Volume 1

Business Performance Measurement – A Soft Systemic Approach

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Quite when I decided to attempt to write a thesis I am not sure of, however I am sure of the two people who are responsible for setting me in that direction. R. to whom I will always be grateful for personal reasons, and Sionade. I am further indebted to them for steering me through the years in both an academic and pastoral sense. I am not sure how Sionade would describe the experience of supervising me but I believe that I have thrived on the freedom (indulgence?) that she has given me. I am more than grateful for her support, advice and belief that I would follow a useful path. To Sionade I have two specific things to say: the Aussie at ISSS was wrong; and I still believe that Chile is the 'mother of all case studies'!

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Abstract

The first objective of the research presented in this thesis, was to perform an investigation into the challenges of business performance measurement. The second objective of the research was to respond to these challenges, by articulating a Soft Systemic approach to business performance measurement. To meet the objectives of the research, the project draws on two key areas: a review of literature about measurement in different fields of study; and three real world action research case studies. The work in these areas is presented in this thesis, the main topics of which are:

- Identifying specific challenges to measurement in the area of business performance measurement.

- Identifying a number of generic causes of complexity in measurement situations; and introducing a new measurement classification based on the complexity of measurement situations.

- Using the new classification of measurement situations to critique the traditional approach to measurement; and thereby identifying situations, such as business performance measurement, where a new approach to measurement is needed.

- Proposing a set of Soft Systemic principles to measurement; and showing that this Soft Systemic approach is significantly different to the traditional approach.

- Showing that the Soft Systemic approach is more suitable to the complex challenges of business performance measurement.

- Translating the Soft Systemic approach into a practical framework, the Soft Systemic Performance Measurement Framework (SSPMF), to assist measurement practitioners in business performance measurement; and validating that framework in case study work.

Chapter One: *Introduction*

1.1. Research Project Objectives

The key objectives of this research are to articulate the challenges of business performance measurement, and then to formulate a new approach to measurement that addresses these challenges based on Soft Systems thinking.

If one takes the starting point for any research project as the identification of some research problem, then two generic objectives necessarily follow. The first is to articulate the nature of the research problem (business performance measurement) more clearly i.e. to move knowledge of the problem from acknowledging its existence to appreciating it causes. Following from this, the second generic objective is to formulate some response (a new measurement approach) to the problem. Within both of these generic research objectives a set of more specific objectives have been identified for the research project, these are listed below:

Problem Articulation:

1. Identification of the measurement challenges within the area of business measurement.
2. Categorisation of the complexity of measurement situations.
3. Critique of the use of the traditional approach to measurement within complex measurement situations.

Problem Response:

4. Define a Soft Systemic approach to performance measurement.
5. Contrast the Soft Systemic & traditional approaches to measurement.

6. Show how the Soft Systemic approach is better suited than the traditional approach to the complexity of business performance measurement.
7. Formulate a practical performance measurement framework based on the principles of the Soft Systemic approach to performance measurement.

The following sections review these objectives in more detail.

1.1.1. Problem Articulation: The Challenge of Business Performance Measurement

The first overall objective of this research project was to articulate the challenges presented by business performance measurement. As the project continued so it was possible to determine the issues that clouded knowledge of the problem. These issues were investigated in order to yield a clearer understanding of the problem. The specific the objectives of this investigation were:

- Identification of the measurement challenges primarily within the area of business measurement, and to a lesser extent in other complex measurement situations.
- Categorisation of the complexity of measurement situations.
- Critique of the use of the traditional approach to measurement within complex measurement situations.

The research project began with an emphasis on the area of customer service measurement. This emphasis remained an important theme throughout, however early on in the project it was realised that the issues facing customer service measurement mirrored those in the wider area of business performance measurement. Hence the focus broadened to a consideration of the measurement issues challenging those striving to

measure within the area of business performance measurement. Such issues were deemed to be the causes of complexity within such measurement situations.

Other complex measurement situations, such as quantum theory and chaos theory, were then investigated to see if any general causes of measurement complexity could be defined. From this it was proposed that a number of generic causes of complexity do exist in measurement situations, and these causes were investigated in more detail. The results from this investigation were then used to form the basis of a new classification system for the complexity of measurement situations. Four different categories within the measurement context classification system were articulated.

The traditional approach to measurement was then analysed in terms of the challenges of each category of the new measurement classification system. Following from this it was revealed that a traditional approach is unsuitable for some of the categories of measurement contexts. Business performance measurement is classified into such a measurement context. So it was proposed that some other kind of approach to measurement is needed to facilitate measurement within contexts such as business performance measurement.

1.1.2. Problem Response: A Soft Systemic approach to Business Performance Measurement

The second overall objective of this project is to formulate a response to the problem articulated in the first part of the project. Essentially that problem and response may be articulated as follows:

Problem:

There are certain categories of measurement situations, such as business performance measurement, that contain complex challenges that render a traditional approach to measurement unsuitable. Hence, a different approach to

measurement is required to deal with the complexity of business performance measurement.

Response:

A Soft Systemic approach to business performance measurement

The main proposition of this research project is that a Soft Systemic approach is better suited to deal with complex measurement situations. This is the central tenet of the problem response offered in this thesis and its articulation is the second overall objective of the project. In order to carry out this investigation a number of specific objectives were identified:

- Define a Soft Systemic approach to performance measurement.
- Contrast the Systemic & Traditional approaches to measurement.
- Show how the Systems approach is better suited than the traditional approach to the complexity of business performance measurement.
- Formulate a practical performance measurement framework based on the principles of the Soft Systemic approach to performance measurement.

In order to define what a Soft Systemic approach to business performance measurement is, it was first necessary to appreciate what a Soft Systemic approach to measurement in general might be. In order to do this the Systems literature was reviewed. This review found little work that takes measurement as its central theme, consequently the work of writers from different perspectives of the Systems discipline was reviewed where they make reference to measurement. From this review a set Soft Systemic themes to performance measurement were identified. These themes were the starting point for the first phase of action research within the project, which involved their application in a case study business organisation. The themes were then combined with the lessons

learned from the action research, and from both a Soft Systemic approach to performance measurement was articulated for the first time.

The Soft Systemic approach to measurement was then contrasted with the traditional approach, and it was proposed that they are fundamentally different. Both approaches were then analysed in relation to the categories of complex measurement contexts identified earlier in the research project. From this analysis it was shown that the Soft Systemic approach is better suited to deal with the challenges of complex measurement, such as business performance measurement.

Having demonstrated that the principles of a Soft Systemic approach to performance measurement are better suited to the demands of business measurement, they were translated into a practical framework: the Soft Systemic Performance Measurement Framework (SSPMF). This framework was introduced as a means of turning the implications of the Soft Systemic measurement principles into a guide for practitioners engaged in business performance measurement. The SSPMF was then used in the second phase of the action research associated with this project. During this phase the framework was used in two different case studies, each case study represented a different category of measurement context. These case studies were used to provide an initial validation of the practical framework.

1.2. Overview

The structure of the thesis reflects the objectives outlined in the previous section. Aside from the introduction and methodology chapters, the thesis is split into two parts. The first part concentrates on articulating the challenges of business performance measurement and the need for a new approach to measurement: problem articulation. The second part articulates the project's response to the need for a different approach to measurement: problem response. Given the length of the thesis university guidelines require that it be presented in two volumes, rather than split the thesis at the arbitrary point of three hundred pages each key part in presented as a single volume.

1.3.1. Introduction & Methodology

After this introductory chapter that outlines the research objectives and thesis structure project, the second chapter discusses the methodological approach of this research project, namely that of action research. The basic tenets of this approach are discussed and there is some critical reflection of the methodology with respect to this research project. This section largely draws on the work of Eisenhardt (1989), Foster (1972), Mintzberg (1979) and Checkland (1981). The 'experience-action cycle' model of action research developed by Checkland & Scholes (1990) is modified and then used to identify the key development stages of this project. Finally, as befits an action research project, a brief introduction to the case-study organisations that made up the action research phases of the project is provided.

1.3.2. Problem Articulation

Chapter three marks the beginning of the problem articulation part of the thesis with a review of the literature of metrology. The chapter deals with two main themes. The first section seeks to provide the reader with a basic impression of the development of

measurement theory / metrology. Two key stages of this development are reviewed with reference to the work of Campbell (1920, 1928 1938) in terms of the *classical* approach and Stevens (1946, 1951, 1959) in terms of the *relational* approach. The second section concentrates on Finkelstein (1973, 1975, 1982, 1994) and his 'informal' definition of measurement. This definition is introduced and then analysed in terms of its implications for a Soft Systemic approach to measurement.

The fourth chapter reviews the work of business / management writers who have written about business performance measurement. Two types of such writing are identified and reviewed. One is concerned with the aims, state and future development of business performance measurement: such as the work of Holloway, Lewis & Mallory (1995), Eccles (1991), Johnson & Kaplan (1987), Johnson (1990), Genauracos & Meiklejohn (1992), Nolan & Norton (1991) and the Royal Society of the Arts (1995). The other key theme of the management writers is to offer practical advice on doing business performance measurement: such as the work of Drucker (1968, 1992), Peters (1987), Kaplan & Norton (1992, 1993, 1996), and such organisations as the European Foundation for Quality Management.

The fifth chapter marks the final part of the initial literature review. It shows that developments in 'hard' areas such as maths and physics present challenges to the traditional approach to measurement. It is argued that it is not just business performance measurement situations that cause new complexity for metrology, but also the areas of quantum physics and chaos theory. Implications of these theories for both the traditional and Soft Systemic approach to measurement are identified.

The sixth chapter seeks to draw together the measurement challenges identified in the chapters above. A number of common themes to do with complexity are identified across the areas reviewed. These are described as generic causes of complexity in measurement situations. Systemic classifications of complexity are then used to try to

categorise these generic causes of measurement complexity. The approach taken by Jackson & Keys (1984) is found to be most suitable. However, this classification does not capture all the richness of complexity in measurement situations, so a new classification specifically for measurement contexts is introduced. The categories within this classification are reviewed in relation to the traditional approach to measurement and fundamental conflicts are identified. Thus the chapter concludes with a call for a different approach to measurement in such complex measurement contexts.

1.3.3. Problem Response

Chapter seven marks the beginning of the problem response part of the thesis. The chapter forms the final part of the literature review. The work of writers who may be considered to fall within the Systems movement is reviewed, specifically in terms of their writing with regard to measurement. Writers were chosen as their writing paid attention to the area of measurement, and may be argued to be; either typical of a certain school of though within the Systems movement; or offer insights into the area of measurement.

The chapter follows the categorisation of modern systems thinking offered by Flood and Jackson (1991), hence writers from the *hard* (such as Kircher (1959), Jenkins (1972), Jenkins & Youle (1971), Forrester (1961), Wolstenholme (1990), Sterman (1984, 1994)), *cybernetic* (such as Weiner (1948), Ashby (1956), Beer (1981)), *soft* (such as Churchman (1947, 1959, 1971), Ackoff (1979, 1981, 1986, 1994), Checkland (1981), Checkland & Scholes (1990), Warfield (1989)), and *critical* (such as Jackson (1991), Ulrich (1983, 1987)) strands of systems thinking are reviewed. From this review a set of themes of Soft Systemic measurement are identified.

Chapter eight details the first phase of action research carried out as part of the project. It takes the Soft Systemic themes and reviews their application in a real world business performance measurement situation. A measurement project at PFS a financial services

company is described, during which the themes were used to guide the activities of the project. A number of learning points are identified that are used to help formulate the principles presented in the next chapter.

Chapter nine begins by proposing a new Soft Systemic definition of measurement. When the new definition is contrasted with the traditional definition, the new is shown to be more encompassing. This Soft Systemic definition forms part of the set of principles that are introduced as a means of guiding a Soft Systemic approach to measurement in complex situations. In total seven such principles are proposed. Having established the principles of a Soft Systemic approach, it is contrasted with the traditional approach and significant differences are identified.

Chapter ten seeks to transform the theoretical lesson learned through out the project into practical assistance for measurement practitioners; it does this by introducing a Soft Systemic Performance Measurement Framework (SSPMF). The chapter begins with a discussion about the purpose of the framework. The framework is positioned not as a prescriptive approach to measurement, but rather to facilitate practitioners in their attempts to appreciate and respond to the unique complexity of a measurement situation. The framework specifically aims to assist practitioners with the categorisation and appreciation of measurement situations. Since knowledge of these areas helps practitioners to determine the most useful method of measurement in a given situation.

The Soft Systemic approach to performance measurement is presented in terms of a continuous feedback cycle linking categorisation of the measurement context, appreciation of the measurement context, and measurement itself. The categorisation stage of the performance measurement framework makes use of the classification of measurement situations presented in an earlier chapter. The appreciation stage makes use of the framework jigsaw that aids practitioners to consider five key areas of their measurement context. Key issues are identified within each of the five areas, and

practitioners are encouraged to consider these issues in order to appreciate the complexity of their situation. In this way they gain an appreciation of the whole measurement system, and not just the measurement process itself.

Chapter eleven details the second phase of action research. It reviews the use of the framework in two real world case study experiences at Network SouthCentral, a railway company. Here the SSPMF was used to build two different business performance measurement systems that fall into different categories of measurement context. The aim of the chapter is to show how the SSPMF has been used in practice, and to give insight to potential users of the framework. In doing so it seeks to offer an initial validation of the SSPMF.

The twelfth and final chapter is the discussion and concluding chapter of the thesis. The discussion section covers a number of issues such as the critical nature of the research project, its implications for metrology, future research, and its contribution to knowledge. The concluding section draws together the work of the whole research project. The material covered in the thesis is considered in relation to the research objectives identified, and it is shown that these have been fulfilled by the project.

Chapter Two: *Methodology*

2.0. Introduction

From the beginning this project has associated itself with the methodology of action research. However, it would be too simplistic to say that the methodology of this project has been wholly one of action research. The insight gained from real world experience has been invaluable, however this has been more than supplemented by insights from the study of existing literature. Both have been crucial in driving the fusion of insights, experience, and concepts that have produced the Soft Systemic approach to measurement revealed in later chapters.

The first section of this chapter aims to introduce the concepts of action research and why they are suitable for this project. It also acknowledges some of the strengths and weaknesses associated with this approach to research. Having reviewed the methodological approach, an account is given of its use in the project. To do this a revised version of Checkland & Schole's (1990) model of the learning experience cycle is used, to provide an analysis of the key development stages of this project. The chapter concludes with a general description of the case study projects that made up the two action research phases of this project.

2.1. Action Research

2.1.1. What & Why Action Research?

Eisenhardt (1989) offers a road map for building theories from case study research based on the experiences of action researchers. It is clear that action research is a relatively un-restrictive approach that allows practitioners a good degree of freedom, however there are a number of common attributes fundamental to every program of action research. These are summed up in Foster's (1972) formal definition of action research:

> *"A type of applied social research differing from other varieties in the immediacy of the researcher's involvement in the action process and the intention of the parties, although with different roles, to be involved in a change process of the system itself. It aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable framework."*
>
> Foster (1972) p.6

From the definition above there are three important attributes that differentiate action research from other research methodologies; the involvement of the researcher; the desire to change the system; and the dual form of knowledge acquisition, both practical and social scientific. It is these three attributes that make the action research approach especially relevant to this project.

The role of the researcher is the core attribute of action research. The assumption is that the researcher is part of the field of study, as such there is no way that they can maintain the idea of objective observation. Action research accepts that it is impossible to distinguish between researchers and their involvement in the system under study, and so

calls upon researchers to recognise their influences on the research subject. Checkland (1981) describes this attribute succinctly:

> *"Its core is the idea that the researcher does not remain an observer outside the subject of investigation but becomes participant in the relevant human group. The researcher becomes a participant in the action, and the process of change itself becomes the subject of research."*
>
> Checkland (1981) p.153

The role of the researcher is especially important when the aim of the research project is not only to monitor the process of change in a case-study organisation, but also to help initiate and guide change. If the researcher is to fulfil the second part of this aim there is no way they can be considered as separate from the system under study. Foster (1972) speaks of the intention of actors to be part of the change process within the system. It is this willingness to accept the role of the researcher as an important and welcome influence on the behaviour of the system, which makes this methodology so attractive to those wishing to research real world, human activity systems. Since one of the aims of this particular project is to introduce a new measurement technology, based on Soft Systemic principles to organisations; recognition and investigation of the influence of the systems practitioner/researcher represents an important part of the project.

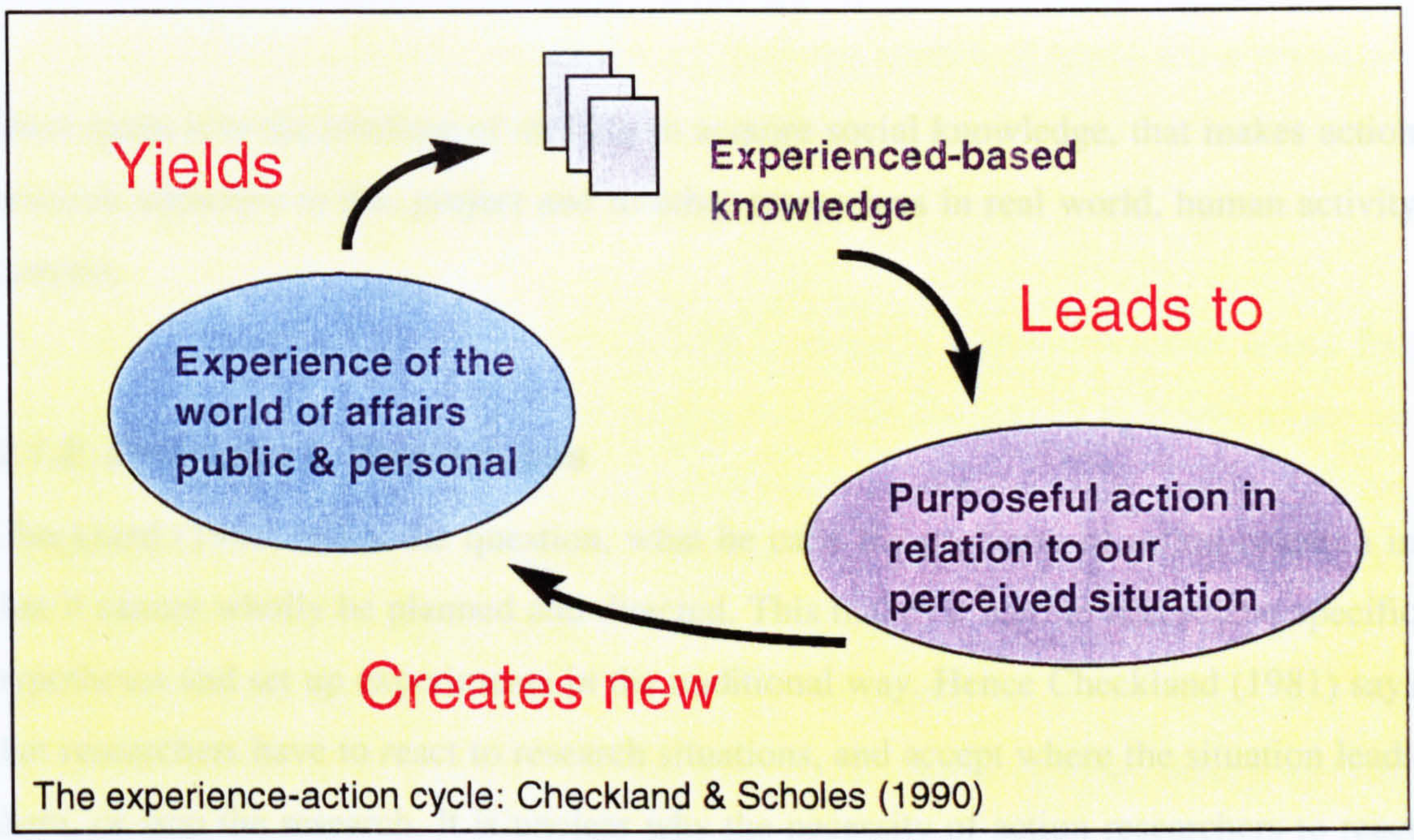

Fig. 2.1. The experience-action cycle: Checkland & Scholes (1990)

Checkland & Scholes (1990) have identified a basic loop that can be used to describe the process of action research, what they call the experience-action cycle (fig. 2.1.). The action research methodology promotes two areas of learning. What Foster (1972) calls learning that addresses immediate and practical concerns of people, and learning that also helps achieve the objectives of social science. This can be described as the acquisition of social scientific knowledge, and the acquisition of organisational knowledge. This distinction is more along the lines of use of knowledge, as opposed to content, however it does stress the importance that action research places on providing knowledge that it directly relevant to real world activity systems. Practitioners of action research are interested in the acquisition of what Hoover (1988) calls social knowledge:

> *"Knowledge is socially powerful only if it is knowledge that can be put to use. Social knowledge, if it is to be useful, must be communicable, valid and compelling".*
>
> Hoover (1988) p.6

Once again it is the attribute of striving to acquire social knowledge, that makes action research attractive to this project and to other researchers in real world, human activity systems.

2.1.2. Strengths & Weaknesses

Checkland (1981) raises the question, what he calls the problem, of action research in that it cannot wholly be planned and directed. This makes it hard to investigate specific hypotheses and set up experiments in the traditional way. Hence Checkland (1981) says that researchers have to react to research situations, and accept where the situation leads them, or stop the research. It is unclear why the necessity of action researchers to react to research situations is any different from the options available to researchers following other methodologies. Checkland's (1981) pessimism seems contradictory to his earlier ideas on the ability of a researcher to influence a research situation. Indeed far from facing the prospect of ceasing research activities, other writers on action research see these difficulties as positive aspect of the methodology. Eisenhardt (1989) argues that contradictory or paradoxical evidence often tends to unfreeze thinking and force researchers to rethink their preconceptions, which may help generate novel theory.

