THE ROLE OF QUALITY IN THE MANAGEMENT OF PROJECTS

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Abstract

Quality is often claimed as the 3rd dimension of any project: the success of a project depends on the management of time, cost and quality. However, quality is a much more elusive substance and its management can be problematic. This thesis examines some of the models proposed for managing quality in projects and considers their relevance via a number of case studies. The present study aims to provide a foundation from which a methodology for the management of quality in projects can be evolved.

The general definition of "quality" is still discussed and its interpretation in the specific area of project management is open to debate. In this thesis it has been found useful to consider three levels of quality management in the project environment, broadly equivalent to those usually accepted in operations management: quality control, quality assurance and total quality management. Various methods of quality control have been employed in projects for many years. The emphasis of the present study is on the project management equivalents of quality assurance and total quality management and to examine whether they fulfil the true need.

A major element of successful quality management is the establishing of constructive methods of feedback. Feedback is also often claimed to be a vital ingredient of successful project management: learning from past successes, and failures. A conduit to provide feedback is often problematic due to the very nature of projects and their finite lifespan. Mainstream thinking believes that standard quality systems employed in the production and operation environment can be incorporated effectively in project management thus increasing operational consistency and reducing the risk of activity or project failure. However, is the model of quality embedded in these systems relevant to projects with their characteristics of uniqueness and long time scales?

Initial debate assumed that existing quality management systems would be of benefit in projects, which exhibited a lower level of uniqueness and were closer to an operations management perspective. A literature review followed to gauge the level of importance attached to quality systems and its role in the project process. This determined that there was a need to investigate what existing quality systems, contributed in a purely project environment and what impact they had on improving project success especially in regard to

the uniqueness of the projects and to the size of the project organization involved. In addition, the impact an industry-standard quality system had on project organizations compared to project organizations that did not possesses any formal system.

To compare and contrast the conventional approach to quality in projects, the complementary areas of systems thinking and system dynamics were explored. Examining an alternative field to quality management was beneficial in providing a different perspective on how systems can be modelled evaluated and applied to real-world applications. This part of the research contributed significantly to the formation of the ideas and opinions on the way in which the concept of quality should be promoted in project management. In particular, the identification of mental models and the use of graphical representations to describe, illustrate and model the tangible and intangible entities found in most types of system.

The use of a case study methodology was seen as the most valid way of attaining a holistic view of the complete project process and exploring the salient issues surrounding quality and projects. The fieldwork carried out to facilitate this goal, comprised of a restricted number of in-depth case studies, which encapsulated complete projects. An essential part of this process was the use of participant observation and in part action research, as these approaches increased the access to the available qualitative data whilst being mutually beneficial to the research and to the organisations involved.

The scope of the case studies carried out was governed by a number of constraints:

- The availability of suitable projects.
- The timespan of the available projects matching that of the research, consequently the projects studied are on a relatively small scale.
- The organizations in which the action research process could be a valid exchange of services.
- The reluctance of organizations in certain industries to allow access to data on projects in particular activities that had led to project failure.

The alternative models and techniques offered by systems thinking and system dynamics were explored to see if they could deliver more insights into the diverse aspects of project quality and how feedback in systems can be effectively represented.

From the four case studies carried out, it is evident that there is a need for a fundamental revision on how quality is both defined and measured in project management. There is a need for greater emphasis on the acquisition and retention of knowledge by project organizations including the ability to disperse that knowledge by a practical and useful medium. Existing quality management systems still exhibit their origins, which do not take into account the uniqueness and instability of the project environment. In practice, the demand for registration to an industry-recognised quality standard appears to discriminate against the smaller project organization. The impact on the larger organizations is no less significant due to the creation of 'underground' parallel working practices, which are a significant waste of resources. The veneer of compliance to a global standard does not help the project organization learn or accumulate knowledge.

In conclusion, this thesis proposes that project management needs an alternative methodology to provide a more practical method of project feedback, to enhance the ability of future projects. This thesis puts forward a foundation for this methodology based upon the valuable attributes of the models identified during the research in addition to the value of the case studies compiled. The aim for the implementation of a practical quality system has to be based on a reappraisal of what its purpose is. Therefore, it is proposed that the objective of any system would be to capture knowledge, store and redistribute that knowledge in a manner that makes a positive contribution to future project success. Emphasis is placed on increasing success by the acquisition of knowledge, in contrast to the traditional quality concepts of decreasing risk by the control of activities. In essence a shift from existing mechanistic systems towards more neurocybernetic systems. The increasing capabilities of communication and information technologies make the practicalities of creating this type of system perfectly feasible.

