total behaviours occurring within an organisation that are expected to be affected by the innovation, a function of how many organisational members are expected to change their behaviours due to the innovation and how much of the time those involved will be behaving in new ways. It is evident that each of the innovations in the sample represent significant departure from existing practice – if only at the conceptual level	0h enormous [emphasised]. Even though the scale was not large, conceptually this is massively challenging, massively. Like, you know, it contradicts so many cultural things about the way in which the NHS has worked. From strategic bodies like health authorities right down through to operational staff. **(A5)**
Disruption	So-called radical innovations impact existing systems in a disruptive manner (Rabson & DeMarco, 1999), conversely, innovations that are not, do not. Similar to what Beyer and Trice (1978) called 'magnitude': the degree of displacement of existing organisational states that the innovation implies - structural, personnel, financial etc.	But what they did not want to do was to let go of it [i.e. maintain the status quo]. And there we were, suddenly talking about moving people into a single managed team and actually taking them out of their employer Trust to put them into a different one. **(A2)**

Novelty	Novelty receives surprisingly little direct attention in the literature, perhaps because it is a taken for granted feature of innovating. Where it is considered it receives fairly consistent treatment, that is the perceived changes in the status quo (Zaltman et al. 1973; King, 1992; West and Anderson, 1996; Montgomery, 1990; Voss et al. 1999). It takes a broader perspective than departure and considers a wider context of innovation than existing practice.	…and said "Tell us what your vision is and how we can do it", well, we didn't know how we could do it, to be frank. We knew that we needed somehow to intertwine everybody that was part of palliative care, and that was a completely alien concept, particularly here**. (A3)**
Ideation	What are the origins of the ideas that form the basis of the innovation? Successful innovation can have its roots in creativity but this is not a necessary antecedent (Amabile et al. 1996) so, the dimensions of ideation range from a wholly original idea to borrowed ideas. White and Graham (1978) develop the concept 'inventive merit'. At the heart of innovation is a combination of new knowledge or recombination of existing knowledge (Nonaka, 1990; Nonaka and Takeuchi, 1995; Norman and Streiner, 2000). Pelz (1983) identifies three dimensions of originality: origination, adaptation, borrowing.	
Origination	A first time solution to a problem without benefit of similar, prior examples. In the development of the innovations for which they won awards teams B & C did smaller ones, some of which were borrowed, other parts wholly original. Team A doggedly pursued an original innovation for 2 years.	…how [we] integrated it was ours, self-generated. And it grew from thinking "well instead of having Macmillan nurses in 5 Trusts let's have them in one…actually give them some specialist management so that they have got a manager who knows what it is they do and understands what the pressures are. It grew from that. **(A2)**
Borrowing	Well developed solutions to the problem are found elsewhere and are copied with little or no change. The data seems to suggest that Team C's innovation was borrowed compared to those of A & B which relied more on adaptation and their own origination. The data gathering though, did not seek to differentiate in terms of degree, just to identify salient features for a survey tool. This I think it has done.	