Eisenhardt (1989) discusses a number of strengths and weaknesses of action research. On the plus side, apart from the increased likelihood of building novel theory, she believes that the emergent theory from action research is likely to be testable, since measurable constructs are the bedrock of the theory-building process. It is also likely that the resultant theory will be empirically valid, because the theory-building process is so closely linked with the empirical evidence. Consequently, action research often produces theory that closely reflects real world situations. However, this closeness to empirical evidence can tempt researchers to build theory that is too complex, in an attempt to make use of all the evidence. On the other hand, action research can sometimes result in theory that is very idiosyncratic when the researcher has been

unable to build a general theory from the specific case studies. Clearly, these are issues that a researcher should consider before choosing to follow an action research methodology.

Once a researcher has chosen action research there are a number of initial issues that need to be addressed. Researchers are required to think about such technical issues as: type of data to be used (qualitative/quantitative/both); the type and number of case studies; the method of data collection. However, the most difficult part of the action research process is the initial definition of the research question. Researchers must balance the requirement of creating a focus for the project from the outset, with the knowledge that no initial construct is guaranteed a place in the resultant theory, and that the research question may shift during the project. Two perhaps contradictory quotes from experienced action research practitioners demonstrate this dilemma:

> *"No matter how small our sample or what our interest, we have always tried to go into organisations with a well-defined focus."*
>
> Mintzberg (1979) p.585

> *"Most importantly, theory-building research is begun as closely as possible to the ideal of no theory under consideration and no hypotheses to test."*
>
> Eisenhardt (1989) p.536

There are no firm guidelines on this point, so it must be left to the researcher to develop an initial research question that is most suitable to the need of their project. How well defined the question is, will probably depend on the existing social knowledge about the subject and the researcher's personal knowledge and experience of the subject. In the case of this project, both the existing social knowledge and the researcher's personal knowledge were limited, and so a broad initial research question was defined.

2.2. Development Cycles of the Project

In the section above the *experience action cycle* of Checkland & Scholes (1990) was discussed. This model of the practice of action research is a useful way of presenting the history of the development of this project. However, this project cannot be considered purely in terms of action research since the process of reviewing and extending concepts that exist in current literature has been just as important. This process can itself be described as a cyclical in nature. Consequently, it is possible to add a second cycle to Checkland & Scholes' (1990) model, which represents the contribution from developing existing concepts in the literature (fig2.2). This revised model more accurately describes the methodology of this project.

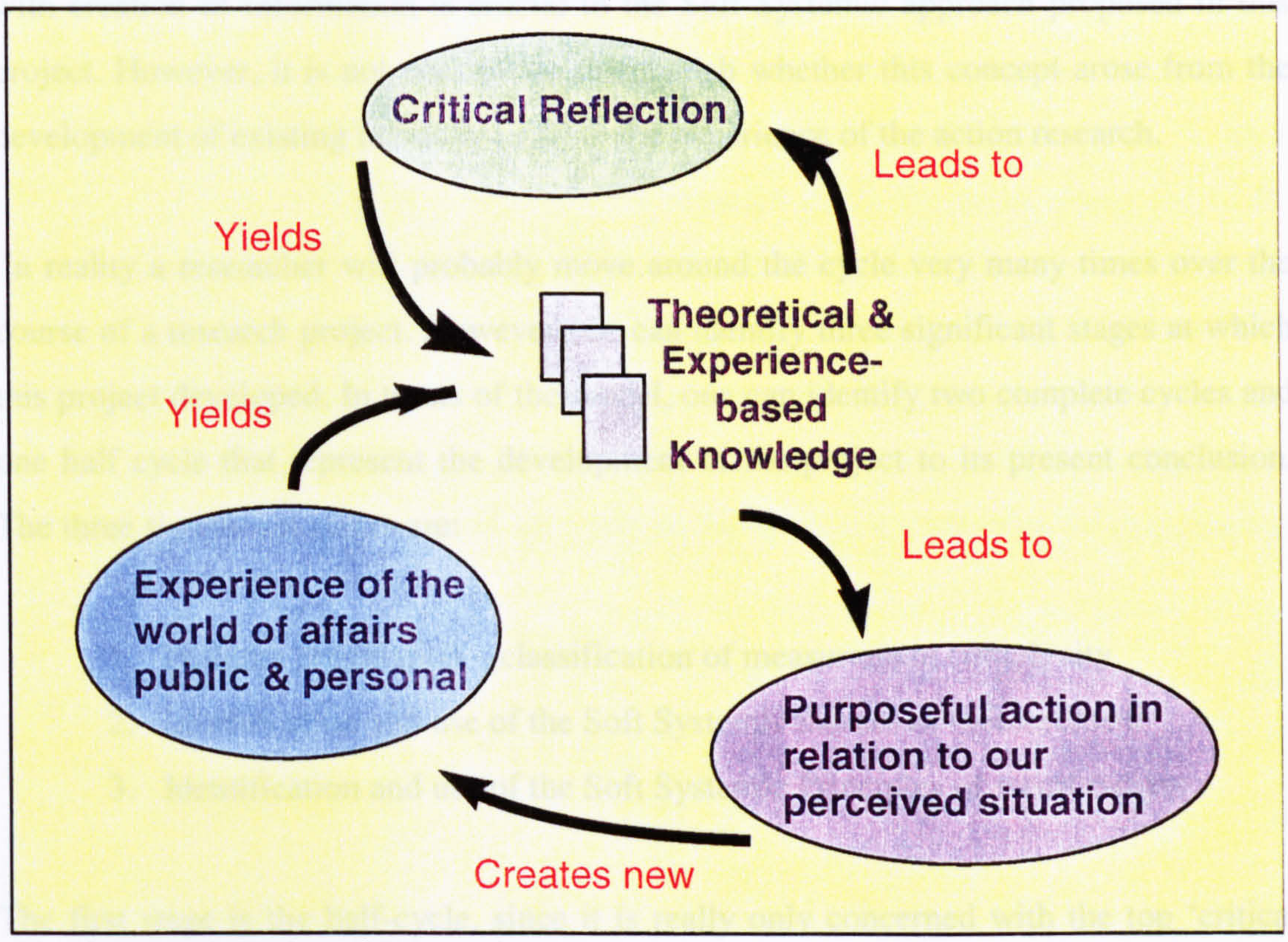

Fig. 2.2. Dual Cycles of Research

It easy to draw a model of the general processes that have been active in the research project, but it is much more difficult to ascribe certain developments to a definite cycle. For example, later in the thesis it is proposed that measurement should be viewed as a process for generating information, as opposed to just a process for assigning numbers. Both cycles of the research model may be seen to have played a role in this development. A review of the literature revealed that Churchman (1959) investigated the implications of viewing of measurement as an information generating process. Hence this concept was developed in the thinking that formulated the project. A similar, and perhaps stronger, message was simultaneously being experienced in the action-cycle. Working with the case-study organisations it became very clear that managers expected measurement to yield information, if it did not then the measurement system did not work as far as they were concerned. The concept of measurement as being to do with creation of information is crucial to the Soft Systemic approach proposed in this project. However, it is not possible to distinguish whether this concept arose from the development of existing literature or from the experience of the action research.

In reality a researcher will probably move around the cycle very many times over the course of a research project. However one can identify three significant stages at which this project developed. In terms of the model, one can identify two complete cycles and one half cycle that represent the development of the project to its present conclusion. The three significant stages are:

1. Problem articulation – classification of measurement complexity
2. Identification and use of the Soft Systemic themes of measurement
3. Identification and use of the Soft Systemic Principles of measurement

The first stage is the half-cycle, since it is really only concerned with the top 'critical reflection' aspect of the model, this is the problem articulation stage of the project. In this stage the literature review of metrology, business performance measurement, chaos

theory, and quantum theory led to critical reflection. This reflection resulted in the formulation of the new classification of measurement complexity introduced in the thesis.

The next stage of the project, and the first full cycle of the model, is concerned with the identification and use of the Soft Systemic themes of measurement. The literature review of the Systems Movement and the identification of the specific Soft Systemic measurement themes represent the 'critical reflection' part of the cycle. The application of the Soft Systemic themes in a real world measurement situation at PFS represents the first 'action cycle' of the research project. The themes and the lesson learnt from applying them both created the 'theoretical and experienced based knowledge' that was the starting point for the next stage of the research.

The final stage of the project, the second and last full cycle of the model, is concerned with the identification and use of the Soft Systemic principles of measurement. 'Critical reflection' of the knowledge created in the research cycle described above led to the formulation of the principles. The principles were then applied to the real world through the use of the Soft Systemic Performance Measurement Framework (SSPMF) at NSC, thus completing the 'action cycle' of the research model. The principles and the benefits of their application contributed a large part to the new 'theoretical and experienced based knowledge' that represents the original knowledge contribution of this research project.

2.4. The Case Study Organisations

Throughout the span of this project there have been cases studies supporting the investigation. These organisations have been business organisations and most have been dealing with measurement issues to do with customer service. It is for this reason that many of the examples referred to in the thesis relate to customer service. This section is a brief introduction of the two companies associated with the two action research phases of the project. A comprehensive description of the companies and the work done in three key case study projects is contained in chapters eight and eleven.

2.4.1. Personal Financial Services

Personal Financial Services (PFS) is the financial services arm of one of the major high-street banks in the United Kingdom. Work here was to do with the creation of a business performance measurement system for the whole organisation. A detailed review of this work is provided in chapter eight.

2.4.2. Network SouthCentral

Before privatisation of the United Kingdom's railway system, Network SouthCentral was one of the train operating units of Network South-East, which in turn was a division of British Rail. Work with the organisation featured a range of customer service measurement issues; the two key projects were the Customer Correspondence System and a Customer Recovery Index. The relationship with this organisation was by far the longest in the project, lasting three years and involving a number of different specific projects. The two key projects are discussed in detail in chapter eleven.

2.5. Chapter Summary

The first section of this chapter was concerned with the action research aspects of the methodology of this project. The defining features of such an approach were identified i.e. the involvement of the researcher; the desire to change the system; and the dual form of knowledge acquisition, both practical and social scientific. These features were shown to be especially relevant to the specific aims of this research project. It was then shown that the development of concepts to be found in the existing literature was equally important to the project. Checkland & Scholes' (1990) experience action cycle model was revised to take account of the contribution of the development of existing knowledge in the literature. The next section reviewed the development of the research project making use of this revised model of the methodology. It was shown that the project had been though three key development stages, represented by two and a half iterations of the research model. Each of the cycles was described in detail. The final section of the chapter provided an overview of the organisations and projects that made up the key case studies, the action research cycles of the project.

Chapter Three: *Review of Metrology Literature*

3.0. Introduction

One of the main concerns of this thesis is to articulate an approach to measurement based on Soft Systemic principles. In order to compare and contrast such an approach with traditional approaches to measurement, it is necessary for the reader to have an overview of traditional measurement theory, metrology. It is the aim of this chapter to provide the reader with such an overview.

The development of metrology is a large and complex topic; the intention here is to equip the reader with only a basic knowledge of the main concepts and developments of metrology. This review is divided into two parts. The first part concentrates on the development of metrology, incorporating a review of the classical and relational views of measurement. The second part investigates a contemporary definition of measurement, whilst seeking to illuminate possible implications for a Soft Systemic approach to measurement.

3.1. Development of Metrology

3.1.1. The Classical View

The origins of metrology can be traced back to the time when people first developed the idea of formal number systems. These systems reflected actions that they might do with everyday objects, i.e. counting the sacks of corn in the storehouse after harvest. Eventually such processes were analysed in an abstract way, and the underlying laws that corresponded to such scaling of numerosity of objects (numbers) were identified. Not surprisingly these corresponded to the empirical processes that the systems had originally been developed to reflect. Thus, if there had been two sacks of corn in the store before the harvest and another seven were added there were now a total of nine sacks (2 + 7 = 9). Equally 7 + 2 = 9, since it can be empirically observed that the order in which the sacks are countered does not matter.

The link between the rules of the abstract numbers system and the empirical operations in the physical world was to dominate the development of metrology, and can be considered as the main tenet of the classical approach. The quintessential view of classical measurement theory can be found in the writing of N.R.Campbell (1920, 1928, 1938). From his work it is possible to say, that the classical view of measurement is one where fundamental measurement is only possible when axioms of addivity can be directly mapped onto empirical operations. Hence the vast majority of measures are best described as derived measures, since they must be measured indirectly through the use of fundamental, or direct, measures such as length and weight. In this approach all measures are concerned with physical measurement based on fundamental additive magnitudes, and magnitudes derived from them.

The classical view holds that the test for a formal measurement system must be that the additive rules can be empirically validated, or that they be derived from other rules that

can be. Following from this, the assignment of numbers to objects other than through the process of fundamental or derived measurement could not be described as measurement. The predominance of this view in the beginning of this century is revealed in the findings of a committee set up by the British Association of the Advancement of Sciences (1940). This, after due deliberation, concurred with the classical view of what constituted and what did not constitute measurement i.e. that the concept of additivity must be applicable when measuring. However, by this time there were those who had difficulty with this rigorous view of measurement, from their ideas and writings the concept of the relational view of measurement emerged.

3.1.2. The Relational View

The main problem with the classical view of measurement is its inability to deal with the measurement situations found in the non-physical realms, such as behavioural and social sciences. In these areas there are many properties that we might wish to measure that cannot be empirically added or derived from additive qualities. Writers in these fields rejected the idea that additivity is the bedrock of measurement, and began to identify with a broader definition of measurement as typified by the one given below:

> *"Measurement is the assignment of numerals to aspects of objects or events according to rule."*
>
> Stevens (1959) p.24

Stevens (1946, 1951, 1959) was one of the first to articulate a distinct alternative to the classical view of measurement. Therefore, an understanding of his work will give the reader an appreciation of the contrast with classical measurement theory, and hence an awareness of this key stage in the development of metrology.

The definition of measurement offered by Stevens (1959), represented a radical progression from the classical view of measurement. Since the processes that could now be considered as measurement were vastly increased. Under this definition all that is required is the consistent application of a rule by which numbers are assigned, hence the only procedure excluded is random assignment. Stevens (1959) identified four main kinds of rule, or scale, by which one could classify different types of measurement; these were nominal, ordinal, interval and ratio. He arrived at these scale classifications by approaching the problem of measurement via the viewpoint of invariance:

> *"The best way seemed to be to approach the problem from another point of view, namely, that of invariance, and to classify scales of measurement in terms of the group of transformations which leave the scale form invariant."*
>
> Stevens (1959) p.23

Nominal scale is the determination of equality e.g. numbering of a rugby player according to position. Ordinal scales is the determination of greater or less e.g. hardness of minerals (Moh's scale). Interval scale is the determination of the equality of intervals or of differences e.g. temperature scale (Celsius). Ratio scale is the determination of the equality of ratios e.g. length. Under the classical view of measurement only those measures that can be classified as ratio scale would be considered as proper measurement.

The classification proposed by Stevens (1946, 1951, 1959) is still in widespread use today. For example, Flood & Carson (1988) in their textbook of systems theory and application devoted much of their chapter on measurement to an analysis of these scales. They saw the major role of the scales as a means of ascertaining which analytical and statistical techniques may be validly applied to a set of measures:

"In essence the scales act as an arbiter. To meet the requirements of that arbiter we must consider the data we have (or may acquire) and attach them to one of the scales. Following this we must not perform unpermissible transformations on the data; nor must we make statements or observations on the data that are inappropriate; for example, we cannot make interval statements on ordinal data."

Flood & Carson (1988) p.66

From the above, one can see that the introduction of a relational view of measurement permits a greater degree of complexity into the measurement debate. Furthermore, the scales have become a way of dealing with that complexity, proper measurement is no longer seen as being done or not, but rather as an activity that can be carried out at different levels of rigour. Perhaps this is the most important development in metrology; because implicit in this view of measurement is a recognition that measurement is a complex issue, and that there can be a variety of approaches to a measurement situation, all of which can still be accurately described as 'proper' measurement. The choice of which method is most appropriate is one that this thesis will address at length.

3.1.3. Contemporary Measurement Definition

In 1982 the International Measurement Confederation (IMEKO) set about assembling a book concerning the theory and philosophy of measurement, Sydenham (1982). To tackle the complex issue of a definition of measurement, the editor turned to a writer who had a history of work in this area, Ludwig Finkelstein (1973, 1975). So Finkelstein (1982) offered an informal definition of measurement, over a decade later Finkelstein (1994) continued to propose the same definition.

Early in his discussion about the definition of measurement Finkelstein (1982) drew attention to the complexity of measurement and the role of metrology. He said that the role of metrology is to provide theory and procedures for setting up suitable scales of measurement to tackle a measurement situation. He went on to provide the reader with an appreciation of measurement complexity and where it can be found:

> *"It is the social and behavioural sciences and their managerial application, which give particularly good examples of practical and philosophical problems in the foundation of scales of measurement"*
>
> Finkelstein (1982) p.3

Finkelstein's (1982) discussion gave examples of the types of measurement situation that present challenges to metrology, for example in psychological areas such as taste, smell and intelligence. In sociology, the problems of measuring community conflict or standard of living represent complex measurement situations. In the area of management, the paper identified the problems of measuring such a simple thing as profit, not to mention the more complex issues to do with customer service, employee satisfaction and other performance measures that this thesis seeks to address. Against the backdrop of all this Finkelstein (1982) introduced his informal definition of measurement:

> *"Measurement is the process of empirical, objective assignment of numbers to the properties of objects and events of the real world in such a way as to describe them."*
>
> Finkelstein (1994) p.201

There seem to be four key points to this definition:

1. Measurement is a process of **assigning numbers to describe the real world**
2. Numbers are assigned to **properties** of objects & events

3. Measurement is an **empirical** process
4. Measurement is an **objective** process

Most strikingly is the absence of the requirement for additive property, or indeed the need for a consistent rule guiding number assignment. However, it seems that the relational view of measurement is really being presented through the requirement that measurement be an empirical process. Rather than seeking to define all types of scale of measurement in the manner of Stevens (1946, 1951, 1959), in effect Finkelstein (1982) defined a more fundamental rule, namely, that whatever rule/scale is being applied it must reflect the observable relationship between properties in the real world measurement situation:

> *"Then the numerical relations between the numbers or measures, imply and are implied by empirical relations between property manifestations"*
>
> Finkelstein (1982) p.6

There are other aspects of Finkelstein's (1982, 1994) definition worth noting. He stressed that measures are descriptions of properties of objects and events in the real world; they are not the measures of the objects and events themselves. In this case measurement presupposes that the concept of property in relation to the events and objects in the real world measurement situation, exists before measurement begins. Whether this is the case, and if not how metrology must reach this point, is an issue discussed in the next section and later in the thesis. Also of crucial importance is the concept that measurement must be objective. Discussion concerning this is an issue that is prevalent through out this thesis, and implications of this for a Soft Systemic approach to measurement are discussed in the next section.

Finally there is one more aspect of Finkelstein's (1982) paper that is relevant for this discussion; he made much of the link between science and measurement:

"Science aims at an objective and empirical description of the universe and thus measurement of what is observed is the goal towards which scientific investigation is directed"

Finkelstein (1982) p.2

Finkelstein (1982 p.8) identified six properties of measurement that ensure this close link with science, since they are properties valued by the scientific approach. Firstly, that the objective nature of measurement provides proper scientific datum. Secondly and thirdly, that measures are description of great conciseness and they are precise. Fourth, that measurement allows one to express facts and conventions about properties in the formal language of mathematics. Fifth, he seemed to imply that the relationship is symbiotic since description by numbers is not good in itself; the only value to measurement lies in the use to which the information is put. Sixth and finally, he noted that measurement enables the measurand to be expressed in signals that can be managed by machines.

From all the above Finkelstein (1982) clearly demonstrated the close link between science and measurement. Given this, one can not help but ask the question has it become too close? Has the development of metrology been overly influenced by the role measurement plays in science, to the detriment of the needs of non-scientific measurement? This is a question that has implications for a Soft Systemic approach to measurement that seeks to offer a broader approach than traditional metrology, especially in the area of business performance measurement. This question and other issues identified in the preceding review of the development of metrology, are discussed in the next section that investigates the implications of metrology for a Soft Systemic approach to measurement.

3.2. Implications for a Soft Systemic approach

The review above has tried to give the reader a brief overview of metrology through considering three stages in its development namely the classical, relational and a contemporary view of metrology. It is perhaps only to be expected, that as the concepts of measurement theory get more sophisticated so they have more useful implications for a Soft Systemic approach to measurement. After all there is little to discuss with respect to the classical view, since the type of measurement that a Soft Systemic approach is hoping to assist would not have been considered as proper measurement at all. The arrival of the relational view of measurement is important to any Soft Systemic approach, because it is this development that officially recognised the variety and complexity that exists in measurement situations. When the likes of Stevens (1946, 1951, 1959) proposed a classification of different measurement procedures. They were acknowledging that different varieties of measurement activity existed, and also different types of measurement situation existed.

It is interesting to note that Stevens'(1946, 1951, 1959) classification system is being used today as a means of classifying both the type of scale, and the measurement situation. There seems to exist a tacit assumption that the most robust type of measurement is the best type of measurement. Following from this, the measurement situation is classified according to the type of data it is possible to collect, and hence the type of scale it is possible to use, not necessarily the level of measurement that would best suit the situation. A Soft Systemic approach would be more likely to concentrate first on an analysis of the measurement situation, and then translate these into the requirements of a measurement system. Only at this stage would the most suitable measures and scales be identified. It can be argued that the scale classification reviews what it is possible to measure and classifies the system based on this, whereas a Soft

Systemic approach would seek to identify what needs to be measured and then classify the measurement situation according.