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Chapter 1

Introduction

1.1 Chapter Synopsis

Quality is a generic concept that is seen as an integral part of any organization in business today. The inclusion of quality as one of the key dimensions in a project is common in most project management literature. Turner[1] evolves the traditional project management time/cost/quality triangle into a pyramid allowing the five project management objectives to be taken into account. Figure 1.1 illustrates the progression of Turners diagrams.

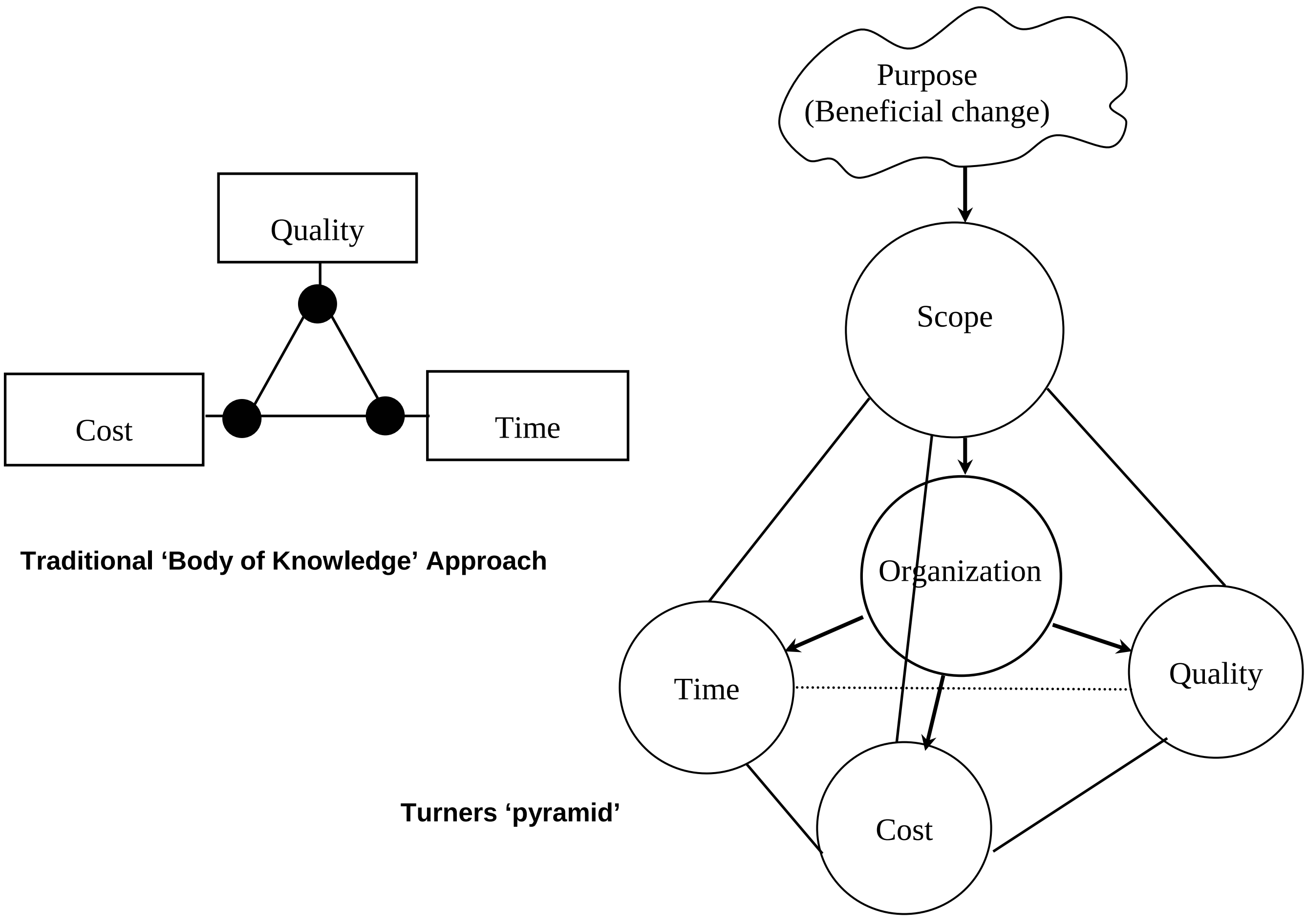

Figure 1.1 Turners pyramid an enhancement of the traditional project objective triangle

The inclusion of a quality dimension as a project objective mirrors the rise in prominence of quality in business generally. This has not always been the case as can seen from Figure 1.2, which is based on a diagram by Nicholas[2] from the early eighties. The definition of performance has now been extended to encapsulate scope and quality[3] thus integrating