Significance		
Scope	The fundamental notion underpinning this dimension of innovation is the nature of the linkage between the innovation and its environment. That is, to what extent can the innovation stand-alone and be pursued independently, does its introduction require changes elsewhere in the system? Chesborough and Teece (1996) call these autonomous and systemic innovations. Goodman (1981) specified individual and synergistic innovations. Individual innovations affect only a single functional area and do not affect other functions or cause wider change. A synergistic innovation is one that requires that many functions be affected. At a rather finer level, using the product as the unit of analysis as opposed to the organisation, Henderson and Clark (1990) describe component and architectural innovations. With the former, one component simply replaces another, but architectural innovations require that whole systems be reconfigured Similarly, Nord and Tucker (Nord and Tucker, 1987) describe innovations by the degree to which they concern the major day to day work of the organisation. A5.1 suggests a wide scope in that behaviour change has happened within the context of the innovating group. However, A5.2 alerts us to be aware that although there is evidence to suggest wide scope, other evidence might indicate a dispersed and wider significance.	So the notion of them all coming into the room and…writing it up on the board which patients need to be seen today and who is going to see them -- you know that is a level of collaboration at an operational level that the service had never known. **(A5.1)** 0h enormous [emphasised]. Even though the scale was not large, conceptually this is massively challenging, massively. Like, you know, it contradicts so many cultural things about the way in which the NHS has worked. From strategic bodies like health authorities right down through to operational staff. **(A5.2)**
Complexity	Pelz (1985) describes complexity as "the degree to which an innovation is perceived as relatively difficult to understand and use" (pp. 264) which itself is a function of its composition (how many parts make it up and how do they link together: so, for example, the complexity of a technical innovation could be assessed along a continuum from tight packages of inter-linked parts to technically loose composites of independent parts that could be adopted separately). Similarly administrative or processual complexity would range from homogenous innovations involving only a few units to heterogeneous ones requiring co-ordination among many units. Excerpt illustrates how informants perceive complexity as something that emanates from the innovation. Each innovation is described as complex because of the range of impact, the ripples from the pebble in the pond extend a long way and require the conscious integration or incorporation of other units and considerations.	I think it is the closed universe wherein they bring everybody together in palliative care. And the thing that the hospices particularly like is that they are given a stake and some say in the whole of the way in which palliative care works not just their hospice bit of it. So they have some say in the way NHS resources are used and Macmillan resources are used, not just how other hospice resources are used. And I think it is that holistic approach **(A5)**
Visibility	The extent to which innovation is observable by others (Wolfe, 1994).	I think it is not so much what they will notice it is what they will not notice…I don't particularly ever want again to have a patient ever say to me "don't all you people talk to each other?" **(A1)**

Profile	Profile echoes visibility, but, whereas visibility focuses on the innovation, profile considers where the innovation rubs off on people, institutions and so forth. The reflected glory. The idea receives little treatment in the literature, though Mohr's (1969) concept of status captures some of the idea: the extent to which an innovation is adopted in the quest of prestige rather than profit or effectiveness.	…yes, I think it was [the pursuit of personal ambition]…I think for [name] it was. And I think that that may be unfair…But I think it was thought that it was there to make a name, to make a difference, to make a change and that it was not about patient care. **(A4)**
Effectiveness		
Adaptability	**T**he ability to refine, elaborate and modify an innovation according to the needs and objectives of the implementor, can be flexible or inflexible (Wolfe, 1994). Not a great deal of evidence of adaptability being a feature of these innovations. This might suggest that successful innovations are very specifically targeted to the problem to the extent that they do not need to be flexible, they just need to solve.	…and what we have decided to do is we are going to buy into the health service package (database system) and adapt it to suit ourselves as best we can. It is not a perfect solution but I firmly believe it is the nearest we are going to get and, from a financial point of view we are going to save ourselves £100,000 a year on software – and that is a lot of coffee mornings! (**A3**).
Relative advantage	The extent to which an innovation is perceived as being better than the idea it supersedes (Wolfe, 1994). White and Graham (1978) develop the similar idea of market merit, whether or not final demand will be expanded by the innovation. For the innovation that is only conceptual (Team A) no coding to this node – seems reasonable, so a validation of the construct and its application?	…I have access to the health service in a way that most […] Chief Executives do not have. I have access to all that health service money…so I have much better access to the people I need to have access to **(A4).**
Actual Operation	The extent to which the innovation achieved its purpose (Pelz, 1983). Different from relative advantage in that it considers the innovation in the context of its original aim. An innovation may not have achieved all that was intended for it (in its actual operation) though it may be a considerable improvement on what went before (relative advantage).	I think more [patients] are being seen and they are being seen quicker. The access to the service is better and clearer. **(A7)**

APPENDIX NINE: EARLY RENDITIONS OF THE FRAMEWORK

Category	Properties
Descriptive Categories, innovation type	Administrative, Social, Technical, Process, Product, Market, Ancillary, Programmed, Physical Properties.
Substantive Categories, innovation perceived to be about	Newness, Significance, Effectiveness.
Substantive sub-categories, perceptions consist of	Adaptability, Architectural, Autonomous, Central, Compatibility, Complexity, Component, Continuous improvement, Cost, Disruptive, Divisibility, Evolutionary, Incremental, Individual, Instrumental, Magnitude, Modular, Observability, Peripheral, Pervasiveness, Radical, Revolutionary, Risk, Scope, Synergistic, Systemic, Ultimate, Uncertainty.