Finkelstein's (1982, 1994) definition of measurement has many implications for a Soft Systemic approach. To start with the good news; it is useful that he states that measurement is a process that describes properties of the real world, this ties in well with the concept crucial to a Soft Systemic approach that measurement is to do with producing information for people. Again this point is reinforced with Finkelstein's (1982) concern that there is no reason to do measurement unless the information is put to use. Finkelstein (1982) was preoccupied with the relationship with science, but the point is equally applicable to the non-scientific areas of measurement, particularly to business performance measurement. Useful measurement is another fundamental concept in a Soft Systemic approach to measurement.

Another key implication of Finkelstein's (1982) definition for a Soft Systemic approach is that measures are properties of real world events and objects. He wrote that his definition assumed that these properties exist in a clear and abstract way before measurement begins. This assumption may be valid in less complex measurement situations but in more complex situations, where a Soft Systemic approach aims to assist, it does not necessarily follow. In such contexts the definitions of the properties to be measured are unlikely to exist independently of the measurement system, so any measurement process will have to be involved with their identification and agreement.

The greatest implication for a Soft Systemic approach to measurement of Finkelstein's (1982) definition is that much of the measurement activity where such an approach seeks to offer assistance, for example business performance measurement, would not be considered proper measurement. This arises from the requirement that measurement should be objective and empirical. Take the example of customer service measurement that aims to obtain information about customer perceptions of a business' service. Much

of this type of measurement is done through the use of questionnaires completed by customers who give a score of between one and ten. However, such techniques would not pass as measurement since they are not empirical or objective. They fail in terms of objectivity because when using a scale of one to ten:

> *"Numbers resulting from such a valuation cannot be considered measures, unless it is established that the same numbers would, within acceptable limits of error, result from any valuation process of the subject using the same procedure."*
>
> Finkelstein (1982) p.7

Questionnaires would also fail to meet empirical standards since:

> *Empirical - "This means first that it must be the result of observation and not, for example, of a thought experiment."*
>
> Finkelstein (1982) p.7

From the above it seems necessary to conclude that a Soft Systemic approach to measurement must turn away from the ideas of objectivity and the need to be empirical. The acceptance of subjectivity is essentially recognition of the complexity of a situation, and hence this is a challenge that a Soft Systemic approach measurement must incorporate.

The final important implication of Finkelstein's (1982) paper is the relationship he identified between science and measurement. This relationship is hardly surprising since throughout out history most of the challenges for metrology have arisen from the scientific arena. However it is possible that needs of science for such qualities as objectivity, precision, mathematical application etc may not be the requirements of the range of non-scientific measurement situations such business measurement, sociology,

etc. Hence a Soft Systemic approach to measurement must give equal precedence to the measurement demands that arise form the new complexities of measurement discussed in the next chapter.

Finkelstein (1982) recognised the issues to do with measurement in the social and behavioural sciences. His advice was:

> *"for social and behavioural sciences it is right to pursue the Galilei programme: to attempt to measure that which is measurable and to render measurable that which is not: This endeavour will answer doubts about the feasibility and usefulness of measurement in these domains in one way or another."*
>
> Finkelstein (1982) p.26

This research project may be seen as an attempt to heed Finkelstein's advice.

3.3. Chapter Summary

The main aim of this chapter was to provide the reader with an overview of traditional measurement theory, metrology. Two key stages in the development of measurement theory were reviewed, namely the classical and relational views of measurement. Then a contemporary definition of measurement according to metrology was reviewed, Finkelstein (1982, 1994). Two key elements were identified in the definition, that measurement be empirical and objective.

Having explored this definition of measurement, its implications for a Soft Systemic approach to measurement that would assist business performance measurement were investigated. It was found that tools of measurement, such as surveys, used in the business performance area would not be considered as proper measurement, under the traditional definition. Furthermore, it was found that the traditional approach to measurement did not seem to be able to cope with the ambiguity, or subjectivity, found in some measurement contexts. Finally, it was noted that Finkelstein (1982) encouraged efforts to practice measurement in the complex areas of social and behavioural systems, it was suggested that this research project might be viewed as such an attempt.

Chapter Four : *Review of Management Literature*

4.0. Introduction

Two broad types of management writing about performance measurement can be discerned, theory and practice. The following review is intended to provide a survey of measurement from both these perspectives. The first part of the chapter concentrates on those writers who have reviewed current thinking about performance measurement. Their work investigates such issues as why new performance measurement systems are needed, the developments in the business environment that have triggered these changes, and the requirements that future business performance measurement systems must fulfil. The second part of the review takes a pragmatic approach and investigates some basic questions concerning the real world application of performance measurement.

To begin with Holloway, Lewis & Mallory (1995) and Eccles (1991) are reviewed since, when taken together, they provide a good overview of the issues and influences currently affecting business performance measurement. Criticisms of traditional financial performance measures are then evaluated by considering the work of Johnson & Kaplan (1987), Johnson (1990) and Geanuracos & Meiklejohn (1993). The emphasis then shifts from management theorists to management practitioners who have recognised the need for a radical change in the way business performance is measured. Studies that have investigated the measurement issues facing managers from a more pragmatic standpoint. Three of these reports are reviewed through the work of Geanuracos & Meiklejohn (1993), RSA (1995) and Nolan Norton (1991).

Building from this work, the second part of the review poses three basic questions:

- What should be measured?
- How should it be measured?
- What is the role of the performance measurement in the organisation?

Aspects of the work of Peter Drucker (1968, 1992) and Tom Peters (1987) are cited as representative of a typical general management approach to performance measurement. After these are reviewed two specific approaches to business performance measurement the balanced scorecard (Nolan Norton (1991), Kaplan & Norton (1992, 1993, 1996)) and the European Foundation for Quality Management (EFQM) are assessed.

The concluding section of the chapter highlights common themes throughout the management literature, and then identifies gaps in knowledge that a Soft Systemic approach to performance measurement might fill.

4.1. How and why is Performance Measurement Changing?

4.1.1. Overview of Performance Measurement Issues

4.1.1.a. Holloway, Lewis & Mallory

One of the most comprehensive publications to survey the issues of management and performance measurement is a collection of papers published by the Open University, Holloway, Lewis & Mallory (1995). In the preface the editors identified three themes that they believed to be representative of the new approaches to performance measurement.

They noted that performance is multidimensional and multidisciplinary, as such the status of an organisation must be gauged across a profile of differing types of measures, no longer are purely financial performance measures enough. These measures would depend on the nature of the business or organisation, for example economy, efficiency and effectiveness may be cited by many businesses. However, some organisations, particularly those in the public sector, may use other measures such as equity and efficacy. It is possible to read two messages from this point. Firstly, that measurement systems must be more holistic in approach if they are to give an impression of the performance of the whole business, this term is explained in more detail later in the thesis. Secondly, that different organisations could require very different types of performance measures and characteristics to their measurement systems.

The second theme of Holloway, Lewis & Mallory (1995) was the political nature of performance measurement that arises from the power to set performance evaluation agenda for an organisation. They noted that authors often refer to this concept implicitly rather than explicitly. However it is important that powerful stakeholders think through the consequences of their performance agendas. That is not to say that this power can not be put to beneficial use, indeed it is noted that the rationale behind total quality

management is that recognition of differences in perspectives and agendas between stakeholders can be the starting point for improvements in performance.

The third theme highlighted is the need for careful design and implementation of performance measurement systems. They recognised that measurement methods from different organisations and environments are transferable to other organisations. However they warned that there is no guarantee that such diffusions of measurement concepts will always be successful and so caution must be practised.

As described above Holloway, Lewis & Mallory (1995) have identified three major themes that they believe constitute most modern management writing about performance measurement. The first, which calls for a more holistic approach to the areas measured in performance measurement systems, is theme that is echoed in much of the rest of the literature review. The second theme, which recognises the political nature of performance measurement, is of subtle yet vast importance. Through this type of work crucial issues to do with measurement as an influence on behaviour are being explored, this is a theme that will be returned to many times within this thesis. Their third and final theme sounds a cautionary note for measurement practitioners, warning that organisations must be viewed as idiosyncratic and that measurement systems must take this into account. As such there can be no single and valid type of generic measurement system, therefore any methods for designing and building them must have a large degree of flexibility. This last point has critical consequences for some of the prescriptive approaches to building performance measurement systems that are reviewed later in this chapter.

4.1.1.b. Eccles

Holloway, Lewis & Mallory (1995) identified three changes within performance measurement theory and practice, Robert Eccles (1991) offered suggestions as to what influences are driving change within this field. He identified three major factors that had

helped to bring about this "quiet revolution" towards non-financial performance measures. The first of these he attributed to a widespread and growing dissatisfaction with traditional accounting measures. The second he attributed to the emergence of non-financial measures, such as benchmarking and customer satisfaction measures. And the third he attributed to the effects of the rapid increases in information technology.

Eccles (1991) claimed that the predominance of financial performance measurement systems does not only place limitations on firms, but that they are now widely recognised to be damaging to organisations, this point is discussed and expanded in the next section. He argued that these accounting systems are fundamentally flawed for modern businesses, since they are based on a model of a business that is now redundant. They were developed for use in the nineteenth century when most firms were small and their processes fairly simple. This model of business does not take account of the complexity of modern business created as a result of diversity in products, markets and business units, these point are also made in Curtis (1985) and Johnson & Kaplan (1987). Eccles (1991) argued that the information generated by the accounting system often leads managers to make decisions which result in a lack of investment in new technologies and global markets.

Traditional accounting methods have also been held responsible for the short term thinking that has been prevalent in respect to the competitiveness of many companies. External and subsequently internal concentration on the quarterly earning figure for businesses, has been seen as the main cause of this, (Abegglen & Stalk (1985)). In effort to combat this Eccles (1991) reported that many analysts, managers and financial economists now advocated the belief that cash flow is a more accurate representation of a company's economic condition. He was also worried that financial figures are good at measuring the consequence of yesterday's action, but have little relevance to the performance of tomorrow.

Eccles (1991) was confident that there existed a high level of dissatisfaction with the traditional financial performance indicators. However, he felt that the revolution in performance measurement would only gain momentum when managers realised there were other forms of measurement to replace financial ones. The first of these alternatives came in the guise of the quality movement.

> *"Quality measures represent the most positive step taken to date in broadening the basis of business performance measurement."*
>
> Eccles (1991) p.7

Eccles (1991) claimed that with the advent of total quality, the theory and skills behind the original manufacturing quality measures such as defect rates, response times and delivery commitments, were used to create measures for the performance of the whole organisation. In addition to this, the concept of benchmarking enabled organisations to be aware of possible improvements to their business processes that are orders of magnitude beyond what they originally thought possible. At the same time more service-oriented businesses were developing measures of customer satisfaction. Looking to the future Eccles (1991) felt that work in the areas of customer service performance would be vitally important he wrote that:

> *"What quality was for the 1980s, customer satisfaction will be for the 1990s. Work on this class of measures is the highest priority...."*
>
> Eccles (1991) p.7

Hence Eccles (1991) argued that such measures as customer retention rates, market share, and perceived value of goods and service would become increasingly important. As more and more organisations define their strategy in terms of satisfying, or indeed exceeding, customer expectations, useful customer service performance measures will be crucial to the survival of an organisation. For as argued by other writers, Drucker

(1992) Peters (1987) Geanuracos & Mieklejohn (1993) Nolan Norton (1995) and as it will be argued later in this thesis, if measurement systems do not provide information that links directly to strategic implementation performance they are failing in a fundamental sense.

The final factor that Eccles (1991) saw to have contributed to the performance measurement revolution is the increase in information technology. Thanks to the enormous improvements in the capabilities and affordability of both software and hardware, the range of measures that have become economically feasible has greatly increased:

> *"Organisations can generate, disseminate, analyse, and store more information from more sources, for more people, more quickly and cheaply than was conceivable a few years back."*
>
> Eccles (1991) p.8

Eccles (1991) recognised that just because the potential now exists for measurement revolution it does not follow that changes will be put into practice successfully. He identified five areas of activity that must be addressed by managers in order to bring about changes to measurement systems:

1. Developing an information architecture
2. Putting the supporting technology in place
3. Aligning incentives with the new system
4. Drawing on outside resources.
5. Designing a process to ensure the four activities occur.

Eccles (1991) p.8

Of the five processes Eccles identified above the first is pivotal. The information architecture of an organisation is; the categories of information needed, the methods used to generate the information, and the rules regulating its flow. Key to achieving the best information architecture is to ensure that information is generated about your mission. Therefore, if the strategic objectives talk about customer service then information about this subject must be obtained. It is also vital that an organisation articulates a corporate grammar for measurement that is common to all members of the organisation. Eccles (1991) warned against stringent uniformity, but it was his opinion that most organisations had lost the ability to compare different parts of their business except by using the bottom line. Also, it is more than likely that the same information will be relevant to different parts of the business. To make this point Eccles (1991) used an example of a merchant bank:

> *"The organisation is so fluid that one senior executive likens it to a collection of hunting packs that form to pursue business opportunities and then disband as the market windows on those opportunities close. The faster the organisation can assemble information for newly formed groups, the greater the odds of success. So this executive (who calls himself the czar of information) has been made responsible for developing standard definitions for key information categories."*
>
> Eccles (1991) p.9

The generation of data is the second part of the information architecture. Measures for financial performance have been well established during years of accounting practice, however other measures such as quality, innovation, human resources and customer service are much less well developed. Eccles (1991) talked of different ways of allocating responsibility for creating measures, but did not throw light on how to actually measure these variables. The only advice he did give was to stress that methods

for measuring should evolve as the company's expertise does so, even at the cost of historical compatibility:

> *"Unlike a company's grammar, which should be fairly stable, methods for taking new performance measures should evolve as the company's expertise increases. Historical compatibility may suffer in the process, but this is a minor loss. What matters is how a company is doing compared with its current competition, not with its own past."*
>
> Eccles (1991) p.10

The final part of the information architecture is the set of rules that governs the flow of information. Since information is an important source of power these rules can have a large affect on the way an organisation goes about its business. Managers need to bear this influence in mind when addressing such issues as, who is responsible for determining what should be measured, who should collect the data, who should receive the information?

Eccles (1991) concluded his list of action areas for managers, by stating that the information technology must be built to match the information architecture and not the other way around, as is often the case. He also stressed that incentives must be linked to the new performance measures. Within this context, managers should determine all the available information and not use some predetermined information that is either too narrow or open to distortion. Finally he called for the involvement of outside parties to assist in the performance measurement revolution. He emphasised the beneficial role of organisations like industry and trade associations, third-party data vendors, information technology companies, consulting firms, and public accounting firms can play in dispersing information and offering expert advice.

Eccles (1991) entitled his paper 'the performance measurement manifesto' and it can be argued that it does live up to this billing. It does not provide in-depth answers for those seeking to improve performance measurement, but it fulfils the role of a manifesto by identifying relevant issues to do with performance measurement. His comments on building the correct information structure are fundamental to successful business performance measurement. His call for partnerships between firms and outside organisations proved prophetic, since one of the most influential new approaches to performance measurement was produced in this way (Kaplan & Norton (1992) (1993) (1996)).

Eccles (1991) explored the factors that had made the change to non-financial performance measurement possible. In doing so he probed the major issue that must be the starting point for changes to performance measurement. Namely what are the problems with traditional financial performance measurement systems? This issue is a consistent theme throughout the management literature that calls for changes to performance measurement. Some of the most influential work in this area is described below.

4.1.2. Problems with Traditional / Financial Performance Measures

4.1.2.a. Johnson & Kaplan

One of the most significant works on the detrimental effect of financial measures is Johnson & Kaplan (1987). They spent much time tracing the development of management accounting systems and question the relevance of these to contemporary business organisations:

> *"The original purpose of providing information to facilitate cost control and performance measurement in hierarchical organisations has been transformed to one of compiling cost for periodic financial statements."*
>
> Johnson & Kaplan (1987) p.255

They argued that cost accounting systems are no longer useful for process control or identifying individual production costs. Hence they concluded that that only rationale for such systems is to provide the data for periodic financial statements. Johnson and Kaplan (1987) identified two main reasons for the obsolescence of management accounting systems. Firstly, that financial measures are too short term in nature:

> *"The reduction of direct labour content in final products, the increased capital intensity of production processes, and the great contribution to a firm's success provided by its stock of knowledge and intangible resources all combine to make it impossible to obtain a valid measure of short term profit."*
>
> Johnson & Kaplan (1987) p.156

Secondly , that the importance of non-financial indicators is overlooked:

> *"More important than attempting to measure monthly or quarterly profits is measuring and reporting a variety of non-financial indicators. The indicators should be based on the company's strategy and include key measures of manufacturing, marketing, and R&D success."*
>
> Johnson & Kaplan (1987) p.156

Later Johnson (1990) returned to the subject of performance measurement. He reiterated his concerns about financial measures since they ignored competitive advantages that arise from quality, dependability, flexibility and service:

"At best, costs are imperfect signals that a problem exists: they provide no clues as to what the problem is, or how to treat it."

Johnson (1990) p.81

Johnson (1990) visited two firms that featured in previous work (Johnson & Kaplan (1987)) to see how far they had progressed with developing new measures. Initially his investigation was encouraging since both the companies had indeed developed non-traditional measurement systems, however he identified a new kind of accounting lag. Firms may have developed new measures but these existed side by side with the old measures. He described the two measurement systems as like passing ships in the night, with the old measurement system often ignoring and certainly not changing course to take account of the new one:

"With performance measurements, however, we observe the old persisting alongside, and in many cases even dominating, the new."

Johnson (1990) p.84

Johnson (1990) attributed the persistence of traditional measurement systems to the hold of the capital markets, and the subsequent fixation with the bottom line. He felt that change in performance measurement would not come easily since a shift in the paradigm of those within and without the organisation is needed to bring it about. This shift represents a move from the view that profit is about optimising within constraints and making full use of economies of scale. In place of this profit must be viewed as coming from eliminating waste, delivering quality and achieving dependability and flexibility.

One can argue that Johnson's (1990) work is significant because he recognised that a change in the way a business measures performance, is a radical change in the way the organisation views itself and its business model. He implies that for an organisation to

make a successful transition it must engage in some double-loop learning (Argyris & Schon (1978)) and change the dominant mental models of its membership. His work took a strongly pragmatic tone when it highlighted the all too frequent problems encountered at the implementation stage, what he called the new accounting lag. Hence his message is crucial, that even if an organisation has created the ideal performance measurement system in theory, implementing it successfully is by far the greater challenge.

4.1.2.b. Geanuracos & Meiklejohn

Geanuracos & Meiklejohn (1993) focused their investigation on the management consultancy firms' approaches to business performance measurement. They investigated the way different consultancies were approaching performance measurement and the lessons that they had learned through practical experience. They began their report with the results of a survey that asked companies about their performance measurement situation (Business Intelligence Survey (1992)). The results of this survey, see fig.4.1, showed that eighty-eight per-cent of respondents were not satisfied with their company's performance measures, and that eighty-nine per-cent were actively redefining them. The widespread dissatisfaction and the massive percentage of firms engaged in changing their performance measures, once again demonstrated the need for work in this area.

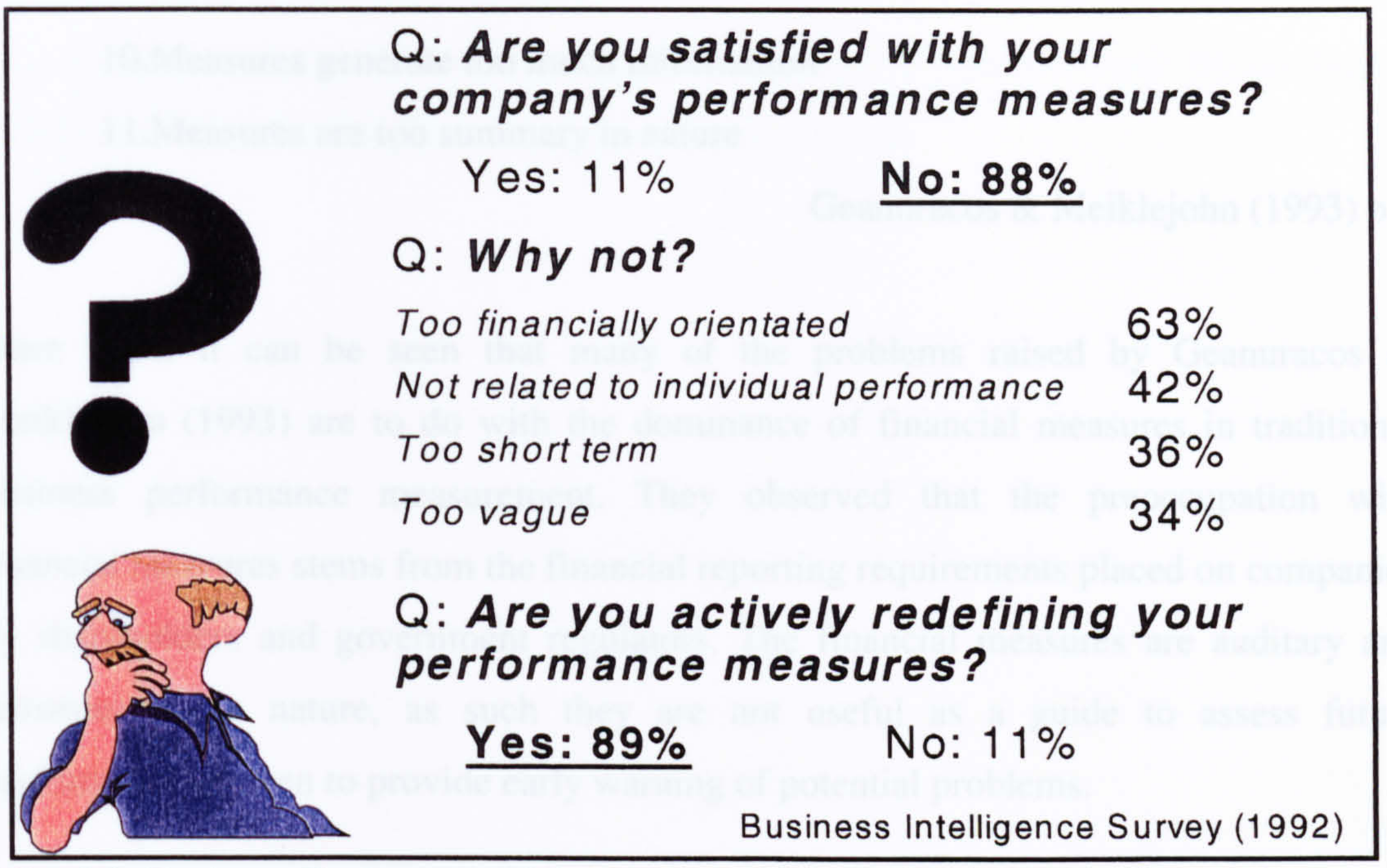

Fig. 4.1. Business Performance Measurement Survey - Business Intelligence Survey (1992)

Geanuracos & Meiklejohn (1993) were convinced that the dissatisfaction evident from the survey was the result of problems with the traditional array of business performance measures. Through their research they identified eleven problems that managers indicated were responsible for their dissatisfaction:

1. Measures are based on an outmoded paradigm
2. Measures are too financially orientated
3. Measures are too inward looking
4. Measures are too historical
5. Measures lack predictive power
6. Measures reflect functions not processes
7. Measures are structured to fit the organisation
8. Measures reinforce the wrong behaviour
9. Measures are focused on inputs, not outputs

10.Measures generate too much information

11.Measures are too summary in nature

Geanuracos & Meiklejohn (1993) p.6

Once again it can be seen that many of the problems raised by Geanuracos & Meiklejohn (1993) are to do with the dominance of financial measures in traditional business performance measurement. They observed that the preoccupation with financial measures stems from the financial reporting requirements placed on companies by shareholders and government regulators. The financial measures are auditary and retrospective in nature, as such they are not useful as a guide to assess future performance or even to provide early warning of potential problems.