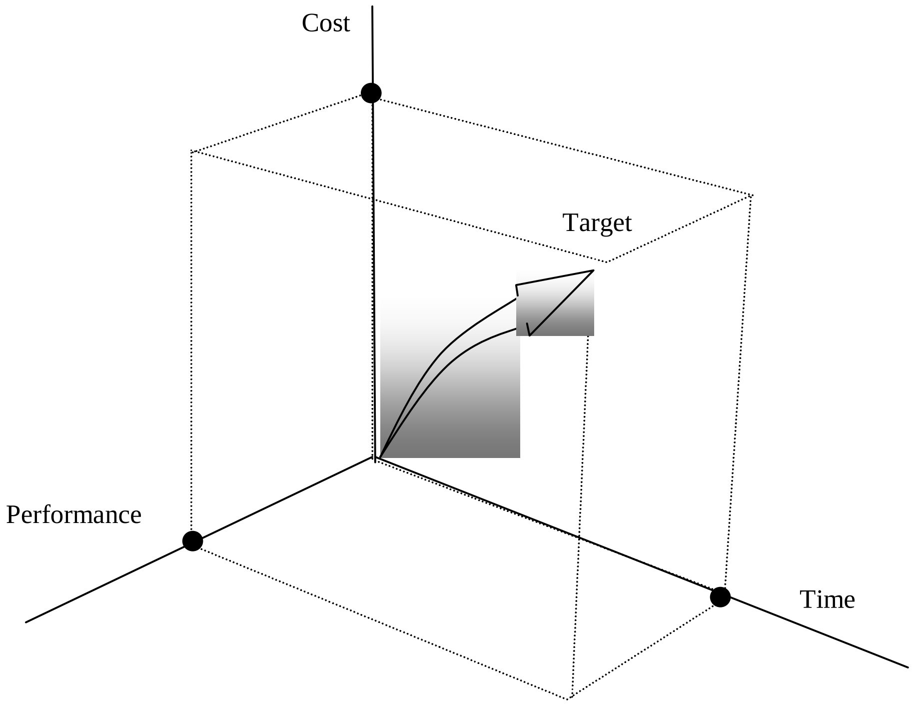

Figure 1.2 Traditional representation of the three dimensions of project goals

quality into the project management lexicon. Despite quality being frequently cited as a key dimension of project success as Turner [4] points out it is rarely seen as a valid topic for research,

> " Even though quality is mentioned as one of three key measures of project success, its management is hardly ever covered."

With this quote, Turner is assuming that quality is an attribute that can be managed in the project context.

More fundamentally, what constitutes quality in a project environment? Is there a need for a redefinition of quality in the project environment? Including a redefinition of how it is managed? Wilkinson and Wilmot[5] comment on the fact that there are few studies of the effectiveness of quality initiatives, with existing literature being very insular, and failing to address its efficiency,

> "The leading advocates of quality management are not inclined to refer to previous management literature or indeed, to reference anything outside of the quality management field. Nor are they inclined to draw upon ideas and literatures that can provide a more rounded evaluation of the claimed benefits of quality initiatives ...yet few studies that address its meaning, or reflect upon its practical implementation or social significance…"

This appears to suggest that quality management is on the whole a self-serving discipline, which does not integrate well with other management fields. With respect to project management does the wholesale adoption of quality systems based on the ISO9000 series of standards reinforce this isolated approach to quality? It is a very salient issue as these standards are prevalent throughout the UK and are now starting to be used in other countries as a global measure of quality despite the absence of empirical data to prove their effectiveness.

1.1.1 Why Quality?

The catalyst to discover what constitutes quality in projects was generated by the work experiences of the author and others; it often appears that existing quality thinking does not properly encapsulate the project environment. Time and cost are the most common benchmarks in industry, with seldom any questioning as to whether they are sufficient in terms of contributing to project success and to the project process.

1.2 What is Quality in a project context?

1.2.1 The difficulty of defining 'quality' in project management

The following archetypal definition conveys what conventional quality management is meant to offer project management,

> "Quality management is the policy and associated procedures, methods and standards required for the control of projects. The purpose of quality management is to increase certainty by reducing the risk of project failure. It also provides the opportunity for

> continuous improvement."[6]

Yet, at a more fundamental level what is quality? If it exists how can it be managed in a project environment. Are conventional quality techniques appropriate in a project environment or is there a need for more fundamental methodologies?

> "Quality is the ability to manage a project and provide the product or service in conformance with the user requirements on time and to budget, and where possible maximizing profits."