First rendering (December 2000)

Innovation type	**Innovation essence**	**Innovation newness**	**Innovation significance**	**Innovation effectiveness**
Administrative	Essentiality	Architectural	Centrality	Adaptability
Process		Autonomous	Compatibility	Systemic
Technical		Radical	Complexity	Operational merit
Product		Inventive merit	Divisibility	Market merit
Ancillary		Embodiment merit	Magnitude	
Physical properties			Observability	
Programmed			Pervasiveness	
			Risk	
			Status	
			Uncertainty	

Second rendering (December 2001)

APPENDIX TEN: INTERVIEW PROTOCOL AND INDICATIVE LINES OF ENQUIRY, PHASE III

Idea
How did the idea develop? How did the idea change over time? Screening of ideas?

Process
- Characterise the process for me – linear, sequential, patterned, routine, evolutionary, conflict ridden, confrontational, synthesising, goal driven… Was it at all predictable?
- Can you recall or describe a sequence of events/activities that you engaged in? Particularly with regard to core or enabling processes? Did individual events serve to motivate or demotivate?
- Put some date parameters on it? How long did it all take?-
- Was this a formal project, what degree of structure did it have. It took place within an existing team, not one that had been specifically established for the purpose. Any clear priorities? How much a part did deliberate activities play – were there any deliberate activities – did you set off in pursuit of deliberate change?
- Was there anything about the process that was recurrent – reviews, and so forth. What structure was built into the process

Climate
- What's the climate like for change and innovation – in the team and in the hospital/trust. A creative environment? Senior management support.
- Were there ever occasions when you did not know what to do next?

Team
- Internal and external team issues. Were you able to do this in isolation or was there a reliance on external influences. What is and was team morale like during the process?
- As a clinician/consultant to what extent do you regard it as part of your job to bring about change. I would not, I don't think, have expected to see it listed in a typical job description. Do you do it in extremis?
- Describe your personal style. Any significant personnel changes?
- Is there anything that you would have done differently?

Incidents
- Recall any significant incidents. What hampered and what enabled? Can you say... "If it were not for x y z we would not have been able to achieve what we did"?
- Was there a path? Was it defined beforehand or only recognisable with hindsight?

Interview guide (to respondent). Indicative lines of enquiry.

Process research concerns understanding how things evolve over time and why they evolve in that way. Process data is essentially a story about what happened, and who did what and when and with what sort of impact. It is about events, activities and choices made over time. I am interested in the sequence and nature of the events that lead to a specific outcome, in your case…NAME OF INNOVATION

Innovation core processes: areas to explore

- How did the need for an innovative solution manifest itself? Trigger mechanisms.
  What were the origins of possible solutions? Where did the ideas come from, purposeful exploration, serendipity…?
- How were potential solutions tabled for consideration, appraised and evaluated? Intra-group communications and knowledge transfer, role of external influences…
- Nature of the selection/adoption decision. Basis for decision making – alignment with organisational imperatives, cost, utility, acceptability…
- How was the innovation implemented? Testing, pilot study, suck-it-and-see, routinisation of the change, co-existence of the old and the new…
- Description of overall process. What were the characteristics of the process: managed, random, straightforward, experimental, trial-and-error...? Are different phases identifiable? What distinguishes the phases one from the others?

Innovation enabling processes

- Visioning. Was there a vision of the end-state that motivated the activities? Where did this come from? Collective understanding and concurrence with vision? Evolution of vision as process progressed – did it change? How, why and with what consequences.
- Participative safety. Explore extent to which participants felt safe in engaging in a process of change. Nature of environmental characteristics: judgmental vs non-judgmental, supportive vs non supportive, cohesiveness vs non cohesiveness, level of collaboration, relative strength of social ties…
- Change orientation. Exploration of the way in which the team manifests its concern for the task. Can the team demonstrate tolerance of competing perspectives, divergent thinking, individuals empowered to challenge the status quo, independence from external interference?
- Support for innovation. Is there a climate that supports individuals and teams in thinking about and developing new and improved ways of doing things?
- Evidence of presence or absence of articulated or enacted support for innovation. Might exist at the level of the individual, intra-team or outside the team.