The problems above are compounded by the outdated nature of accounting systems, the authors believed them to be based on a man/machine, manufacturing paradigm. Thus accounting techniques are based in a paradigm that is not well suited for the needs of modern service firms which place emphasis on customers and employees. Nor are they suited to the modern organisational structures of firms, since measures tend to be organised in terms of functions rather than processes and concentrate on inputs rather than outputs and added value.

Finally, Geanuracos & Meiklejohn (1993) were concerned about the amount of information being presented to managers. They noted that improvement in information technology had made it possible to generate statistics on a large scale. Unfortunately this seemed to reduce the quality of the information given to managers. More often than not the data has been summarised, so that actionable information is clouded or it is impossible to distinguish from a sea of statistics. In view of the problems with traditional financial measures identified by Geanuracos & Meiklejohn (1993), they proposed a vision of the attributes of an ideal modern business performance

measurement system. This vision, together with two alternative views (Nolan Norton (1991) and RSA (1995)), is outlined in the section below.

4.1.3. Vision & Requirements of Future Performance Measurement Systems

This section draws from three areas of work to describe and investigate the requirements of future business performance measurement. Geanuracos & Meiklejohn (1993) reviewed the different approaches of management consultancies to performance measurement and elaborated a vision of the future based on their experiences. The Royal Society of Arts (RSA (1995)) and Nolan Norton (1991) both try to identify what the business organisation of the future will look like, and what implications this will have for business performance measurement.

4.1.3.a. Geanuracos & Meiklejohn

Of primary importance to Geanuracos & Meiklejohn (1993) in future performance measurement is the nature of the measures. No longer will they be purely financial, instead they will be multidimensional focusing on people and processes. Measures must also track indicators of performance such as customer satisfaction, product quality, business processes and employee skills. Indeed they argued that customer satisfaction measures are the most important non-financial measures that can be devised. New performance measures should be developed in association with a strategic review and should be used as a aid to decision-making in the implementation of that strategy. Furthermore they indicated that as the strategy and measurement skill of the firm develops there should be a process of continuous development of the measurement system. Finally, they recognised that performance measurement systems will rely on information technology that will allow the interaction between strategic and front-line operations; therefore effective performance measurement systems are essential for successful delegation and empowerment.

As written above, Geanuracos & Meiklejohn (1993) are not the only people to have a vision of the role of performance measurement in the future; there have been two recent

studies that have tried to predict the shape of the company of tomorrow. Each of these reports has concluded that much importance should be placed in the role of the performance measurement system. The findings of both these investigations in relation to performance measurement are discussed below.

4.1.3.b. Tomorrow's Company

One of these investigations is a report published by the UK Royal Society for the encouragement of the Arts, Manufactures and Commerce. This report entitled 'Tomorrow's Company, the role of business in a changing world' (RSA (1995)) made public the conclusions of an investigation into the future of business organisations. The report argued that three obstacles are preventing UK companies from becoming globally competitive; one of these was an over-reliance on financial measures of performance. Part of the RSA's (1995) vision of the company of tomorrow is one that uses its understanding of the relationship between its purpose and values to develop a model of success. This model of success must be used to generate a framework for 'meaningful' performance measurement. The Royal society noted that to bring about change the role of business leaders is crucial, and they set leaders a challenge:

"take action to create a new language of business success, to develop effective new measurement systems, and to bring the reporting process into line."

RSA (1995) p.1

The report went on to discuss the best way to establish a measurement framework that would help meet the challenge above. To do this, four key areas were identified together with several principles for effective measurement. According to the RSA (1995) the measurement framework of tomorrow's company should include financial components, feedback on values, the health of key relationships, and the performance of key processes. Having identified these four primary areas of concern the report maintained

that the principles outlined below must be heeded. The RSA (1995) proposed that an effective measurement system is one which:

1. Manages complexity to create clarity - encompassing a coherent set of carefully selected key measures.
2. Matches the success model of the business.
3. Includes one leading indicator from each relationship.
4. Includes measures of the strategic health of the business.
5. Enables benchmarking against world class performers.
6. Balances immediate results with future capabilities.
7. Includes measures that assist the board with risk assessment and management.

RSA (1995) p.13

Aside from these guides as to what to measure the RSA (1995) was also very interested in how information was reported outside the company. The report recognised the demands of the current financial reporting requirements, and also had a new vision of the annual report of tomorrow's company. It has a number of requirements for the annual report of the future. The annual report would contain clear statements about the company's: purpose and value; its definition of success; and its key relationships - with customers, suppliers, providers of capital, employees and the community; also relevant disclosure of its progress. It is clear that without the sort of measurement system outlined above, the company would not be able to produce a report that contained this information.

If an investigation into the shape of tomorrow's company seems an especially progressive issue for a British institution to be involved with, one may not be surprised to learn that a similar American study was done five years earlier. In 1989/90 consultants Nolan Norton, KPMG Peat Marwick, a group of Fortune 500 companies and

some academics investigated the shape of the future business organisation (Nolan Norton (1991)).

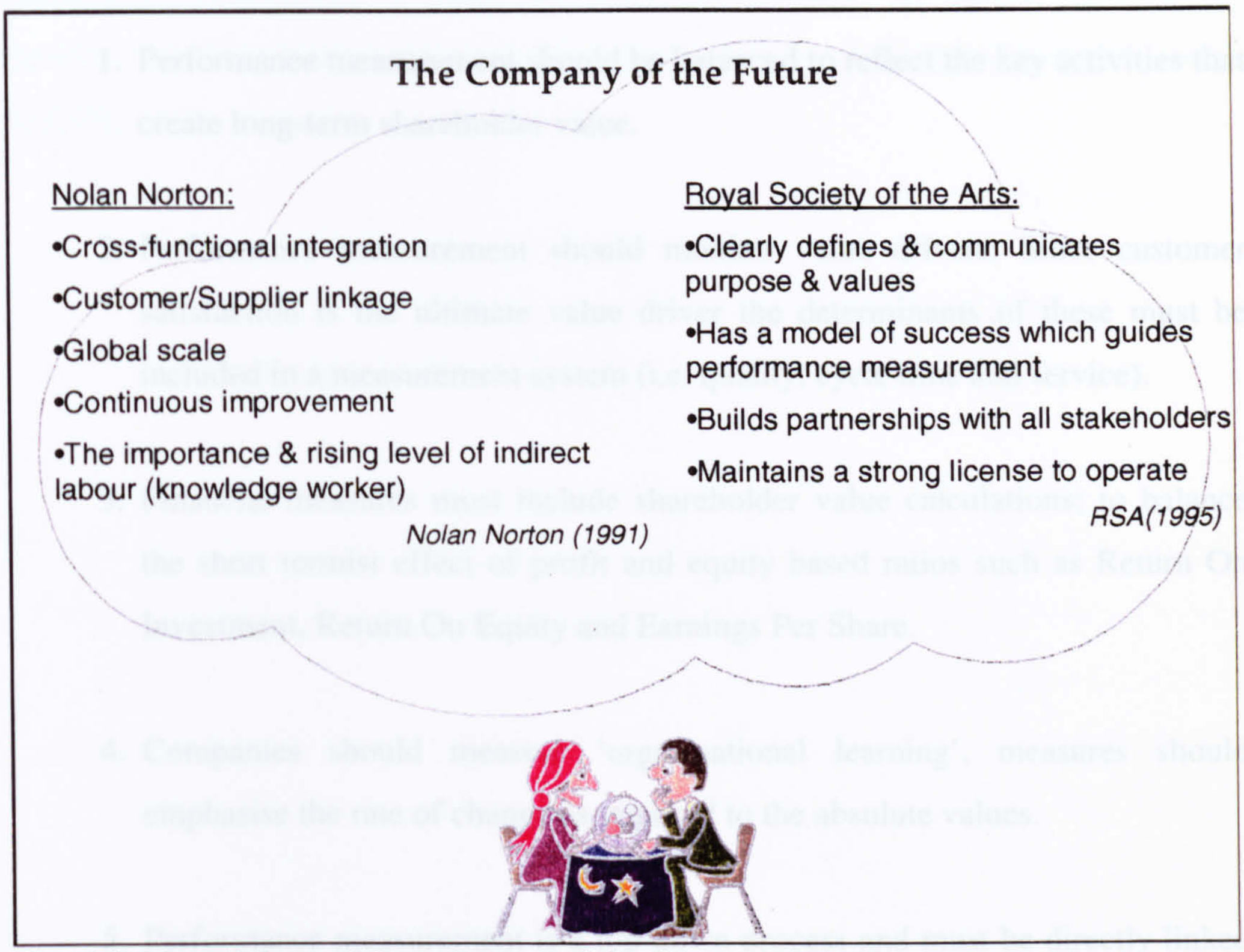

Fig. 4.2. Two visions of the company of the future.

The Nolan Norton (1991) report identified a number of new organisational Trends that would influence the future organisation (fig.4.2.). These include cross-functional integration, customer/supplier linkage, global scale, continuous improvement, the importance and rising level of indirect labour (knowledge worker) in the organisation. The study recognised that these influences represent radical differences from the present and so the performance measurement system must reflect these changes. New measures should be based around long term shareholder value and its drivers, quality, service and time. Also the study called for the measurement system of the future to be tied to a new

team based reward system, and linked to a new Executive Information System based on the new performance measurement principles. These principles were:

1. Performance measurement should be balanced to reflect the key activities that create long-term shareholder value.

2. Performance measurement should monitor value drivers. Since customer satisfaction is the ultimate value driver the determinants of these must be included in a measurement system (i.e. quality, cycle time and service).

3. Financial measures must include shareholder value calculations; to balance the short termist effect of profit and equity based ratios such as Return On Investment, Return On Equity and Earnings Per Share.

4. Companies should measure 'organisational learning', measures should emphasise the rate of change as opposed to the absolute values.

5. Performance measurement is a top-down process and must be directly linked to an organisation's vision and strategy.

6. Future performance measurement systems must be able to link the work of every member of the organisation to its overall vision and strategy.

4.1.4. Summary

Reviewing the work of the authors above, there is significant evidence that much is wrong with the traditional financial performance measurement systems current in many organisations. Also that, in so much as the needs of future companies can be anticipated, the future role and scope of performance measurement will require a radically different approach. Many have already accepted these conclusions and have started to formulate

such new approaches to business performance measurement. To be successful these approaches must answer three fundamental questions: '*what*' should be measured, '*how*' should the measurement be done and what is the '*role*' of measurement in the organisation? The next section of this chapter reviews attempts to answer these questions.

4.2. New Approaches to Performance Measurement

This section of the chapter investigates the pragmatic questions posed at the end of the previous section, namely:

1. What should be measured by the organisation?
2. How should performance be measured (the measurement process)?
3. What is the role of performance measurement in the organisation?

The answers to these questions can be sought in two main bodies of work. These are general approaches to management that address measurement issues, and specialist approaches which concentrate primarily on performance measurement. Firstly some of the works of Peter Drucker (1968) (1992) and Tom Peters (1987) are reviewed to provide the reader with examples of a general management approach to performance measurement. After which specific approaches to business performance measurement, Nolan Norton (1991), Kaplan & Norton (1992) (1993) (1996) and the European Foundation for Quality Management (EFQM), are investigated in order to seek answers to the practical questions posed above.

4.2.1. General Management Approaches

4.2.1.a. Drucker

In 1991 Robert Eccles proclaimed his manifesto for the performance measurement revolution in the Harvard Business Review (Eccles (1991)). At the beginning of this paper he made reference to the fact that revolutions start long before their official declaration. From what he wrote it is clear that he had a period of several years in mind, however calls for performance measurement revolution can be traced to much before

then. Indeed over two decades before Peter Drucker (1968) hinted at a similar revolution. He identified whole areas of business performance in which he felt then current measurement theory and practice was severely lacking, with respect to measurement in these areas he wrote:

> *"the subject is brand new. It is one of the most active frontiers of thought, research and invention in American business today. Company after company is working on the definition of the key areas, on thinking through what should be measured and on fashioning tools of measurement."*
>
> Drucker (1968) p.85

Since companies and management theorists are still engaged in the process above, a reiteration of what Drucker (1968) wrote would seem to be a good starting point for a review of approach taken by management generalists to performance measurement and management theory.

Drucker (1968) discussed an organisation's objectives and in doing so identified eight areas in which performance goals and measures need to be set. He felt that the difficulty for an organisation does not involve determining objectives, but in deciding how to set them. The key to this decision is measurement, in each area it is necessary to determine what shall be measured and what the yardstick for measurement shall be. His eight areas were:

1. *Market standing* - should be measured against the market potential and against the performance of competitors. To be able to measure market standing a company must be aware of: who their customers are; where they are; what they buy; what they consider to be value; what their unsatisfied wants are.

2. *Innovation* - there are two types of innovation in a business: innovation in product or service; innovation in the skills and activities needed to supply them. It is very difficult to measure the relative impact and importance of various innovations. Managers should be concerned with trying to measure innovation in both the short and long term. The short-term measures should look ahead and deal with the ability to develop fairly concrete improvements, in effect carry out innovations that have already been made. The long-term measures should look ahead much further and should aim to assess how well the organisation responds to and develops what might be. When striving to measure innovation managers must always remember that it is a slow process.

3. *Productivity* - is, according to Drucker (1968), the only yardstick with which we can gauge the competence of managers and allow comparison of managers between different units. He advocated the use of the concept of contributed value; this is the difference between the gross revenue from the sale of products, and the amount paid out by it for raw materials and service rendered by outside suppliers. The aim of managers should be to increase the ratio of contributed value to total revenue within existing processes and the proportion of contributed value retained as profit.

4. *Physical & financial resources* - the planning for adequate supply of financial and physical resources is the job of top management and functional specialists carry out the implementation of these plans. Hence these measures are not always the concern of every manager, but Drucker (1968) felt that too often decisions relating to these issues are 'crash decisions' and consequently measures are needed to help make this process more planned.

5. *Profitability* - profit serves to measure three processes: the net effectiveness of the business; the 'risk premium' for staying in business; and to ensure the

future supply of capital for innovation and expansion. Profit measures should not be concerned with the maximum profit a business can produce, but rather the minimum amount of profit it needs to survive, as such the last of the three processes identified above, rate of return, is most relevant. The major problem with measuring profit is how to ascertain a reliable yardstick to compare measures. Drucker (1968) concluded that the best way for managers to proceed is to make use of measures such as capital return on investment, however to be aware of the limitations and flaws of the measure being used.

6. *Manager performance & development* - see below
7. *Worker performance & attitude* - see below
8. *Public responsibility* - see below

Drucker (1968) argued that the first five objectives listed above should create little dispute, however he recognised that this would not be the case with respect to the final three. In his opinion these intangibles are paramount to the success of a business organisation, he stressed that an organisation's performance is that of its human members. Consequently these areas had to be planned for and measured, even if this created a problem for those traditionally responsible for measurement in business organisations:

> *"The very reason for which economist and accountant consider these areas impractical - that they deal with principles and values rather than solely with dollars and cents - makes them central to the management of the enterprise, as tangible, as practical - and indeed as measurable - as dollars and cents."*
>
> Drucker (1968) p.84

He recognised that attempts to measure such intangibles creates difficult issues, he himself saw a very strong link between measurement and control. Nowhere is the

relationship between measurement and control more fraught than with respect to worker performance. He felt that control could be interpreted as the ability to direct one's own work, and also as the domination of one person by another. The ability to measure objectives should be used for the first type of control but not the second.

Drucker (1968) believed the link between management self control and measurement to be absolutely critical. He argued that if managers do not have the information to change their behaviour how could they be responsible for meeting the goals of the organisation. As shall be argued later in this thesis for an organisation to truly empower its members it must liberate the flow of relevant information around the organisation. Drucker (1968) urged organisations to ensure that information should go to the person responsible for performance in that area, and not to the superior of the person. He stressed that this information should not be used as a tool of control from above:

> *"To be able to control his own performance a manager needs to know more than what his goals are. He must be able to measure his performance and results against the goal. It should indeed be an invariable practice to supply managers with in all key areas of a business."*
>
> Drucker (1968) p.162

Despite advocating the possibility of measuring these intangibles, Drucker (1968) did not provide massive detail about how to actually do this. However, he did advise managers that it is more important to attempt to measure intangibles even if they cannot be done so in a traditionally rigorous way:

> *"These measurements need not be rigidly quantitative; nor need they be exact. But they have to be clear, simple, and rational. They have to be relevant and direct attention and efforts where they should go."*
>
> Drucker (1968) p.162

Many years later Drucker (1992) referred to the work above when writing about performance measurement. He believed that these objectives should still be the mainstays of an organisation's activities, and hence its measurement system. He saw that the role of financial measures should be to draw all the other measures together. However he did not mean the traditional form of financial measures, rather he advocated the use new types of long-term financial performance measures. These measures do not:

> *"maximise shareholder value or short-term interest of any one of the enterprise's 'stakeholders'. Rather, they maximise the wealth producing capacity of the enterprise."*
>
> Drucker (1992) p.195

Once again he berated the use of old style financial performance measures, he stressed that most CEOs now recognised that measures are unreliable and often misleading. He felt that all CEOs needed five measures with which they should be able to have early warning of any changes in the company's performance. He likened these to five dials on the dashboard with which one controls a car, or in this case, a business:

1. Market standing - both within the organisation's own market and in comparison with products that fulfil the same function.

2. Innovative performance - the organisation must be able to answer two questions. Firstly, is the organisation's success as an innovator equal to its market standing? Secondly, is the ratio of successes to false starts increasing or decreasing?

3. Productivity - the ratio of input to value added by the business. Where input is money, materials, people and value added is the total revenue from the product minus supplies and services from outside the company.

4. Liquidity & Cash flows – Drucker (1992) made the point that a business can run without profit if it has adequate cash flow, but not vice-versa. Consequently he believed that cash flow was a better financial performance indicator, and an easier measure with which to plan future needs.

5. Profitability - this should measure the capacity of the resources to produce profit. Drucker (1992) believed that profit should be analysed on a thirty-six month rolling basis as opposed to the half-yearly, or even quarterly, stand alone figures now published. He also wrote that the profitability trend should be analysed in three ways in order to test its adequacy: the cost of capital; whether forecasts for new ventures would have a positive or negative affect; and that profitability should be tested in respect to its composition.

With respect to the measures above Drucker (1992) recognised that companies may be wary about implementing them because accurate information in such areas is difficult to collect. However as far as he was concerned this should be a problem for statisticians, it should not be one for practitioners. He urged practitioners to remember that precise readings of the values of measures are not important, what is very important is the trend of these measures:

> *"What matters to him is not the absolute magnitude in any area but the trend that the measurements will give him no matter how crude and approximate the individual readings are by themselves."*
>
> Drucker (1992) p.36

When Drucker's (1968) (1992) work is analysed in terms of the three questions concerned with, what, how and the role of measurement, it provides some answers in all areas but few in relation to how one *should* measure. With regard to what to measure, he was very clear. Like authors after him he saw that measures should be strongly linked to the objectives of the business, in his case, eight of them. He believed that measures were the crucial means by which organisations could translate broad objectives into real management plans and operational decisions. Here then, he identified the areas in which measurement must take place and the role of measurement in turning strategic objectives into managerial action.

In the later work discussed Drucker (1992) narrowed his list of eight measurement areas down to five, which he termed the dials on the dashboard of a car. This concept of a simple, yet representative, set of measures that provide an indication of the performance of the whole system has a strong resemblance to the balanced scorecard concept reviewed later. Not only are the measurement concepts similar i.e. they seek to fulfil the same role, but also virtually the same measurement areas are reflected in both frameworks.