Merna's[7] definition of quality is intended to be compatible with the requirements of project management, it appears to describe quality as 'an ability to manage'. But how is this ability secured? Is quality management in its present form, a prerequisite to obtaining these skills?

1.2.2 Existing definitions of 'quality'

One of the most frequently quoted definitions of quality is from the British Standard BS 4778[8]

> 'the totality of features and characteristics of a product and service which bear on its ability to satisfy a stated or implied need.'

Quality is viewed as an attribute that has to be controlled to achieve the desired outcomes from an activity whether it is in production or a service industry, yet is quality not an outcome rather than an integral part of the activity? The combinations of intangible and tangible components that are welded together to produce a quality product or service are not easy to define or to emulate. To satisfy the 'implied need' used in the BS4778 definition, there needs to be recognition of failure, an ability to identify the areas where things were done well and where things failed.

The basis of this research is to question whether the existing interpretations of quality are adequate in a project environment context. The following definitions from BS4778 are indicative of the way in which quality issues are perceived, a series of generic concepts applicable to all environments,

> **"Quality Control**: The operational techniques and activities that are used to fulfil requirements for quality.
>
> **Quality Management**: That aspect of the overall management function that determines and implements the quality policy.
>
> Notes
>
> 1 The attainment of desired quality requires the commitment and participation of all members of the organization whereas the responsibility for quality management belongs to the top management
>
> 2 Quality management includes strategic planning, allocation of resources and other systematic activities for quality such as quality planning, operations and evaluation
>
> **Quality Policy**: the overall quality intentions and direction of an organization as regards quality, as formally expressed by top management.
>
> **Quality Assurance**: all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality."

Having definitions of quality is actually expressing a desired goal, a state perceived by the creators of the standard as an optimal system. Yet, in project management objectives are frequently conflicting and dynamic, therefore it is imperative that any project quality system is also dynamic with an ability to harness both negative and positive experiences. Transforming these experiences into knowledge that can be distributed and disseminated by all involved in the project life cycle should be the aim of any quality system, increasing the likelihood of future project success. The form and function of existing quality systems when applied in a project environment may have contributed to the dilution of their true goal i.e. to increase quality.

1.3 The Three Levels of Quality

During the course of the research a simple definition was proposed to describe how quality in project management was perceived. This personal definition was based on experience and discussion and tried to avoid the ambiguity that quality definitions frequently exhibit. Figure 1.3 is a basic representation of this definition (proposal), showing on the left-hand side the ‘three levels of quality’ that influence projects at a practical level. Mapping these definitions onto existing models of quality attempts to differentiate between the different levels of quality model.

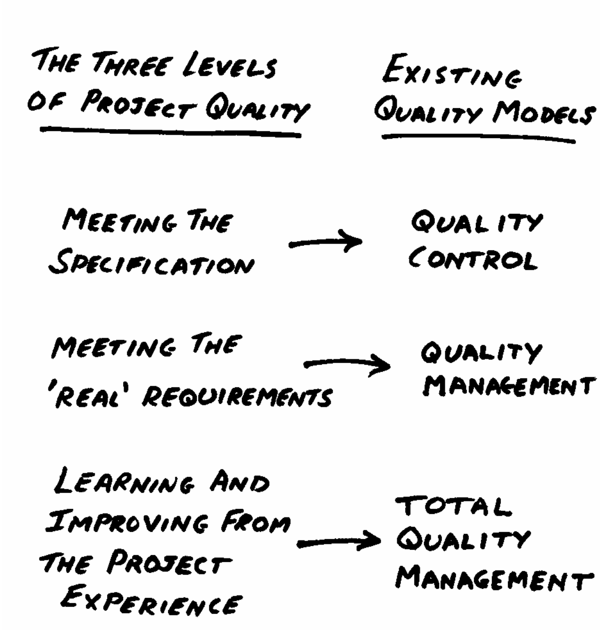

Figure 1.3 Mapping the ‘three levels of project quality’ onto existing quality models

Interpreting the definitions of the existing quality models shown in Figure 1.3 is complex due to the wide range of definitions available and the degree of overlap that occurs. The concepts of Quality Control, Quality Management and Total Quality Management are all strongly inter-linked.

1.3.1 Defining level one: ‘Meeting the specification’

The first level of quality is where a project is carried out to solely meet the contractual specification. This presupposes the clients know what their own optimal requirements are. Specifications that stem from the design phase of the project life cycle frequently do not involve the contractors or suppliers who are going to execute the project. Therefore the client may get what was specified but this may not be what they really *need*.