As already mentioned Drucker (1968) (1992) seemed to give much thought to the role of measurement in organisations. One aspect of particular interest is what Holloway, Lewis & Mallory (1995) would term the political nature of measurement. He believed that measurement could have a controlling influence on one's own work and also on the work of others, this second influence he viewed as a potentially malevolent force. Thus his work serves as one of the first warnings to managers that they should acknowledge, and take account of, the behaviour influencing dimensions of measurement.

The third question of interest is that concerning how to measure. Drucker (1968) (1992) did not provide any comprehensive answer to this question, however he did provide some hints for managers. Firstly he provided encouragement, he argued that although

the intangible aspects are the most difficult to measure it is from these that the greatest rewards would come. Secondly he made some critical observations as to the nature of measures. Primarily amongst these he recognised that measurement has a role in the business, that of helping a company to achieve its objectives. In this respect he believed that measures do not have to be exact or accurate, but rather should be used to identify trends that direct attention and effort to the right place. In a word, they should be relevant.

4.2.1.b. Peters

Tom Peters (1987) recommended some basic steps that managers could take to develop non-traditional measures. Each business unit and department should be given the task of developing new measures for themselves. He suggested that each grouping be given thirty days to establish five rough, unconventional, paper and pencil measures of what will be important for their unit's ability to support the company's mission. These measures should be used in rough form in formal performance reviews. He also advocated that two thirds of the new measures should emphasise customers (quality, service, listening), flexibility (responsiveness), and the ability to innovate.

Peters (1987) advocated a strong message of change in his writings about performance measurement. He saw two broad aims for performance measurement systems. Firstly that they should be developed to be simple systems that encourage participation and understanding by everyone. This participation would help encourage and support initiative at the front line. He identified six essential variables that should be present in performance measurement systems:

1. Simplicity of presentation.
2. Visibility of measurements.
3. Everyone's involvement.

4. Undistorted collection of primary information throughout the operational area.
5. Straightforward measurement of what is important.
6. Achievement of an overall feeling of urgency and perpetual improvement.

The second broad aim that Peters (1987) identified for performance measurement is to measure what is important to the business, and shed the distracting biases of traditional cost-accounting procedures. He too believed that traditional performance measurement systems are dangerously misleading because of their almost total preoccupation with financial measures:

> *"Our fixation with financial measures leads us to downplay or ignore less tangible non-financial measures, such as product quality, customer satisfaction, order lead time, factory flexibility, the time it takes to launch a new product, and the accumulation of skills by labour over time. Yet these are increasingly the real drivers of corporate success over the middle to long term."*
>
> Peters (1987) p. 484

The work of Peters (1987) discussed above is interesting because each of its main themes corresponds to one of the three measurement issues that we have already posed. He detailed how to set about building a measurement system, and his two broad aims cover issues surrounding what to measure and the role of measurement in the company.

Of all the writers so far mentioned in this review Peters (1987) can be seen as the most pragmatic in his approach. He was not so much concerned with the intellectual arguments for using non-financial measurement, the importance of which he took as given, rather with the successful implementation and operation of new performance measurement systems. Not only did he lay down six variables that should be represented in a measurement system, but also mapped out a process by which to initiate the

development of new style performance measures. Also, of the six variables the first three are to do with ensuring the acceptance of the new measures by the firm's people. It could justifiably be said that ensuring measurement systems are simple, transparent and involving can be considered as golden rules for measurement practitioners.

4.2.2. Specialist Approaches

Specialist, in this context, should be taken to describe those measurement approaches that have been primarily designed to tackle measurement issues and are not part of an author's thinking on the whole of management practice. The approaches now investigated have been created specifically to deal with performance measurement.

The first approach builds on some of the work discussed early in this chapter Nolan Norton (1991), where the ideas about the future performance measurement needs of business have been incorporated into the balanced scorecard concept (Kaplan & Norton (1992) (1993) (1996)). A number of business organisations have actively committed to this approach and have built balanced scorecards with which to measure performance. These organisations have consciously chosen to change their performance measurement systems. Another way that organisations are led to change their performance measurement systems is through quality awards. Often organisations wish to enter quality competitions, to do this they must put in place a measurement framework that provides information to judge their performance. Thus such awards have an impact on the way a business might approach performance measurement. The measurement framework of one such award, the European Quality Award (EFQM), is investigated in the last part of this section.

4.2.2.a. The Balanced Scorecard

The balanced scorecard ((Nolan Norton (1991)) and (Kaplan & Norton (1992)(1993)(1996))) seeks to complement traditional financial measures with operational measures of performance.

> *"The balanced scorecard is like the dials in an airplane cockpit: it gives managers complex information at a glance."*
>
> Kaplan & Norton (1992) p.71

The operational measures centre on such aspects as customer satisfaction, internal processes and the organisation's ability to innovate. It is these types of measures that are indicators of future financial performance. The aim of the balanced scorecard is to look at the performance of a business from four perspectives by asking four questions: How do our customers see us (customer perspective)? What must we excel at (internal perspective)? Can we continue to improve and create value (innovation and learning perspective)? How do we look to our shareholders (financial perspective)? Nolan and Norton recognised that managers are more likely to suffer from information overload than a scarcity of information. Consequently, they emphasised that the balanced scorecard must restrict the number of measures used.

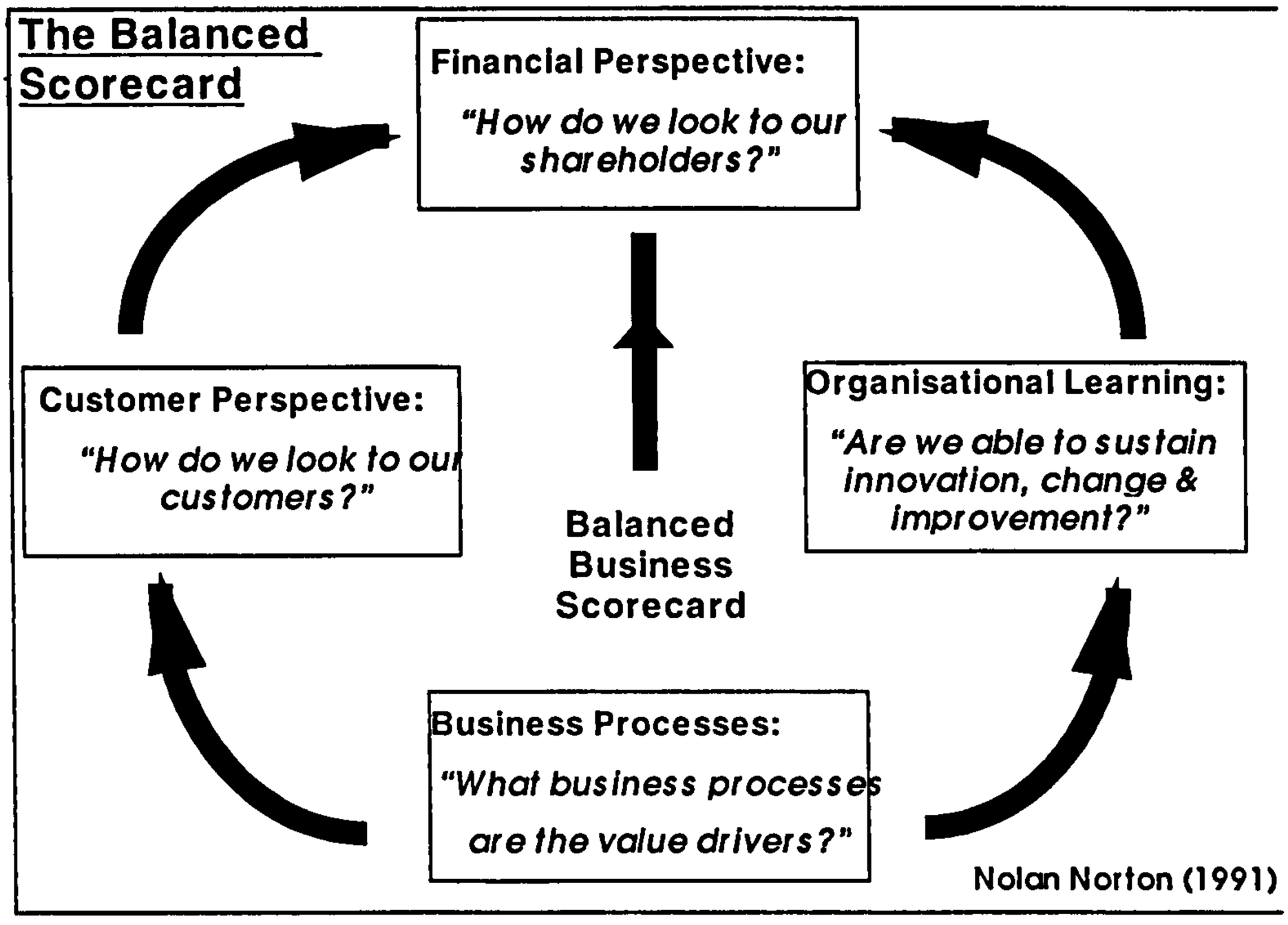

Fig. 4.3. The Balanced Scorecard.

A strength of the balanced scorecard is its ability to present information about the whole of the company's performance in one report. In this way it helps managers to view organisational performance from an holistic point. The authors argued that managers couldn't help but notice if improvements in one area seem to be having detrimental effects in another area. Hence the balanced scorecard forces managers to be responsible for the whole of an organisation's performance, and not just any single part that falls within their particular function.

One of the most notable aspects to have arisen out of the experiences of organisations who have used the balanced scorecard is its influence on the strategic performance of an organisation. This influence reveals itself in both the implementation and the development of strategy. This was noted in the work done with a case study organisation, namely Personal Financial Services (PFS) as part of this research project. Here it was found that a major reason for the weakness of the company's performance

measurement system was the lack of focus of the measures specifically in relation to the main strategic goal of growth. Also first attempts to implement the balanced scorecard failed because the implementation team was not sufficiently rigorous in focusing measures on the strategic goals, and cutting measures that were not directly linked to strategic performance. As a consequence of this the initial PFS balanced scorecard had too many measures, in which the important strategic performance indicators got lost, and a lack of focus. These two things contrived to ensure that the first attempt at a balanced scorecard was not well received at PFS. A more detailed analysis of this action research is discussed later in this thesis.

Kaplan & Norton (1996) identified four management processes that help managers link long-term strategic objectives with short-term actions through measurement:

1. *Translating the vision* - helps managers build a consensus around the organisation's visions and strategy. Strategy statements must be expressed as an integrated set of objectives and measures that describe the long-term drivers of success.

2. *Communicating & linking* - lets managers communicate their strategy up and down the organisation and link it to departmental and individual objectives. Traditionally departments are evaluated by financial performance and individual performance is linked to the accomplishment of short-term financial goals. The scorecard enables managers to develop departmental and individual measures that link with the long-term strategy of an organisation.

3. *Business planning* - enables companies to integrate their business and financial plans. Most organisations have a plethora of change programs that compete for resources. Managers can use the measures of the balanced

scorecard as a basis for allocating those resources and setting priorities, according to which initiatives move them nearer to their strategic goals.

4. *Feedback & learning* - gives companies the capacity for strategic learning. Traditional performance measurement systems provide feedback on whether financial goals and budgets are being met. The balanced scorecard provides feedback from the three additional perspectives and thereby enables, so the authors believe, an organisation to evaluate and modify strategy to reflect real time learning.

Kaplan & Norton (1996) p.75

The balanced scorecard takes good notice of the criticisms of financial measures, as discussed in the previous section, and couples this knowledge with the perceived needs of tomorrow's company to answer one of the fundamental questions facing measurement practitioners. The question it answers so well is that of 'what' to measure. The balanced scorecard is one of the clearest frameworks available with which to build a business performance measurement system. Another strength of the balanced scorecard is its investigation of the role of the measurement system in the organisation as the predominant driver of strategy implementation, Kaplan & Norton (1996). This is important because, as this thesis will argue, practitioners must realise that the nature of a measurement system is a fundamental influence on the behaviour of the human activity system being measured.

For the reasons outlined above, much credit should be given to the balanced scorecard concept, unfortunately it fails in at least one vital area. The balanced scorecard does not provide an answer to the question of 'how' one is to measure. It identifies the broad areas that should be measured and rightly states that managers must identify the specific measures that will be idiosyncratic to the objectives of their particular company or department. However it does not tell managers how to set about measuring these

specific measures once they have been identified. The balanced scorecard seems to assume that the organisation knows how to measure if only it knew what to measure. Hence the framework is predominantly useful for identifying and ordering measures. The question of 'how' to measure is for the most part ignored by the balanced scorecard framework and literature.

4.2.2.b. The European Quality Award

Aside from the efforts of academic-practitioners and consultants, such as the balanced scorecard described above, there has been one other major impetus for change in performance measurement, the quality movement. There is a strong emphasis within all the total quality work on measurement, nowhere does this show itself more than in the requirements of the various quality awards. The European Foundation for Quality Management (EFQM) runs the European Quality Award.

The EFQM has created a business model that it uses to characterise how people, processes and results fit into a framework to score companies. The model describes the process by which a set of *enablers* drives *results*. The award's committee scores the organisation in both of these areas, fifty per-cent of the possible marks in each area. *Enablers* are scored according to the degree of excellence of approach and the degree of deployment of approach. *Results* are assessed according to the degree of excellence of results and the scope of results. In each of the categories described below an assessor can record one of five levels. The European Quality Award *results* categories are not surprising, customers satisfaction, people satisfaction, impact on society and business results, it is the *enablers* that are more interesting and represent the major new measurement challenges for organisations.

The EFQM enablers:

1. *Leadership* - This is described as the behaviour of all managers in driving the organisation towards total quality. Managers should ensure: they are seen to

be involved with progressing quality management; there is a consistent TQM culture that purveys the company; individuals and teams are recognised and appreciated when successful; they are involved with customers and suppliers and promote TQM outside of the organisation.

2. *Policy & Strategy* - This category investigates the values, vision and strategy of the organisation and the ability of the company to implement them. Policy and strategy must be: grounded in the concepts of TQM which should be evident in mission and strategy statements; the foundations from which business plans are determined; communicated through-out the whole company; reviewed regularly with the aim of finding and implementing improvements.

3. *People management* - how the organisations realises the full potential of its people to ensure continuous improvement. Key attributes in this area are: the continuous improvement of people management; the development and preservation of a set of core skills across the organisation through the use of recruitment, training and promotion; the involvement of every member of the organisation in the quality movement; how performance targets are agreed and reviewed with staff.

4. *Resources* - the management and utilisation of the company's organisation within the areas of: financial resources; information resources; material resources; and the application of technology.

5. *Processes* - the management of all value adding activities within the organisation. Key to this are: identification of key processes; systematic management of key support services; how process performance indicators are used to review progress and set new targets; how the company encourages

process improvement; how the company implements process changes and evaluated their effect on performance.

It is worth analysing the EFQM award in light of the three fundamental questions outlined above. As with the balanced scorecard it is very strong at indicating what companies should be measuring, however unlike the balanced scorecard it attached different relative values to the different categories within the EFQM model. Of the thousand marks available it is notable that twenty per-cent are allocated to customer satisfaction, whilst only fifteen per-cent are allocated to business results. Next highest are the processes of the organisation and then the leadership. Also notable is that six per-cent of the marks are related to the organisation's impact on society. So not only does the EFQM model answer the question 'what' should be measured, it also provides supplementary information that describes what is more important to measure.

In terms of the 'role' of measurement within the organisation the EFQM is much poorer than the balanced scorecard since little help is offered on this topic. This cannot be considered a major criticism on the part of the EFQM, because their approach is not intended to provide an organisation with a measurement system with which to continuously monitor and improve performance over time. Rather their framework is meant to be a dipstick tool to ascertain the performance of a company at any given period of time. Given that it is such a static measuring device it might be concluded that it would be of great assistance when tackling the question of 'how' to measure. However, as a generic guide for companies to follow when dealing with performance measurement issues it is of little help. In summary, the EFQM is an interesting example of a specific measurement system built to meet the requirements of a specific measurement situation.

4.3. Implications for a Soft Systemic approach to Performance Measurement

This chapter has sought to survey the main issues concerning performance measurement found in the management literature. This survey has identified and investigated a number of fundamental questions. This section of the chapter summates the important lessons from the investigation, and identifies areas of special interest and relevance for a Soft Systemic approach to performance measurement.

The first issues to be tackled centred on the broad questions of how and why performance measurement is changing. The work of Holloway, Lewis and Mallory (1995) generally tackled the first of these questions, namely how performance measurement is changing. They identified three major themes to modern management writing about measurement. Primarily they noted the need for a more multidimensional and multidisciplinary approach to measurement. This a theme that is strongly reflected, perhaps one could say anticipated, in the systemic writing on performance measurement discussed later in the thesis. When it will be shown that the calls for a more encompassing approach by management writers, sit very comfortably along side the Systems theory tenets of holism and emergence.

Secondly Holloway, Lewis & Mallory (1995) detected a concern amongst writers about the general assumption that measurement skills, or techniques, can be transferred across different market sectors or even between different organisations in the same sector. From this it is possible to discern an underlying message, that perceives measurement to be a very complex process dependent on the idiosyncrasies of the organisation and its environment. Once again it would seem that a Soft Systemic approach that places emphasis on the unique nature of a system and its environment, would be complimentary to this approach.

Systems thinking has recognised that much of the uniqueness of a system stems from the transparent political and human behavioural influences on a system. Holloway, Lewis & Mallory (1995) pointed out that this idea is reflected in management writing, in particular over concerns that measurement can be used as a means of control in organisations. This political area of control and human behaviour is one in which a soft systems approach will have much to offer. The concept of measurement worldviews and their impact on the behaviour of the system being measured, will probe this area in depth and will be discussed at length later in the thesis.

Having identified the main thrust of the changes to business performance measurement, the review turned to Eccles (1991) to investigate the possible reasons for the changes to performance measurement. He identified three major factors that provided the impetus for measurement changes, two of these can be considered as enabling factors and the other as persuading factor. Eccles (1991) believed that changes could never happen unless the enabling factors were in place. The first enabling factor he identified as the new measurement techniques that had been developed by growth in such concepts as total quality and customer satisfaction. For the first time managers had an alternative choice to the traditional financial measurement techniques. Coupled with this the advances in information technology, the other enabling factor, allowed managers the option of performing much more complicated measurement tasks.

Both the enabling factors have put organisations in the position of being able to face and leverage much more complex measurement situations. In the past no one would have considered investing resources in measurement in order to gain information based competitive advantage. However many organisations are now facing such complex measurement challenges, and dealing with such complexity is the hallmark of a Soft Systemic approach, as will be made evident repeatedly in this thesis.

The second question posed by the review, what are the problems with traditional performance measures, had much to do with Eccles' (1991) persuading factor. This factor is what he identified as widespread and growing dissatisfaction with the traditional financially oriented performance measures prevalent in modern business. He highlighted that financial measures are based on an outdated model of manufacturing and single market business organisations, that is no longer able to encompass the complexity of modern business. Genauracos & Meiklejohn (1993) made many of the same points, they drew on survey results to demonstrate the dissatisfaction with current measures, and thought much of this was due to the model of business upon which the measures are based. A more detailed investigation into the problems of financial performance measures, the work of Johnson & Kaplan (1987), was reviewed. The main problems were identified as the meaninglessness of short-term profit, and the neglect of non-financial performance indicators.

Johnson's (1990) later work was reviewed where he reiterated his concerns about the focus of financial performance measures. He stated that they ignored the competitive advantages that could be gained from such factors as quality, dependability, flexibility and service. He also revisited firms that had taken steps to introduce non-financial measures and identified an accounting lag. Here old and new performance measurement systems co-existed in the same organisation and for the most part the old system remained the dominant influence. This is a point that is of particular interest for a Soft Systemic approach, since it recognises the importance of human perception and organisational culture. The relationship between corporate culture and performance measurement is one of the main themes discussed in the later parts of this thesis.

The work of Genauracos & Meiklejohn (1990) together with reports from the RSA (1995) and Nolan Norton (1991), were used to answer the third question posed in the review, namely what are the future requirements of performance measurement? Each of the three works reviewed offered up visions of the future and associated implications for

performance measurement. Many of their ideas are similar, including the key feature of a widening of the type of measures used away from a reliance on solely financial performance measures. Where financial measures are used, they should be more long term measures of shareholder value and its drivers such as quality, service and time.

The Nolan Norton (1991) report placed particular emphasis on linking measures directly to the organisation's visions and strategy, furthermore this linkage should be right down to the level of the work of every individual in the organisation. The issue of measurement and strategy linkage is a factor of the worldview reflected in a measurement system, and recognition of this is a key part of the Soft Systemic approach to measurement investigated later in the thesis. Also of interest from a Systems point of view is the importance attached by the RSA to key relationships, e.g. customers, suppliers, providers of capital, employees and the community. These relationships are what enables the company to do its business and are for the most part outside the organisation itself, what Systems thinkers might term as in the wider system of interest and or the environment. The need to measure these relationships is a complex task ,and necessitates a more Soft Systemic approach to measurement, as described later in the thesis.

The second section of this review investigated some new approaches to performance measurement already advocated in the management literature. Once again it sought to answer a number of fundamental questions: what should be measured by organisations, how this should be measured, and what is the role of performance measurement within the organisation? To answer these questions it drew on work from different areas: Drucker (1968) (1992) and Peters (1987) represented general management writers who had written about performance measurement as part of work into the whole of function of management, those who in popular language could be called management gurus. The concept of the balanced scorecard was investigated as a representation of a specific approach to performance measurement. The European Foundation for Quality

Management award was reviewed as a representation of what could be termed an indirect approach to performance measurement, indirect because organisations are forced to measure so that they can be assessed for the award.

The first question was concerned with what organisations should measure and is by far the most comprehensively answered within the management literature. In general all the approaches are prescriptive in nature, directing organisations to ensure that they measure certain areas of performance. There is not a single author out of all of those reviewed who would not agree that organisations should be engaged in measurement that assesses overall performance. Whether the measures are Drucker's (1992) dials on the dashboard of a car, or Kaplan and Norton's (1992) dials in aeroplane cockpit, each author has their own definition of what overall performance is and their choice of measures reflects a subtle, yet important, difference in approach.

Drucker's (1992) measures aim to reflect the objectives in areas in which he believes every organisation should have goals. Similarly the EFQM award has identified a business model with areas in which a business must perform well. Although some of the EFQM areas are more people oriented than Drucker's (1992) measures, they are both essentially prescriptive in approach. Kaplan and Norton's balanced scorecard (1992) (1993) (1996) is the least prescriptive approach, it leaves the organisation free to define its own objectives but identifies four key perspectives from which performance, in relation to those objectives, must be measured and assessed. One can make the point that the balanced scorecard allows organisations greater freedom, and recognises that successful performance is a matter of human perception. Both the concepts of freedom and recognition of human perceptions, are crucial to a Soft Systemic approach to performance measurement, for without these such an approach will not be able to deal with the complexity of the measurement situations in which it is seeking to assist.

Having established what to measure the next logical step is to ask how to measure it? Drucker (1968) (1992) offered insights into the nature of measurement, he stressed that managers should be interested in trends and that these could be analysed from the most crude and approximate data. He also encouraged managers to attempt to tackle difficult and intangible measures, since from these the best information would come. The balanced scorecard had little more to offer in this area, as its strengths seem to lie in identifying and ordering measures. Clearly then a Soft Systemic approach to performance measurement must give practical assistance in this area.

The brief review of Peters (1987) work was included to address the question of how to measure, or in other words the process of measurement. Like the others, he argued that non-financial measures should be used and suggested that every business unit be given thirty days to invent five unconventional, non-financial, paper and pencil measures. He went on to identify six essential variables of a performance measurement system, two of which were that they should be simple and visible. By visible one can argue that he means that they should be transparent to people in the organisation, so that they know how the data is collected and analysed. Peters (1987) was hinting that for measures to be successful, the people using them must trust and understand them. This idea has many implications for the development of measures and measurement systems in organisations. Such a people oriented approach is key to a Soft Systemic approach to performance measurement as will be discussed later.

Another of Peter's (1987) essential variables was participation, everyone's involvement in the measurement system. He believed that for a measurement system to work it must be owned by the people who used it and were measured, and managed, by it. For a measurement system to be owned it needed to be understood and involve people. The concept of participation is a key systems thinking concept, for without the involvement of the actors in a system it is impossible to cope with the complexity arising from the perceptions of those involved. It is also a principle of Critical Systems thinking that

systems should be emancipatory, and this necessitates involvement with the system from creation to operation. In calling for participation, Peters (1987) had started to address the third questions of this review, what is the role of performance measurement systems within organisations?

Drucker (1968) (1992) was clear that he viewed measurement as a way of providing information so that the organisation can achieve its objectives. He also recognised that measurement has a controlling influence on people, and stressed that they should be used for self-control not control of others. As such Drucker (1968) (1992) recognised that measurement has a strong influence on the behaviour of an organisation. Following from this, it is possible to say that measurement can be used as a tool for changing the behaviour of people within organisations.

This point is well emphasised by the importance that Nolan and Kaplan (1996) place in the relationship between strategy and measurement. As they have gained more experience in using the balanced scorecard this relationship has evolved from one where measurement simply reflects strategy, as in their early work, to recognition that measurement is one of the predominant tools for implementing strategy. They described a situation where strategy review/development and the building of a performance measurement system are a single process. One can make the case that this work has recognised that measurement is an active influence on the behaviour of people within business, or any other social systems. Indeed this idea is implicit in the approach taken by the EFQM, for they seek to guide the development of an organisation towards better quality through the use of performance measures targeted in certain areas. Consequently both Kaplan & Norton (1992) (1993) (1996) and the EFQM reinforce the idea that a Soft Systemic approach to measurement must turn away from the traditional measurement concepts of objectivity and passive observation.

4.3.1. Summary

The aim of this final section of the chapter has been to highlight implications of management writing with respect to a Soft Systemic approach to performance measurement. It can be seen that management writers have identified business performance measurement as an area which presents a greater degree of complexity than has traditionally been associated with the area of measurement. This complexity arises from aspects such as the idiosyncratic nature of business systems, the importance of recognising and taking account of human perception and organisational culture, and the affect that measurement has on organisational behaviour.

In order to cope with the complexity outlined above management writers suggest the need for a new approach to performance measurement, one which is both participative, moves away from the traditional measurement concepts of objectivity and passive observation, and can be translated into an framework for action. As will been shown in later chapters of this thesis a Soft Systemic approach to performance measurement will meet all theses requirements.

4.4. Chapter Summary

This chapter has introduced the reader to the main issues to do with measurement in the management / business literature. The current state of performance measurement was generally reviewed. The main problems with financial performance measures and the future demands of business performance measurement were identified. After which a number of different approaches to business performance measurement were reviewed to provide a more detailed appreciation of the issues. Finally the work in the literature reviewed in terms of any implications for a Soft Systemic approach to measurement.

Chapter Five: *Chaotic & Quantum Challenges for Measurement*

5.0. Introduction

> *"The last hundred years have seen a powerful and fruitful development of the understanding of the foundation of mathematics and logic, sciences which in the past were based on vague and intuitive foundations. The theory and philosophy of measurement can be seen as part of that development."*
>
> Finkelstein (1982) p.3

The previous chapter has shown that business performance measurement presents complex challenges for the traditional approach to measurement. This chapter aims to show that business is not unique in presenting new challenges for measurement. Complex measurement situations can also be found in the hard sciences. This chapter identifies complex measurement situations within the hard science so that these may be used to help structure the new classification of measurement situations offered in the next chapter.

The words of Finkelstein (1982) above make clear the close link between mathematics and logic to measurement, in the same paper the strong relationship between measurement and the hard sciences is also recognised. Such relationships are to be expected since these have been the areas that have offered the most challenges to measurement in the past. However recent developments across a wide range of fields have created a whole new set of measurement challenges. It is the aim of this chapter to identify and analyse some of their implications for measurement.

The chapter aims to demonstrate that measurement is more complex than has been traditionally recognised, and that as a consequence new approaches to measurement are needed. It will look at developments in what may be termed more 'hard' areas such as mathematics and physics, namely Chaos theory and Quantum theory. These fields are introduced to supplement the 'softer' social scientific nature of the management literature review. In each area the analysis seeks to identify the properties of the measurement situation from which stem the challenges for measurement. This is the complexity with which a Soft Systemic approach to measurement must be able to deal.

5.2. A Chaotic & Complex World

5.2.1. Introduction

"The most passionate advocates of the new science go so far as to say that twentieth century science will be remembered for just three things: relativity, quantum mechanics, and chaos. Chaos, they contend, has become the century's third great revolution in the physical sciences."

Gleick (1987) p.6

"Chaos theory is not as interesting as it sounds. How could it be?"

Kellert (1993) p.ix

The quotations above show that the jury is still out in terms of the widespread effects of chaos theory. However, whether it will prove to be a true revolution in our development or not, even the most sceptical would agree that it has some fundamental implications for our understanding of the world. And since measurement is part of the means by which we describe the world it follows that chaos theory has implications for measurement.

Stephen Kellert (1993) investigated the philosophical impact of chaos theory on science. The discussion below seeks to investigate the issues he identified in this book and interpret their implications for measurement. Before discussing these it is important to understand how Kellert (1993) defined chaos theory:

"Chaos theory is the qualitative study of unstable aperiodic behaviour in deterministic nonlinear dynamical systems."

Kellert (1993) p.3

It is worth a few words explaining more precisely what Kellert (1993) meant by the definition. To start with chaos is found in *dynamical systems*, this means that a system of interest has been identified and that a model of this system has been created, this may or may not be a mathematical model. Furthermore this system is not in a static state but changes over time. So the model will have an ability to describe the instantaneous state of the system and rule for transforming it into some state at a different time. If the system is *nonlinear* it means that the transformation between one state and another is complex, i.e. not a straight line of values when charted.

The study is *qualitative* because the nonlinear nature of chaotic systems renders exact numerical prediction impossible; therefore the long-term behaviour of the system is investigated. To illustrate this point Kellert (1993) gave an example of an investigation into the motion of three planets. A closed-form solution would aim to predict the precise time when the three planets travelling in elliptical orbit will line up. On the other hand a qualitative study would investigate such issues as what circumstances are more likely to generate elliptical orbits rather than circular or parabolic ones.

In the qualitative study of chaos theory investigators are particularly interested in two types of behaviours, *unstable* and *aperiodic*. Instability is present in a system that will respond to even the smallest of disturbances, it never settles into a stable state when it would be able to absorb disturbances without changing its behaviour. *Aperiodic* behaviour occurs when there is no regular pattern to the behaviour, it never repeats and continues to manifest the effects of any small disturbance. Kellert (1993) provided the example of a crowd as exhibiting unstable and aperiodic behaviour. The final aspect of Kellert's (1993) definition is that chaotic behaviour is *deterministic* since it exists in relatively simple mathematics systems yet it behaves in a way that is described as random.

5.2.2. Unpredictability

The key to the philosophical implications of chaos theory is its inherent unpredictability, this from a feature known as sensitive dependence on initial conditions. Essentially this means that two systems that may have very similar starting points can move very far apart. Given this if one is trying to model systems even the smallest of errors in the initial values of the variables of a model will be tremendously magnified within a short space of time. Hence an unachievable degree of accuracy is required in order to have useful calculations of a systems future state. Theoretically a chaotic system is predictable, however in practice accurate prediction is an impossible task:

> *"The problem is that our initial specification must be impossibly accurate. For times far enough in the future, useful predictability would require an infinitely large device for storing and manipulating data."*
>
> Kellert (1993) p.xi

The statement above has implications for measurement since it is measurement that must provide much of the data about the initial specification. One of the foundations of measurement when carried out for the purpose of prediction, as much of it is, is that small errors will stay small. However chaos theory revokes this assumption. So chaos theory demands the impossible of measurement, in terms of both the level of sophistication of a measurement process and the degree of accuracy of the measures themselves. It has been common for measurement practitioners to pursue more and more accurate measurement, but the message of chaos theory is that this is a fool's errand since the level of accuracy required is beyond our capabilities.

5.2.3. Dynamic understanding

If chaos theory takes away our ability to understand systems through accurate prediction we must seek to understand them in a different way, and measurement must play a role in the pursuit of this new way of understanding. Kellert (1993) described this new way of understanding as dynamic and identified a different approach to the traditional scientific process of gaining this knowledge:

> *"Specifically, chaos theory yields what I call 'dynamic understanding' - a qualitative account of how order and unpredictability arise. The pursuit of dynamic understanding does not involve a search for exact quantitative predictions, and it eschews the use of microreductive explanations and rigorous deductive schemes."*
>
> Kellert (1993) p.xii

On initial inspection the statement above might seem catastrophic for measurement. After all metrology has developed in conjunction with the reductive approach of science and it has been indispensable to the common scientific aim of quantitative prediction. If the process of understanding is to change from quantitative to qualitative and we can no longer predict with any accuracy, what can be the role for measurement? Before panic sets in, it is important to recognise that we can predict the behaviour of chaotic systems and that numbers are crucial to this. It is also important to remember that, regardless of your specific definition of measurement, most would agree with the notion that to some extent measurement can be considered as the process by which numeric information is created. Kellert (1993) showed that chaos theory does allow us the ability to make prediction about a system's behaviour. However the kind of prediction has changed from a quantitative to a qualitative nature:

> *"These assertions refer not to an ability to predict the exact value of some property of a system, but to an ability to foresee and understand changes in the overall behaviour of that system."*
>
> Kellert (1993) p.100

As appreciation of the nature of understanding and prediction has changed from static and quantitative, to dynamic and qualitative, so measurement must respond to this shift in emphasis. In the past the aim of measurement has been to provide an accurate, but static description of a system at a given instant. The challenge for measurement presented by chaos theory is to develop measures that concentrate on the long-term properties, boundaries and changes in the system's behaviour that will enhance our dynamic understanding of the system.

5.2.4. Complexity Theory

As research into chaos theory has continued so our knowledge of some of the characteristics of what dynamic understanding constitutes has increased. Waldrop (1992) called this work complexity theory and identified features of the behaviour of complex systems. They are self-organising, individual elements of a system which organise themselves in such a way as to gain collective emergent properties. They are adaptive so that they don't passively respond to events; rather their behaviour tries to turn whatever happens to their advantage. They are dynamic and able to find a balance between order and chaos; hence they operate at the edge of chaos. Here elements of a system are never static, neither are they dissolving into chaos, they have reached what Systems scientists might call an equilibrium point.

Whether one describes it as the edge of chaos or an equilibrium point the message for measurement is the same, a new approach to measurement is needed. In three words the new aim for measurement is to be qualitative, dynamic and above all holistic. It is the requirement to be holistic that is the strongest indicator that a Soft Systemic approach to

measurement would meet the challenges of chaos theory. It is possible for the traditional approach to measurement to create qualitative and dynamic measures, but it is not possible for such a reductive approach to turn itself into a holistic one. The gap between reductive and holistic approach is expressed well in relation to the transition from periodic to chaotic behaviour in systems:

> *"The whole tradition of physics is that you isolate problems and all the rest flows. That's completely falling apart. Here you know the right equations but they're just not helpful. You add up all the microscopic pieces and you find that you cannot extend them to the long term. They're not what's important to the problem."*
>
> Feigenbaum (quoted in Gleick (1987) p.175)

Complexity theory indicates that the type of behaviour it is possible to understand and predict in chaotic systems is what Systems scientists would call emergent behaviour. If measurement systems are to be useful they must concentrate on measuring such emergent behaviour, the very behaviour that Systems science has been striving to deal with since its beginnings.

5.2.5. Summary

It has been demonstrated above that the inherent unpredictability in chaotic systems presents problems to the traditional scientific approach and to the traditional measurement approach. Chaos theory leads us towards a new type of understanding, namely dynamic understanding. Measurement has a role to play in the process of dynamic understanding but it must take a new approach. This must be an approach that is qualitative, dynamic and holistic. All three of these attributes are present in the Soft Systemic approach to measurement presented in this thesis.

5.3 A Quantum World

5.3.1. Introduction

> *"At the heart of quantum physics there is a set of concepts so bizarre that is it impossible to understand them in everyday terms"*
>
> Gribbin (1992) p.41

> *"The paradox is only a conflict between reality and your feeling of what reality ought to be."*
>
> Feynman (1967) (quoted in Zohar & Marshall (1993) p.17)

One might think that the area of microscopic physics would represent safe ground for measurement theory, granted the practical challenge of measurement at this scale is great but surely physics presents no theoretical challenges to metrology? Such thoughts have been well and truly displaced thanks to the development of Quantum physics. Hence even in the area of physics, traditionally regarded as the 'hardest' and most rigorous of sciences, there are lessons to be learned with respect to our approach to measurement. It would be difficult to investigate these measurement implications without some knowledge of what quantum physics actually says. So in the first past of this section a very basic overview of quantum physics is presented, in the second part a number of features of quantum physics are investigated with respect to measurement.

At its most basic level quantum physics is the study of electromagnetic radiation at a sub-atomic level. At the beginning of the twentieth century it was realised that the nature of the spectrum of radiation emitted from an object could be explained if the radiation was considered to be made up of small units. These units were called quanta. The trouble with this theory was that it was common knowledge that electromagnetic

radiation was a wave phenomenon. To resolve this it was theorised that atoms would only emit radiation at certain energy levels, although radiation could exist at any level.

Much was already known about the structure of an atom i.e. positively charged nucleus surrounded by a field of negatively charged electrons. The question of interest was why did electrons not fall into the nucleus since they would be attracted by the positive charge of it? If electrons did fall towards the nucleus they would radiate energy continuously as they fell, which was not being observed. Quantum theory stipulated that electrons could only occupy certain well-defined energy levels around the nucleus. Electrons can jump from one energy level to another but nowhere in between, emitting or absorbing the appropriate quantum of energy as it does so. Only a limited number are allowed at each energy level and they cannot fall into the nucleus. One way to describe this is to think of the electrons as satellites orbiting the earth, the earth is the nucleus. The satellites can only orbit at certain distances from the earth and are not allowed to occupy the space between these orbits. Also only a certain number of satellites can be in a give orbit at once, finally no satellite can fall towards the earth.

In 1905 the photoelectric effect was observed, which is the way electrons are knocked out of a metal surface by radiation. From this it was concluded that light itself must be quantized in the form of a stream of particles called photons. However it had already been proved that electromagnetic radiation has wave like properties since light waves can produce an interference pattern, as demonstrated in the double slit experiment. Matters were further complicated when it was discovered that under certain circumstances electrons were seen to behave like waves. Both properties were correct and the concept of wave-particle duality was affirmed. This concept is fundamental to quantum theory since from this arises the concept of quantum uncertainty.

5.3.2. Uncertainty

The principle of quantum uncertainty is closely linked to one's ability to measure the properties of an object. The principle means that we can never know the position and the momentum of a particle at the same time. This dilemma arises from the conflicting properties of wave-particle duality, imagine a wave such as the ripples on a pond, they are spread out over a relatively large area and it is difficult to measure exactly where the wave train starts and ends. At the same time imagine a single particle that occupies a definite place in time and space. Quantum theory indicates that electrons and photons have all these properties at once. The quantum image of an electron, or photon, is of wave packets that are small packets of waves that extend only over small areas.

When one tries to measure all the properties of a wave packet at once it is impossible. To measure momentum of an electron we release it from the rest of its wave packet and select a single wavelength, which in theory extends to infinity, therefore it has no definite position. On the other hand if we measure its position we force the electron into a multi-wavelength state and hence an uncertain momentum. Therefore at this level reality itself it determined by the type of measurement we are performing, and so uncertainty is inherent in quantum reality.

The implications of quantum uncertainty for measurement are very interesting. The most staggering of these must be that the act of measurement has a determining effect on the reality of electrons and photons. This effect can be seen in two ways, the first is the practical difficulty of measuring at the microscopic quantum scale. The problem is that when striving to measure something at this level we have to use a measuring system that will affect the object being measured. For example to measure an electron we would have to bounce radiation off it and this very act will change its position and momentum. So it can be seen that the act of measurement has an influence on that being measured. The second effect is because quantum theory goes further than this, it stipulates that the act of measurement determines the creation of the reality of that

which is being measured. These twin complexities of the influence of measurement on that being measured are similar to those that are faced by those engaged in measurement in 'softer' areas such as social science and business performance.

5.3.3. Indivisible Transition

Wave-particle duality is not the only feature of quantum theory of interest to measurement. David Bohm (1983) set this alongside three other features of primary significance. These and their implications for measurement are now discussed. The first was what he termed the indivisibility of quantum action. Quantum theory implies that transition between stationary states is discreet, which is very different from the classical model in physic that implies a continuous series of intermediate states between transitions. Traditionally one might have been aware that measurements were only 'snapshots' in time however one perceived these to be static descriptions of an underlying trend. Quantum theory does away with the concept of the underlying trend used in this sense:

> *"Thus it has no meaning to say that a system passes through a continuous series of intermediate states, similar to initial and final states."*
>
> Bohm (1983) p.128

This concept of instantaneous change is mirrored in such features as bifurcation in chaos theory, and it would not be surprising to identify such jumps or shifts in the human behavioural systems. The trend concept has been predominant in science and hence measurement theory, therefore any alternative represents a challenge to the traditional approach to measurement. In this case the implications do not seem to warrant a fundamental overhaul in approach however a degree of sophistication in both the measurement tool and the analysis of numeric information is required.

5.3.4. Potentiality

The second feature of quantum theory identified by Bohm (1983) is the implication that properties of matter can only be described as statistically revealed potentialities. The common way to describe physical situations in quantum theory is to say that they are characterised by a wave function. However this wave function is not a description of reality, but rather a description of the potential of the situation:

> *This wave function is not directly related to the actual properties of an individual object, event or process. Rather, it has to be thought of as a description of the potentialities within physical situations."*
>
> Bohm (1983) p.128

The implication for measurement is enormous, measurement practitioners have been used to the idea that their role is to provide increasingly accurate descriptions of reality. Quantum theory implies that this task, at this level, is redundant since it is impossible to measure (pinpoint) reality in this way. Measurers are left with the task of measuring the potential of physical situations. In a sense the role of measurement has changed from providing accurate numerical descriptions of a complete system, invariably so that its behaviour can be optimised according to some criteria. The new Quantum theory inspired role seems to indicate that measurement is to provide information about the potential of systems, be this potential striving to have knowledge of future behaviour or spotting the latent potential that exists within systems i.e. the resources and leverage points that can influence performance.

5.3.5. Non-Causal Correlation

Perhaps the most controversial implication of Quantum theory is the concept of non-causal correlation. Put simply, the inference of Quantum theory is that events that are separated in space and without possibility of connection through interaction are in fact

correlated. At present we have no way of providing a detailed causal explanation of this correlation. The problem is that the theory of relativity states that correlations are triggered by signals and that these signals may not travel faster than the speed of light, however we know that quantum correlations are not explained by such signals. The implication of all this on the cause and effect paradigm that is prevalent throughout contemporary thinking is massive:

> *"All of these evidently imply a breakdown of the general order of description that had prevailed before the advent of quantum theory."*
>
> Bohm (1983) p.129

The development of metrology has been almost completely within the model of the order of pre-quantum situations. These types of pre-quantum situations are no longer exclusive and so the challenge for measurement theory must be develop new approaches to deal with the new types of situation, such as a Soft Systemic approach.