The Project Management Institute[9] defines quality control in a project as,

> 'Quality control involves monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project. Project results include both product results such as deliverables and management results such as cost and schedule performance'

Quality control (QC) is the most basic quality model for a project; the minimum level that has to be achieved to complete a project as specified. Despite this, fulfilling the project specification may not equal a successful project. There are many examples of projects, which meet their required specification but do not meet the client's true needs (the M25 motorway that circumnavigates London is one such example). Apportioning responsibility for any failings in the 'product' outcome of a major project can often be the most highly publicised part of the project. (E.g. the British Library). QC is an operational aspect of quality, based on inspection and control, and is the original historic core part of the quality movement. With its roots in manufacturing the 'inspect and control' culture in QC is still intrinsic to the other quality models illustrated in Figure 1.3. Caplan[10] defines the purpose of QC as producing a 'quality' that,

> "1. Satisfies the customer.
> 2. Is as cheap as possible.
> 3. Can be achieved in time to meet delivery requirements."

He stresses that the objective is not to produce the 'highest possible quality' but to merely satisfy the customer. Therefore the marketplace and the type of customer are taken into account in the QC process. QC in recent quality management theory is defined more as a subset of quality management than a stand-alone subject. Mapping the first level of quality to quality control as shown in Figure 1.3 exhibits a close match, as quality control in projects is primarily an operational function.

1.3.2 Defining level two: 'Meeting the 'real' requirements'

Defining the next level of quality is where a project organization goes beyond just meeting the original contractual specification; it actively provides what it believes is the most appropriate product or service. Regardless of what the project is providing, there is no guarantee that the project customer has the expertise or knowledge that what they have specified is what they actually require. At the second level of quality the role of the project organization is seen as more than just meeting the contractual specification: the client and contractor are working together to ensure a successful outcome. This may involve revising the specifications as the client and contractor learn what is really required, and what is feasible. In theory the freezing of specifications is seen as crucial to a successful project, in practice specifications often have to be altered to meet the prevailing conditions encountered.

Unlike the relationship between quality control and level one, the mapping between the second level of quality and quality management theory does not appear to be an optimal match. Yet if a project orientated organization implements the quality management model as intended then theoretically they would provide what the client *needs* in addition to what they *want.* The important distinction between level one and two is that the project organization is contributing more to the likelihood that the project will be a success in both the long and the short term i.e. after completion and whilst in use. It is this 'gap' between levels one and two and between the theory of quality management and the reality that provides one of the major themes throughout this research.

1.3.3 Defining level three: 'Learning and Improving from the project experience'

The third level of quality is arguably the most important level of quality. This is a quasi-theoretical state in which a project organization continually increases its knowledge database through capturing the experiences of past projects. This knowledge is used to feed-forward to increase the success of future projects. This relates to both clients and contractors in that both learn and accumulate experience. The concept of 'continuous improvement' is embodied in Total Quality Management (TQM) with the mechanisms that provide the feedback firmly based on standards from quality management. But, how applicable are these mechanisms in a project environment? Has quality management provided the tools and techniques to capture and reuse knowledge gained from experience? This is a pivotal point for TQM as its complete culture is based on continuous improvement. TQM is still an extension of QM and QC therefore can it practically create a culture of learning in the organization? It is recognised that demarcating levels of quality in this manner is simplistic. There can be examples of all three 'levels of quality' in one project, regardless of this there is a need to clarify the present thinking and practice on quality in project management and examine whether it fulfils a true need.

1.4 Feedback and the Learning Organization

It was expected that any definition of quality would encompass the knowledge gained throughout the project life cycle, the realisation that a successful project is more than just

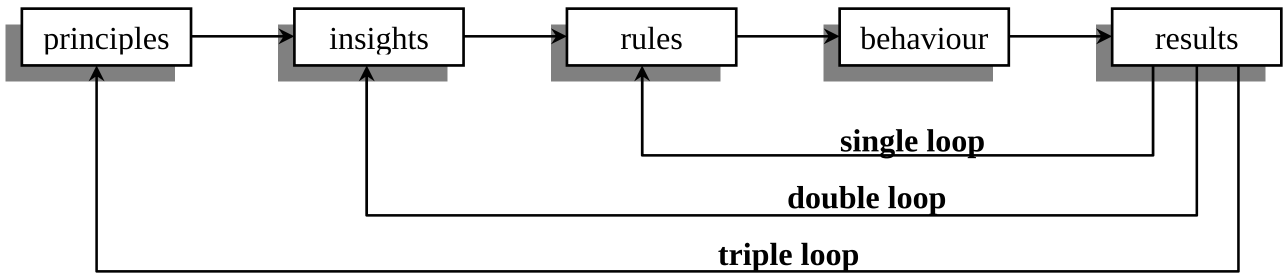

Figure 1.4 Swieringa and Wiersdma's Collective Learning Loops (1992)