5.3.6. Holism

One of the overriding messages of Quantum theory is that its features necessitate an holistic approach. Bohm (1983) wrote about a quality of undivided wholeness to Quantum theory; such a quality is an holism that cannot be analysed through the use of a reductive approach, the sort of approach that is prevalent in traditional measurement theory. As Zohar & Marshall (1993) put it:

> *"In the truly emergent holism or quantum reality, such reduction is impossible. Through this strong holism the new whole possesses qualities (and an identity) of its own that arise only through the relationship of its previously undefined (indeterminate) parts."*
>
> Zohar & Marshall (1993) p.39

Zohar and Marshall (1993) discuss the need for a bottom-up approach to situations. Such an approach is in conflict with the metrology concept of increasing accuracy at increasing levels of analytical resolution, what may be described as a top-down' approach. According Zohar & Marshall (1983) the bottom-up approach is the only way that emergent behaviour can be accounted for. Systems science has been striving to deal with the issue of emergent behaviour since its inception therefore a Soft Systemic approach to measurement has much to offer in this area.

5.3.7. Summary

Quantum theory has some fundamental implications for measurement. The idea of cause and effect is now undermined, the concept of ever more accurate measurement leading to greater understanding and hence a decrease in uncertainty no longer applies. Hence the emphasis of a new approach to measurement needs to shift from accurate, total descriptions and predictions to an approach that recognises that cause and effect can be difficult if not impossible to trace. As will be explained later in this thesis a Soft Systemic approach to measurement seeks to address this point.

5.4. Chapter Summary

The aim of this chapter was to show that areas other than the social systems, which are the main concern of business performance measurement, also represent challenges to traditional measurement theory. The chapter has sought to identify causes of complexity in different measurement situations so that these may be incorporated into the new classification of measurement situations presented in the next chapter.

The analysis of Chaos theory reached the conclusion that a new Soft Systemic approach to measurement needs to be qualitative, dynamic and holistic. The review of Quantum theory also posed challenges to the traditional approach to measurement. It was concluded that any new approach to measurement needed to shift from an emphasis on accurate descriptions and predictions, to an approach that recognises that cause and effect can be difficult if not impossible to trace.

Chapter Six: *Complexity In Measurement Situations*

6.0. Introduction

A Soft Systemic approach to measurement must be able to deal with the complexity to be found in measurement situations, especially of the type with which the traditional approach of metrology is unable to cope. Chapters four and five have outlined some such measurement situations including the primary focus of this thesis business performance measurement. In order to deal with this complexity it is necessary to have some understanding of its generic causes. Furthermore some classification of measurement situations, based on level of complexity, is needed in order to identify situations in which a Soft Systemic approach to measurement would be most appropriate. It is the aim of this chapter to meet these two demands.

6.1. Generic types of complexity in new measurement situations

In previous chapters three areas that present measurement with new challenges were reviewed, namely Chaos theory, Quantum theory and business performance measurement. These areas can be seen to represent measurement situations in the mathematical, physics and social science branches of academia. Diverse as they may seem on initial inspection it is possible to identify a number of commonalties that have an impact on measurement. Essentially these can be described as; the presence of a new and more complex model of perceived reality, the need for measurement to deliver a non-traditional type of understanding, and the influence of measurement on the system being measured. These common aspects are identified in this chapter and may considered as generic causes of complexity in new measurement situations.

6.1.1. Model of the System of Interest

The first generic cause of complexity in new measurement situations extend from our understanding about the system of interest. As knowledge about a system increases so the model of perceived reality associated with that system also changes. In the majority of cases this results in the introduction of a more complex model of perceived reality. Often this new model presents challenges for measurement that the measurement approach designed to operate in the context of the old model cannot meet. For example the traditional approach of metrology based on objective and passive measurement works well for the Newtonian model of the universe. However when the same measurement approach is inadequate when used with the Quantum model of the universe.

The discussion concerning business performance measurement in chapter four again highlights how the traditional measurement approach is not ideal to cope with the complexity of the current model of business. It was identified that the traditional cost-accounting approach to measurement was rooted in a model of business that was based on a single product and medium sized manufacturing company where the relationship between man and machine was of primary importance. A model where companies are often multi-national, multi-product and service oriented, where the relationship between employees and customers is of primary importance, has replaced this model. Hence the business model has changed in both scale and type of activity. Although cost-accounting measures have adapted in an attempt to meet the demands of the new model there are large areas, such customer service and employee satisfaction, where only a different approach to measurement will meet the challenge of the new model of perceived business reality.

Chaos theory also introduced a new model of perceived reality that has massive implications for one of the major assumptions underpinning the traditional approach to measurement. Prior to the advent of Chaos theory it was generally acceptable to assume that size of error in prediction was directly proportional to the size of error in the measurement system. Hence one of the main concerns of measurement practitioners was to develop increasingly accurate measurement systems. Chaos theory introduced a new model of perceived reality that states that even the smallest error in measurement can lead to massive errors in any attempt at prediction. Consequently one of the main aims of traditional measurement, ever increasingly accurate measures, has become a futile effort in some measurement situations. In turn this has serious implications for those engaged in measurement as a means to assist future predictions of the state of a system displaying chaotic properties. Hence the introduction of a new model, Chaos theory, has introduced an element of complexity that impacts upon the role, purpose and type of understanding provided by measurement in certain situations.

6.1.2. Nature of Understanding

The nature of understanding is another challenge of new measurement situations. The new definition of measurement presented in thesis is that measurement is a process of generating numeric information (see chapter nine). From this definition it follows that the main purpose of measurement is to increase our understanding of the system being measured. However the previous review of some of the modern challenges for measurement identified that the nature of understanding is different in different types of measurement situations. It can be argued that understanding based on numeric information can be of a quantitative or qualitative nature. Traditionally measurement has been used to obtain quantitative understanding, which can be said to involve the use of measures in a mathematical model of the system in order to predict future behaviour. In this case the measures are, or are derived from, publicly agreed fundamental measures. Hence understanding is presented in the form of precise numerical values at given time periods. However in certain measurement situations this approach can not be used and measurement must be used to gain qualitative understanding.

Chaotic systems can only really be understood in a qualitative way, as it is not possible to accurately predict the future state of a real system in terms of absolute values. Qualitative understanding gives rise to an appreciation of the dynamic nature of the system, the longer-term trends and patterns in behaviour, as opposed to the absolute snapshot, or series of snapshots, required for quantitative understanding. The concepts of instantaneous change in Quantum theory and bifurcation in Chaotic systems are patterns of behaviour that can be identified, understood and expected at a qualitative level of analysis far more easily than their occurrence can be quantitatively predicted. Another example of qualitative understanding from Quantum theory is the concept that it is impossible to measure both position and momentum at the same time, also that properties of matter are described in the form of statistically revealed potentialities.

At the Quantum level it may be difficult to identify precise measures of elements but in business systems this is even more difficult. For this reason many qualitative measures are used, generally these measures cannot be derived from fundamental measures and cannot be considered as publicly agreed. Qualitative measures are more than likely to result in qualitative understanding. The Quantum idea of understanding the potential of a system is a useful indication of qualitative understanding. It could be said that quantitative understanding is based on predictions of the future states of a system, where as qualitative understanding is based on an appreciation of the potential that exists in a system. This concept can be explained well with reference to business performance measurement. Here financial models, based on cost-accounting data, used to predict future performance are giving way to a more holistic approach to performance measurement that seeks to assess the potential of the organisation. For example the organisation's relationship with customers, employees and the public are now all considered important when seeking to measure the potential of the organisation for good future performance.

Knowledge of the potential resources and the potential behaviour of a system are vital to the acquisition of qualitative understanding. Equally important is the ability of a measurement approach to cope with the complex nature of qualitative measures. From the above it can be concluded that a measurement situation's qualitative nature, in terms of the measures used and the understanding sought, is a major cause of complexity in new measurement situations.

6.1.3. The Influence of Measurement

Perhaps the most striking aspect of complexity in new measurement situations is that which arises from measurement itself. This can be described as the influence of the measurement system on the behaviour of the system of interest, i.e. the system being measured. This influence can be identified as having an impact on the behaviour of a system at two different levels. These two levels may be usefully described by adapting

the concept of learning loops (Argyris & Schon (1978)). Two kinds of such learning loops have been identified, single loop and double loop. Double loop learning occurs when the mental model of the actor, or actors, involved with the system changes, in single loop learning the mental model does not change. Clearly then the determinant of the classification is whether the mental model has changed. This determinant can be useful applied to what may be termed the single and double loop influence of measurement.

Single loop measurement influences take place when the measurement systems has an impact on the behaviour of the system of interest but does not change the mental models of those actors involved with the system. Double loop measurement influences occur when the act of measurement has an impact on the mental models of those involved with the measurement system. In order for the previous statement to make sense it is necessary for there to be human actors involved with a measurement system. The definition of measurement as a purposeful activity, offered in the next chapter, makes plain that there is always a human actor involved with the measurement system. Also for double loop measurement influences to occur it is necessary to recognise that every measurement system reflects a worldview, again this idea is discussed in the next chapter. For double loop measurement influences to occur the worldview represented by the measurement system will in some way influence the mental model of some of the actors within the system of interest, and consequently have an impact on their behaviour.

6.1.4. Summary

The concepts of single an double loop influences are discussed in greater detail later in the thesis, for now it enough to recognise that the impact of the measurement system on the system of interest is a generic cause of complexity in many new measurement situations. Furthermore two other generic causes of complexity in new measurement

situations have been identified, those of the impact of new models of reality and the qualitative nature of measurement systems. The aim of a Soft Systemic approach to will be to deal effectively with this complexity when it exists in a measurement situation. However it is important to recognise that there are many situations where this complexity will not be an influence and a traditional approach to measurement will be most effective. The next section of this chapter introduces a classification of measurement situations that it is hoped will help identify in which situations to use a Soft Systemic approach to measurement and in which to use a traditional approach to measurement.

6.3. Existing Classifications of Complexity & Measurement Situations

Before introducing the new classification of measurement situations proposed in this thesis it is important to distinguish its purpose from other classifications of measurement. The framework presented here is not a classification of measures such as the widely used one presented by Stevens (1946, 1951,1959) that concentrates on the properties of the measures. Stevens' classification can be considered as retrospective in nature since it classifies measures once they have been developed. One of the main concerns of this project is to provide knowledge that helps measurement practitioners to develop measurement systems; consequently there is a need for a classification of the initial measurement situation. The classification presented here is in response to the demand for an initial classification of measurement. Hence this classification framework is based on the complexity that initially exists in a measurement situation not on the properties of the measures once they have been developed.

6.2.1. Existing Classifications of Complexity

One of the implicit hypotheses of this project has been that the complexity of certain measurement situations requires a Soft Systemic approach to measurement. The previous chapters have reviewed examples of such situations and identified three generic causes of complexity in such measurement situations. It is necessary to provide a framework that will classify these measurement situations based on the initial complexity that exists within them. This will enable practitioners to make a more informed choice concerning the most suitable measurement approach to use. A good staring point for this process would be to review some existing classifications of complexity.

6.2.1.a Senge

Senge (1990) provide the simplest classification of complexity:

> *"Systems thinking teaches that there are two types of complexity - the 'detail complexity' of many variables and the 'dynamic complexity' when 'cause and effect' are not close in time and space and obvious interventions do not produce expected outcomes."*
>
> Senge (1990) p.364

The broad classification offered by Senge (1990) above reveals the difficulty in classifying complexity, for there is no single definition of what complexity is. A lack of general agreement for a definition of complexity makes a classification of types of complexity difficult. Consequently any attempt at a generic classification must be at a level that provides little useful guidance when dealing with complexity.

When one tries to apply Senge's (1990) classification to measurement situations it does not help one to differentiate between situations where a traditional approach to measurement and those where a Soft Systemic approach to measurement would be most effective. One could try to make the point that a Soft Systemic approach would be best in dynamic complexity situations. However there are many areas such as the physical sciences, where cause and effect are not closely linked in time or space and where results can be unexpected. Despite this the traditional approach of metrology has proved more than capable of dealing with the complexity in these measurement situations. Another area of difficulty in Senge's (1990) classification is its vagueness, one could argue that the obvious interactions that do not produce expected outcomes are the product of a range of complexity types which his classification ignores. Hence the classification of complexity is not particularly useful for the measurement focus of this research.

6.2.1.b. Flood

Flood (1987) offers a framework through which to conceptualise complexity. He conceptualises complexity in a hierarchical way noting a number of different levels. Complexity is his level one, at level two he identifies systems and people as making up complexity. In other words at its most basic complexity can be classified as to do with the perception of people and the structure of a system. Level three identifies such system classifications as number of parts and relationships, and such people classifications as interests, capabilities and notions and perceptions. He brings all these ideas together in a diagram that shows them as related in a loose way without the hierarchical levels of resolution.

For the purpose of classifying complexity in measurement situations Flood's (1987) conceptual model of complexity has no direct use. However it does provide indirect assistance, for it can be argued that the message of his model is that any classification of complexity will be dependent on the characteristics of the type of situation in which it is to be used. For example the classification of complexity in problem-solving situations would be different from the classification of complexity in measurement situations.

6.2.1.c. Jackson & Keys

The work of Jackson and Keys (1984) would seem to support the concept of striving to develop classifications of complexity in the context of a certain type of situation. For Jackson and Keys the challenge was to build a framework to classify the complexity of problem-solving situations, based upon what they termed the criteria of problem contexts. Like Flood (1987) they identified people, in this context decision-makers, and the structure of the system as the key influences on the complexity of problem situations.

In terms of systems structure they proposed the use of two classifications they are; *Mechanical*, systems which are closed, have passive parts that are observable using the reductionist traditional scientific approach; and *Systemic*, systems which are open to their environment, are not entirely observable, have purposeful and evolving parts, and can not be fully understood using the traditional scientific approach. In terms of the influence of decision-makers they identified another two classifications based on the objectives of the decision-makers; *unitary*, when the decision makers agree a common set of goals for the whole systems and make decisions with respect to these goals; *pluralist*, when decision-makers cannot agree on common objectives and hence make decisions based on differing goals.

The distinction between mechanical and systemic structure is relevant to measurement situations since it would be fair to say that traditionally metrology has operated within a mechanical environment. The complexities of new situations generally do arise in situations that would be termed Systemic according to the classification above. Also useful when applied to measurement situations is the Unitary/Pluralist distinction, this is particularly the case in social systems such as business performance measurement. For example when measuring business performance it is important that the measurement system is assessing performance towards agreed, or at least publicly known, objectives.

Hence the Jackson & Keys (1984) framework does shed light on differentiation in measurement situations but there are problems using it within this context. Describing the structure as Systemic gives us a clue as to the measurement complexities that the situation might present, however it is one step removed from classifying those measurement complexities themselves. Also whilst agreement of objectives is an important people associated influence on a problem-solving context and also to some extent in measurement situations, there is a more important people associated influence on the complexity of measurement situations, namely the influence of the measurement system on the behaviour of actors within the system. For these reasons it was concluded

that a classification system that builds on the foundations of Flood (1987) and Jackson & Keys (1984) but focuses on the specific complexities of measurement situations needed to be created. The next section introduces such a classification of measurement situations.

6.3. A New Classification of Measurement Situations

"Good criteria will result in similarities and differences being revealed which are very pertinent to the questions being asked in the study. Poor criteria will not allow much, if any progress, to be made."

Jackson & Keys (1984) p.140

The quote above reveals the criterion used by Jackson & Keys (1984) to assess the effectiveness of a classification system. In this quote they make reference to the 'questions being asked in the study', for the purposes of the new classification of measurement situations presented here this question is taken to be that of a measurement practitioner deciding the most effective way to do measurement in a given situation. In other words the question at hand will be, should one apply a traditional or a Soft Systemic approach to measurement?

The new classification of measurement situations follows from the work on complexity described in the previous section. Like those it is based on the concept of two primary causes of complexity in situations, the influence of the *structure* of the system and the influence of *people* within the system. However the term structure of the system has been replaced here with the concept of the 'nature' of the system, since this seems to provide a wider scope to describe the properties of the system and their influence on its complexity. Similar to the structure of the Jackson & Keys (1984) framework this classification of measurement situations, or contexts, has two sets of classifications; the quantitative or qualitative nature of the measurement context; and the passive or active influence of the measurement system on the behaviour of the people within the measurement context.

The quantitative or qualitative nature of a measurement situation can be determined with reference to three aspects; the type of measure that will be most common in the situation; the type of numeric information which will be provided by the measurement system; and the existence of a range of possible worldviews, one of which the measurement system will reflect.

The active or passive classification of a measurement situation has to with the influence of the measurement system on the behaviour of actors within the system of interest prior to, or not the result of, the output of numerical information from the measurement system. Passive situations are those in which the measurement system does not have an effect on the behaviour of those within the system. Active situations are those in which the measurement systems does have an influence on behaviour in either a temporary, single loop, way or a long term, double loop, way. As described earlier the distinction between the two cases of active measurement contexts arises from whether the actors' mental models have been influenced or not.

6.3.1. Quantitative or Qualitative Nature of Measurement Situations

There are three aspects that contribute to the qualitative or quantitative nature of measurement situations; the nature of measures, the nature of knowledge yielded by those measures and the existence of more than one potential worldview for the measurement system within the system of interest. This section of the chapter discusses each of these aspects in detail and offers examples to help reinforce the points made in the discussion.

6.3.1.a. Measurement Worldview

It is not possible to build a measurement system until there exists a clear understanding of what the measurement system is for, in other words the purpose of the measurement system. In some cases it is a simple matter to articulate the purpose of the measurement system, such as measurement of a controlled experiment in a laboratory. In other cases it can be extremely difficult, for example the marketing, public relations and operations functions of a business may have different views of the purpose of a customer service measurement system. Lack of agreement with regard to the purpose of a measurement system is a strong contributor to the complexity of a measurement situation.

Even after a common purpose has been established there is another degree of complexity within the measurement situation. Having recognised that measurement is a purposeful activity it becomes clear that a measurement system will reflect some worldview that makes that purpose meaningful. In some situations this worldview will be obvious and widely shared, again the laboratory experiment is such a case, however in other situations this may not be the case. Hence two managers in the same business may agree that the purpose of a customer service measurement system is to monitor performance. One manager may view this as a way of controlling staff, while the other may view it as a means of providing staff with more information so that they can be

empowered to take more control of customer service. Given the potential of a measurement system to influence behaviour it is important that a measurement practitioner considers the range of views that give meaning to the stated purpose of a measurement system.

In terms of the classification presented in this thesis; where there does not exist a commonly agreed purpose, nor a single and widely held worldview for the measurement system, the measurement situation can be considered as more qualitative in nature. The opposite of these situations can be thought of as more quantitative in nature, where there is both a common purpose and an associated worldview that will be reflected in the measurement system. It can be seen that this part of the classification system draws strongly on the unitary/pluralist concept that is a key feature of the Jackson & Keys (1984) framework.

6.3.1.b. Nature of the Measures

Having analysed the purpose and worldview of a measurement system it is possible to consider the most likely nature of the measures themselves. Although 'qualitative' is a description of a type of measures often used by practitioners, what is and is not a qualitative measure is difficult to define. When pressed practitioners tend to describe qualitative measures as those which are not quantitative. Therefore in order to define qualitative measures one must first define what quantitative measures are. The concept of fundamental measures is crucial to this definition, a fundamental measure is according to N.R.Campbell (1920, 1928, 1938) one where axioms of addivity can be directly mapped onto empirical operations For the purposes of the classification of measurement contexts introduced here quantitative measures are those which are, or can be directly derived from, fundamental measures. Following from this qualitative measures are those which can not be directly derived from fundamental measures.

Since quantitative measures are based on commonly accepted standards and definitions their use is much less complex than qualitative measures where this shared understanding has to be created form scratch. It is tempting to see the distinction between quantitative and qualitative measures as one between the measurement situations found in either the physical or the social sciences, where physical science measures are generally quantitative and social science measures are qualitative. However this is too simplistic an interpretation as many social science situations lend themselves to the use of quantitative measures.

To continue with the social scientific case of customer service measurement it is possible to construct a measurement system based on either quantitative or qualitative measures, or a mixture of both. For example a railway company that wishes to measure customer service can do so in terms of quantitative measures, such as how many trains arrived on time, how many hours of the day station offices were open, how many complaints were received, etc. However it can also measure customer service by measuring such areas as how easy it is to buy a ticket or get advice, how polite and helpful station staff are, the value for money of the service, how valued customers felt their custom was to the company, etc. The second category of customer service areas, what might be termed as customer service relationship issues, can only be measured through the use of qualitative measures.

As will be demonstrated in the later discussion of a Soft Systemic approach to measurement qualitative measures are far more complex than qualitative measures. Any measurement approach using qualitative measures must take steps to create levels of shared knowledge within the system of interest, this knowledge can be assumed to universally exist when using quantitative measures. Hence when considering a measurement situation a practitioner must make an assessment of the sort of measures that will be needed to satisfy the purpose of the measurement system. The use of quantitative measures allow the practitioner to draw on universally agreed standards that

do not exist when using qualitative measures, hence the use of qualitative measures necessitates a more complex approach to measurement. Therefore the likely use of quantitative or qualitative measures is a good way of understanding and classifying the level of complexity presented in a measurement situation.