adhering to the specification. With a project always possessing some intrinsic uniqueness knowledge gain will always take place (at varying degrees) the difficult part for any 'system' is the manner in which that knowledge is fed back and how that knowledge is accessed and utilised in the future. Barlow[11] cites evidence that what is called ‘double loop learning’ has a direct link with organizational competitiveness. Double loop learning is an organizations ability to not just resolve problems and accept successes, but to learn from these experiences. To feedback and learn from project experience using the knowledge gained to beneficially alter the organization and challenge the norms. It could be argued that project personnel, already practice double loop learning: experience is gained and actions when dealing with subsequent projects are based upon this experience. Swieringa and Wierdsma[12] break down the concept of ‘collective learning loops’ even further into single loop learning, double loop learning and triple loop learning which they illustrate as illustrated in Figure 1.4.

With regards to project quality, the problem does not appear to be one of individuals double loop learning, but an absence of organizational double loop learning i.e. learning between projects is ineffective. One area, which project organizations appear to be disregarding, is the effectiveness of existing quality systems, which despite the claims of the ‘quality community’ may not be providing any tangible ‘continuous improvement’. Improvement requires a learning process to take place, allowing organizations to contribute to their knowledge bases, yet this philosophy of ‘learning’ in an organizational sense does not appear to be fostered by existing quality management practice. With existing industry wide quality standards, the onus is on organizations to implement a bespoke quality management system. Yet, the template provided to initiate these systems appears to force inappropriate methods and controls onto the organization, leading to in the authors opinion a denigration of the natural feedback systems that already exists, particularly in project orientated organizations. Existing quality systems appear to consist of a great deal of bureaucracy, which stifles what Seddon,[13] refers to as the ‘creative anarchy’ that is present in organizations. Learning, innovation and change the three ingredients of ‘creative anarchy’ are also the key ingredients of a good project team, therefore if existing quality systems are too bureaucratic to foster creative anarchy, what are the alternatives? Where do existing quality systems fall down? Does the definition of quality in project management need to be redefined entirely?

To learn there must be a degree of risk taking and nowhere is the correlation between learning and risk more apparent than in a true project environment. Situations occur or are presented which require a degree of risk to be taken, whether it is in the design, production or termination phases of the project life cycle. Project organizations have to learn from their experiences or they will cease to exist, therefore any ‘system’ that enhances that capability should be an asset.

1.5 Defining a Project and Project Management

The following definition of a project[14] by Turner captures the essence of what makes project management different from other management disciplines:

> “ an endeavour in which human, material, and financial resources are organized in a novel way, to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives.”

Turner puts forward two views of project management[15],

- The body of knowledge,
- The project process.

The body of knowledge outlines a set of project management methodologies like for example the ‘critical path method’ (CPM), which tend to focus primarily on the project on hand. Turner’s alternative view defines project management as a process, which is a combination of project objectives, a multi–level management process to reach those objectives, that should culminate in a successful project. This forms the basis for Turners five project management objectives as shown in Figure 1.1. Turner refers to managing risk as the sixth project objective yet he sees that as an ‘inherent part of the five objectives’. This raises an interesting point. If risk is indeed inherent in all the objectives including quality, is failure defined in terms of poor quality or is it defined in terms of the amount of risk? The role of risk in this research is explored later in relation to a project organization ability to increase its learning potential.

1.5.1 Project Management as a flow process

Levitt and Nunn[16] highlight a key difference in the management of projects compared to other forms of management:

> “To further complicate matters, the underlying dynamic philosophy of project management is not understood by most managers who see a snapshot of work passing the point where they are sitting. This snapshot viewpoint is not a defiency of those managers, because we are not taught to visualize that way”

This research will examine the ‘dynamic philosophy’ of project management and how this is represented in relation to existing quality systems. Alternative methodologies, which also exhibit dynamic traits, including systems thinking and system dynamics may also identify complimentary methods that can be used to describe the role of quality in project management.