6.3.1.c. Nature of Understanding

The nature of understanding that can be anticipated from the numeric information generated by the measurement system also has an impact on the quantitative or qualitative nature of the measurement situation. The review of advances in the disciplines of physics and mathematics presented earlier in this thesis identified types of understanding in these areas that do not provide the conventional model of knowledge. With regards to Chaos theory Kellert (1993) described this as dynamic understanding, and in Quantum physics Bohm (1983) made the point that quantum discoveries would not fit into the pre-quantum order of description. What is true of recent advances in these hard sciences has long been true in the social scientific disciplines. Once again it is possible to classify the nature of understanding likely to be revealed in a measurement situation into quantitative and qualitative categories.

For the purpose of this classification system quantitative understanding is what one might think of as the conventional form of knowledge. In the case of quantitative understanding measurement is used in conjunction with a mathematical cause and effect model, here values for elements are measured and fed into the model in order to predict future behaviour. More often than not understanding is based on analysis and prediction of precise numerical values at exact time periods. Traditional measurement theory has largely been developed to serve this model of quantitative understanding.

The only way to succinctly describe what qualitative understanding actually represents would be to say that it is the sort of understanding not covered by the definition of quantitative understanding offered above. However it is possible to give a general

description of what is meant by the term qualitative understanding. Qualitative understanding is less precise in nature than quantitative understanding; it draws on numeric information but tends to yield an appreciation of the potential of a system rather than an understanding in terms of absolute numerical values. Qualitative understanding does not provide accurate predictions of the future state of a system but it does provide an understanding of the longer term behavioural trends within the system. Quantitative understanding is generally only possible when cause and effect can be identified and the strength of relationships can be ascertained, hence in complex and non-linear systems only a qualitative understanding is really possible.

Business performance measurement provides examples of qualitative and quantitative understanding. Traditionally business has exerted effort to use cost accounting data as a means of predicting future profit. Such predictions can be viewed as attempts to gain a quantitative understanding about future performance. More holistic frameworks such as the balanced scorecard attempt to give an indication of future performance by providing a general impression of the performance of the organisation in key areas, this may be considered as an attempt to gain qualitative understanding with regard to potential future performance.

6.3.1.d. Summary

It has been proposed that the quantitative or qualitative nature of a measurement context can be used as part of a classification framework for measurement situations. This section has investigated the key influences on the quantitative/qualitative nature of measurement situations and found there to be three major determinants: the type of measure that will be most common in the measurement system to be created; the type of understanding that will be provided by the measurement system; and the existence of more than one possible worldview with reference to the purpose of the measurement system, one of which the measurement system will eventually reflect.

6.3.2. Active or Passive Nature of Measurement Situations

The second aspect to the new categorisation of measurement situations is the active or passive influence of the measurement system on the behaviour of the system of interest. A passive influence is one such that the measurement system does not have a preceding influence on the behaviour being measured. An active influence is one such that the measurement system does have a preceding influence on the behaviour of the system being measured.

The use of the term 'preceding' in the definitions of active and passive measurement situations given above does require some explanation. The general definition for measurement proposed in this thesis is that measurement be viewed as a means of generating numeric information. In line with this definition numeric information can be considered as the output of a measurement system, consequently it is reasonable to expect that this information will have an impact on the behaviour of those involved with the system of interest. However this influence on their behaviour is after the measurement system has reported its numeric information. The active/passive nature seeks to categorise influence on the behaviour of the system preceding the output of numeric information by the measurement system. Put another way the active/passive categorisation is to do with the effect of the measuring process on the behaviour of actors within the system of interest i.e. the presence of the measurement system, within the system of interest.

6.3.2.a. Passive Measurement

The passive/active nature of measurement situations is best explained with reference to examples. For an example of passive measurement consider a situation where one wishes to measure the motion of a planet over a given time period. In this situation the act of measurement will in not influence the behaviour of the planet, in other words the

fact that we are measuring the planet will not encourage it to change speed or direction. Since the measurement system does not influence the planet's movement the measurement situation can be categorised as passive. Measurement contexts that require the measurement of decision-making behaviour may still have a passive nature if human actors within the system are unaware of it. For example the business performance measurement practise of mystery customer/shopping can be considered as predominantly a passive measurement tool, since those being measured are unaware of the exact time at which measurement takes place and hence measurement does not influence their behaviour.

6.3.2.b. Active Measurement

Active measurement is when there is a preceding influence on the behaviour of a measurement system. This influence can take two forms, what may be termed as single and double loop influences, as adapted from the work of Argyris & Schon (1978) and shown in fig. 6.1. Single loop influences are essentially temporary in nature, double loop are permanent in nature. This distinction is created by the presence, or lack of, a change to the mental models of the actors within the system of interest caused by the measurement system.

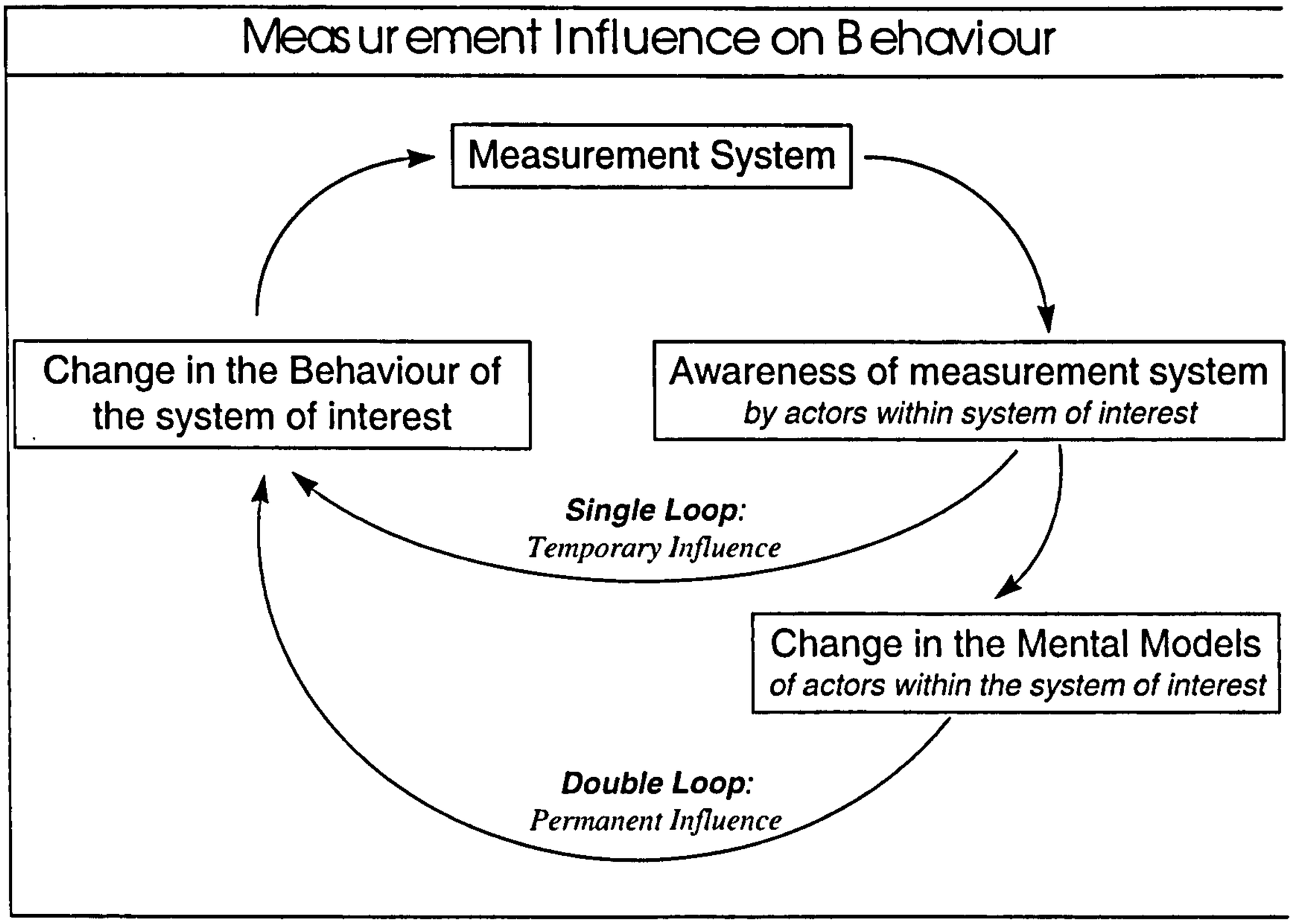

Fig. 6.1. Single & Double Loop Measurement Influences on Behaviour

The model in fig.6.1. clearly shows the two loops which represent the different kind of influence that a measurement system can have on the behaviour of interest. It can be seen that the influence on the behaviour of the system hinges on the awareness of its actors of the measurement system i.e. that they are in some sense being measured. This awareness can produce a change in behaviour of either a temporary or permanent nature, depending on the influence on their mental model. In turn this change in the behaviour will effect the data collected by the measurement system

Before examining some examples of single and double loop influences it is worth reiterating that these influences take place preceding any output of numeric information from the measurement system. After numeric information is output it may be argued that the situation is most appropriately described by the model of organisational learning presented by Argyris & Schon (1978). In fact the model of the influences of

measurement on the behaviour of a system is an adaptation of their model to the measurement context.

6.3.2.c. Single Loop Active Measurement

A good example of a single loop measurement influence on behaviour is the business performance measurement practise of inspection. For example it is still common in business organisations for managers to visit a site and carry out an inspection of the activities and facilities at this site. Very often those working at the site are given notice of the manager's visiting. Consequently it can be seen that actors within the system of interest are aware of the measurement system in terms of when they are to be measured. Hence the workers can use this information to change their behaviour in order make sure that they perform well during the period of measurement. This change in measurement can be considered as temporary since once the visit is over workers at the site know that they are no longer being measured. Therefore the influence that caused the change in the behaviour of actors is no longer present in the systems of interest, however its effect will have been recorded by the measurement system.

6.3.2.d. Double Loop Active Measurement

Double loop learning is of a permanent nature because the mental models of the human actors within the system of interest have been changed. This change in the mental model causes a permanent effect on the behaviour of the system of interest. A subtle example of this influence was given in one of the case-study projects of this research. An oil distributor wished to include in its measurement of customer service an assessment of the performance of its drivers at contacting customers when the delivery would be late. Until recently drivers had not been required to do this, there was now a guideline that they should do it if they were to be more than half an hour late. The company wanted to assess whether drivers were actually following the new policy.

The measurement system involved the use of a questionnaire that was sent to customers; on the questionnaire were a number of questions each with a qualitative six-point scale. Therefore customers had six statements that described different levels of service to do with late running drivers contacting customers, they had to choose the one that most accurately represented their experience. From the same six point scale customers also had to chose the statement that most accurately represented their minimum expectation of service in this area.

When the results of the first wave were analysed the company scored very poorly in the area of late drivers contacting customers. Investigation revealed that most driver were contacting if they were to be half an hour late, however the qualitative scale used for this question gave a description of drivers contacting if they were to be more than ten minutes late. Customers had seen this and had raised their expectations from being contacted if the delivery was thirty minutes late to being contacted if it were fifteen, and in the most demanding cases, ten minutes late. Previous research had shown that the thirty-minute call would satisfy most customers. The fifteen and ten minute calls were put into the scale as something that the company might move gradually towards. However by putting these higher levels of service into the scale they had raised the possibility with the customer, and so permanently raised customer expectations in this area. Hence it can be seen that the level of service presented in the questionnaire had changed their mental model in terms of the level of service customers expected from the organisation. Therefore the measurement had a permanent effect on the behaviour of the actors in the measurement system. According to the definition offered above this effect can be classified as a double loop influence on the measurement situation.

6.2.3.f. Summary

This section has introduced the concept that measurement situations/contexts can be categorised according to their passive or active nature. This nature is dependent on the measurement system influencing the behaviour of the system preceding any output of a

numeric report from the measurement system. Passive nature classifies situations were this influence is not present. Active nature classifies situation were the influence on behaviour is present. Two types of active influence were introduced, described as single and double loop measurement influences on the behaviour of the system of interest. The role of the mental model and changes to it was recognised as the determinant of whether an influence be single or double loop within a measurement context.

6.4. Classification Framework of Measurement Situations / Contexts

The previous sections have introduced the concept that measurement contexts can be classified according to two aspects of their nature, whether they are quantitative or qualitative and whether they are passive or active. These two aspects are brought together in the new classification of measurement situations framework shown in fig. 6.2. It is the aim of this section of the chapter to introduce this framework and to discuss its implications for measurement practitioners and the development of a Soft Systemic approach to measurement.

6.4.1. Classification framework

A Classification of Measurement Contexts

	Passive	**Active**
Quantitative	Yields quantitative understanding Likely use of quantitative measures No conflicting worldviews No preceding influence on behaviour e.g. *Measurement of motion of planet*	Yields quantitative understanding Likely use of quantitative measures No conflicting worldviews Preceding influence on behaviour e.g. *Measurement of wave properties of light or Measurement of particle properties of light*
Qualitative	Yields qualitative understanding Likely use of qualitative measures Potentially conflicting worldviews No preceding influence on behaviour e.g. *Mystery customer/shopping programs*	Yields qualitative understanding Likely use of qualitative measures Potentially conflicting worldviews Preceding influence on behaviour e.g. *Employee performance surveys* *Management performance targets*

Fig. 6.2. A Classification of Measurement Contexts

The classification framework revealed in fig.6.2. is presented in much the same way as the Jackson & Keys (1984) framework of a problem situation, the influence of which in its development has already been discussed. It proposes four main categories of measurement situation: passive/quantitative; passive/qualitative; active/quantitative; active/qualitative. Where the qualitative/quantitative classification has to do with the number of worldviews present in the system of interest, the nature of understanding likely to be derived form the measurement system, and the likely type of measures to be used. The passive/active classification has to do with the presence of any preceding influence on the behaviour of the system of interest, which is directly attributable to the measurement system. Most of the examples given in fig.6.2. have been discussed in earlier section of this chapter however it is worth reviewing them in light of their classification in the framework presented here.

6.4.1.a. Passive/Quantitative Measurement Contexts

The measurement of the movement of a planet is given as an example of passive/quantitative. The measurement context is passive because the act of measurement in no way affects the movement of the planet. The measurement context is quantitative because there are no conflicting worldviews with regard to the purpose of the measurement, the information provided by the measurement system can be used to make accurate predictions using real values, the measures are common measures of length based on fundamental measures.

6.4.1.b. Passive/Qualitative Measurement Contexts

Mystery shopping / customer programs are given as an example of passive/qualitative measurement situations. The measurement context is passive, because the act of measurement does not have an immediate influence on the level of customer service provided by employees. The measurement context is qualitative because there is a

potential conflict between differing worldviews to do with the purpose of measurement i.e. it may be a tool for control or empowerment, the measures are unlikely to be derived from fundamental measures, and the knowledge derived from the measurement system will be based on an appreciation of current trends and common forms of customer service behaviour.

6.4.1.c. Active/Quantitative Measurement Context

An example of the active/quantitative classification would be an experiment to measure the wavelike properties of light. The measurement context is active because at the quantum level the decision to measure wavelike properties will actualise the state of the system into a wavelike nature. Hence the measurement system will find what it is designed to find, however if the measurement system was designed to measure particle like properties of light at the quantum level it would measure these. Hence the measurement system has a strong influence on the behaviour that is measured. The measurement context is quantitative in nature since it makes use of measures derived from fundamental measures, there are no conflicting worldviews and the understanding derived form the measurement system will be real values from which precise predictions may be made.

6.4.1.d. Active/ Qualitative Measurement Context

An example of an active/qualitative measurement situation is business performance targets for managers and employees. The measurement situation is active since the areas being measured by the measurement system will reveal to those being measured where they should focus their efforts. Consequently the areas in which people are measured and assessed will be the areas in which they seek to perform most well; as a result they will adjust their behaviour accordingly. The measurement situation is qualitative in nature because there may be conflicting worldviews concerning the measurement, should it inspire growth or cost control. The measures are often qualitative in nature,

and it is not possible to use values in order to precisely predict the future performance of the individual.

6.4.2. The Traditional Approach to Measurement & the Measurement Classifications

The aim of the measurement classification is to assist measurement practitioners in their selection of what approach to measurement will best fit their particular measurement situation. The Soft Systemic Performance Measurement Framework (SSPMF) introduced in this thesis covers practical steps for assessing a situation based on this classification. So the immediate question to be addressed is, once a measurement situation has been classified into one of the four categories how does this influence the choice of the most suitable approach to measurement?

The chapter that investigated metrology earlier in this thesis concentrated on the work of Finkelstein (1982) in attempting to define what has been termed, in this thesis, the traditional approach to measurement. This approach views measurement in four key ways:

1. Measurement is a process of **assigning numbers to describe the real world**
2. Numbers are assigned to **properties** of objects & events
3. Measurement is an **empirical** process
4. Measurement is an **objective** process

The first point above would be a keystone of any approach to measurement and hence common to all four of the categories in the classification of measurement contexts. The other three points have implications that mean that the traditional approach to measurement is not applicable in all of the four measurement contexts.

6.4.2.a. Properties for Measurement

Although not stated explicitly it seems to be an assumption of the traditional approach that there is a shared understanding about the properties of an event of object which can be used for measurement. For example if one wishes to measure the physical properties

of an object one would measure such things as height, length, breadth, circumference, etc. A common and public understanding about such properties exists prior to any activity within the measurement situation. Whilst this common understanding with regard to properties may exist in some measurement situations it does not exist in all of them. In the case of a measurement situation where one wishes to measure customer service there is no common understanding of what the properties of customer service are and hence what should be measured. Since the traditional approach assumes this common knowledge it would not work well in the qualitative categories where often such understanding must be created as part of the development of the measurement system.

6.4.2.b. Empirical & Objective Measurement

The third and fourth cornerstones of the traditional approach are that measurement be empirical and objective. It is extremely common for qualitative measures to make use of scales where respondents to a survey indicate a point on a scale which best represents their feelings with regard to a certain question or statement. However in order for a scale to be objective the same answer must be expected from other respondents if they are faced with the same conditions, hence this kind of measurement is not objective. The traditional approach requires that the measurement must be empirical i.e. observable and not be a thought experiment. In the case of customer service one is seeking to measure the perceptions of customers, so any assessment of customer service is in some way going to be a mind experiment as the customer strives to turn subjective thoughts and feelings about service into a single point on a scale. Hence the need for measurement to be empirical and objective seems to rule out the effective use of the traditional approach in the two categories where the measurement context is qualitative in nature.

The concept that measurement must be objective also presents some further difficulties. The demand for measurement to be objective implies that the measurement activity stands aloof from the system of interest and in no way influences it behaviour; otherwise

judgement must be exercised to appreciate what influence is attributed to the measurement activity and what to the other influences present in the system of interest. Whilst this may be a basic tenet of the scientific approach it is as unrealistic expectation in many situations involving the measurement of human actors. Indeed in the business world one of the aims of measurement is to deliberately influence behaviour towards certain objectives. Any measurement context that falls into one of the active categories will mean that the measurement system is likely to influence the behaviour of the system of interest. Therefore if a measurement context is classified as active measurement it will not be objective and the traditional approach will not be applicable.

As a general guide the above discussion seems to rule out the effective use of the traditional measurement approach in any qualitative or active measurement contexts. Put the other way the traditional approach will be at it most effective when used in passive/quantitative situations. This is not to say that it is never useful in the other measurement context categories but that certain features of these situations are in conflict with some of the fundamental tenets of the traditional approach. Furthermore it is interesting to note that the passive/quantitative category is where most hard scientific measurement would fit, and that Finkelstien (1982) has drawn attention to the mutual development of science and the traditional approach to measurement.

6.4.2.c. Summary

So the message to the measurement practitioner is that if your measurement situation is best categorised as a passive/quantitative situation then use the traditional approach. However if your situation is best categorised as passive/qualitative, active/quantitative or active/qualitative you should consider using a different measurement approach. Such an approach is the Soft Systemic approach to measurement introduced later in this thesis that seeks to deal with the complexity identified in this chapter.

6.5. Chapter Summary

This chapter started with a investigation into what were termed generic causes of complexity in new measurement situations. It was proposed that underlying much of the complexity in modern measurement situations were a set of common features, these were identified as:

1. The presence of a new and more complex model of reality.
2. The need for measurement to deliver a non-traditional type of understanding.
3. The influence of measurement on the system being measured.

During the analysis of these generic causes of complexity it became apparent that there were serious implications for the effective use of traditional approach to measurement in such complex areas. In light of these implications it was proposed that a Soft Systemic approach would be more likely to deal with this complexity, since dealing with complexity is one of the main purposes of systems thinking.

It was then proposed that in order to assist measurement practitioners cope with the complexity in measurement situations some classifications of measurement situations/contexts was needed. Current definitions and classifications of complexity from influential Systems writers were reviewed. The most useful lesson were learnt form the classification of problem contexts presented by Jackson & Keys (1984). Although useful their work did not capture the richness of measurement situations so a new classification of measurement was created based on their model.

The new classification of measurement situations/contexts was then presented. This classification was based on two aspects:

1. The Quantitative/Qualitative nature of the measurement context. This is dependent on three influences: the presence of a conflict of worldviews; the nature of understanding likely to be gained form the output of the measurement system; and the likely type of measures to be used in the measurement system.

2. The Passive/Active nature of the measurement context. This is dependent on the influence of, or lack of, the measurement system on the behaviour of the system of interest preceding the output of numeric information.

These two aspects were combined into a classification framework of measurement contexts which has four categories: passive/quantitative; passive/qualitative; active/quantitative; active/qualitative. The implication of these different categories for the traditional approach was investigated. It was found that features of both the active and qualitative categories were in conflict with two tenets of the traditional approach, the empirical and objective requirements. Consequently the traditional approach was found to be best suited to the demands of a passive/quantitative measurement context. The chapter closed with the proposal that the other categories of measurement contexts would benefit from a different approach to measurement such as a Soft Systemic approach.