1.5.2 Quality as a variable

Quality management theory and to lesser degree project management theory stresses that quality is sacrosanct and as such is not seen as a variable that can be compromised. Quality is therefore supposed to be ring-fenced from the resource restrictions that affect the other project objectives. In theory this a laudable model, but is it an achievable model in practice? The generic quality standard series ISO9000 (discussed in more detail in Chapter 3) is promoted as a framework for implementing a quality system within all types of organization. With the number of ISO9000 registered companies increasing, on face value it appears that quality issues are being made a priority, but are these types of systems appropriate in project management? Increasingly organizations have to be ISO9000 registered to be allowed to tender for work regardless of their existing abilities. Has this 'coercion' led to the adoption of widely inappropriate 'bolt on' quality systems in project management? Or is it the reluctance of the project world to adapt a useful generic quality model to a dynamic environment?

1.6 Aims of the Research

The underlying history of existing quality systems has meant that they have evolved from a manufacturing background, more suited to relatively stable environments where a process approach is readily implemented. Although as previously mentioned Turner expounds the 'project process' as the most comprehensive definition of project management it is not always readily identifiable with more operations based environments. The main difference between a project and an operation is that a project has some degree of uniqueness, which demands a different approach in its management. Yet even projects possess generic traits. If there were some form of 'system', which captured the best methods to carry out these generic activities, the project organization would have an invaluable source of data. This would feed-forward to aid the success of future projects providing feedback and learning between projects.

Existing quality theory does see this form of feedback as an integral part of the quality system, therefore it was decided to examine the relevance of existing quality initiatives in project-orientated organizations. In addition to more traditional views of quality initiatives the alternative methodologies of 'systems thinking' and 'system dynamics' were investigated to determine if they offered any useful insights into quality in projects.

The questions raised about quality in project management in this introduction have formed the basis for the aims of this research. Whilst it is recognised that quality is a multifarious topic, the overall aim of this research is to provide a foundation stone such that others might construct more applicable methodologies for managing quality in projects. The research pursues the notion that project quality is enhanced by individual and organizational learning utilising existing natural feedback systems present in the project environment rather than imposed structures. Therefore, summarising the primary objectives of this research,

1. *To investigate the pertinence of the models implied by existing quality initiatives in a real project environment and their possible contribution to future project success.*
2. *To develop an alternative model as a basis for the management of quality in projects; this model will aim to rectify any deficiencies, identified in (1).*

The supporting secondary objective, which will contribute to (2), is as follows,

3. *To construct case studies focussing on the topic of quality in project management to provide a useful contribution to the existing project management body of knowledge.*

A particular focus of objective 2 will be to examine whether the alternative methodologies and techniques offered by systems thinking and system dynamics can deliver more insights into the diverse aspects of project quality.

1.7 Scope of the Research

At the preliminary stages of this research, it was realised that there was a lack of suitable in-depth material on quality in project management. Existing project management texts tend to perceive quality as a bolt-on topic; despite it's alleged importance. This is coupled with a lack of qualitative and quantitative data to substantiate the impact of existing quality initiatives in a project environment. In addition, many organizations are reluctant to allow scrutiny of either their existing quality systems or previous project history. Historic project failures that are highly documented typically involve either loss of life or loss of finance (in a large scale). The more mundane project failures are not as well documented, with organizations unwilling to analyse the mistakes made.

There were a limited number of case studies that could be constructed from small-scale projects and project activity which possessed a relatively high degree of generic activity, and which could be followed from start to finish. Despite this limitation, the projects used were studied in considerable depth due to the methods used by the author in his approach to data collection (discussed in more detail in Chapter 2, *Research Methodology*.) This in-depth approach had the advantage of observing the capabilities of existing quality management systems and whether they produced a more operations-based approach to the project process by continually improving the performance of generic activities. It was expected that existing quality initiatives might be more relevant to smaller more routine projects where there was the likelihood of more repetition i.e. a management environment similar to operations management where existing quality systems have been developed. Therefore the quality systems in use should exhibit a strong feedback loop to allow improvement in subsequent projects.

The construction and electrical supply industries provided the majority of the data used in the case studies. Three case studies were collated using the data collected and to provide a comparison a fourth ‘classic’ case study was composed using data available in the public domain. This was to provide a degree of validation to what had been observed in the initial three cases and also to consider whether the experiences gained in the new case studies might be extrapolated to other projects in different application areas. The ‘classic’ project case study comprised a high profile project, which due to its failure resulted in a public inquiry that subsequently provided a large amount of data available in the public domain. Although the magnitude and scope of the classic project differed from the research case studies sufficient parallels could be observed to justify its inclusion as a triangulation point in the overall research.

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Chapter 2

Research Methodology

2.1 Chapter Synopsis

This chapter describes the methodologies utilized in this research, the logic behind the choice of these methodologies and their application in the context of this research. The methods chosen to carry out this research have been determined by the following factors,

- The authors previous experience and knowledge as an engineer in a project management environment, and the experience of others,
- The availability and opportunity to access qualitative data on project management.
- The relevance to the objectives

The main methodology used was *case study research*, with the main information gathering techniques being participant observation and some action research both of which shall be examined in this chapter.

The three case studies presented have been constructed from original research undertaken over the last four years. In addition to and in contrast there is also the inclusion of one ‘classic’ case study from project management literature, to attempt to validate and triangulate the findings of the original case studies and to determine the scope of the general conclusions. The choice of case studies as discussed in Chapter 1, Section 1.7 was determined by the desire to obtain (where possible) in depth data on the complete project life cycle, within the timescale of the research and of a sufficient detail to examine the impact of quality in the project environment.

2.2 The Use of the Case Study in Research

Cassel and Symon[1] describe the purpose of a case study as follows,

> "A case study is an approach not a method. A case study contains detailed investigation, often with data collected over time in one or more selected organizations. The goal with a case study is to provide an analysis of the context and processes involved in the phenomenon under study. It is not a means of making generalisations that fit other organizations. When doing a case study, a combination of methods are often used in addition the researcher is likely to take advantage of other sources of data in the organization such as doing an analysis of documentary details"

In contrast, Yin[2] claims that it is possible to make useful generalizations from a limited number of case studies though case studies should not be used for 'statistical generalization'. Indeed he describes this as a 'fatal flaw' when case studies are chosen to be some form of sampling unit. Instead he promotes the concept of selecting case studies being akin to 'a laboratory investigator selecting the topic of a new experiment'. Therefore the method of generalization is what Yin describes as:

> "….'analytical generalization' in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed…Analytical generalization can be used whether your case study involves one or several cases."

Gummesson[3] points out that there are two types of case study; the first attempts to derive general conclusions from a limited number of cases (as in this research) and the second type seeks to arrive at specific conclusions regarding a single case because of some special interest in that particular case. Regardless of the contrast, the goal of the case study is to produce results that are of general interest with the purpose of providing sufficient evidence to promote further study, as is the case with this research. There are different types of case study as distinguished by Yin[4], exploratory, descriptive and explanatory. These can be defined as,

1. Exploratory: a pilot study that is used as a foundation for formulating more defined

questions or testable hypothesis.

2. Descriptive: a case study, which is used to describe an event or a phenomenon
3. Explanatory: a case study that provides a number of scenarios and attendant solutions to analyse a situation. This type of case study provides the solution to the problem or situation described with the possibility that the solution could be transferable to other similar situations.

Stake[5] (cited in Denzin and Lincoln) identifies three types of case study intrinsic, instrumental and collective. An ‘intrinsic case study’ is defined (like Yin’s[4] descriptive definition) as unique and provides insight into a phenomenon. The second type is the ‘instrumental case study’, which is defined as follows:

> “ In what we call instrumental case study a particular case is examined to provide insight into an issue or refinement of theory. The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else. The case is often looked at in depth, its contexts scrutinized, its ordinary activities detailed, but because this helps us pursue the external interest. The case may be seen as typical of other cases or not. The choice of case is made because it is expected to advance our understanding of that other interest.”

In this research the case studies carried out aimed to ‘investigate the pertinence of the models implied by existing quality initiatives in a real project environment…’ and as such matches the definition of an instrumental or exploratory case study supporting the theories that are provided in the concluding chapters. In addition, the secondary objectives of the research also aimed to provide a useful contribution to the existing project management body of knowledge, i.e. ‘advancing our understanding’ of quality in project management.

It should be pointed out that this assumes that the evidence in the case study has been reported in an unbiased manner, something that Yin[6] highlights can be a problem in using case studies. Part of this problem has been due to the use of case studies as a teaching tool, which has been altered to illustrate a particular principle. Yin differentiates between ‘case study teaching’ and ‘case study research’, and recognises that bias can enter into case study research and is difficult to overcome. It could be argued that Yin’s bias is Gummesson’s[7] ‘preunderstanding’ that the bias that an action researcher has when he enters the organization is in fact the interpersonal skills that helps facilitate the access to information.

2.2.1 Grounded Theory versus Hypothesis

The research examined two related issues, as stated by the primary objectives. It was possible to formulate a hypothesis to express the first objective to determine the pertinence of traditional quality management techniques to project management. This hypothesis was then tested primarily using case study No 2 Balfour Kilpatrick (Chapter 8) though the other case studies also contributed some insights into the validity of the hypothesis. Given the state of knowledge it was not thought appropriate to formulate and test a hypothesis for the second objective examining alternative quality models; there was a need for more exploratory research, as in Yin’s categorisation of the use of case studies. The case studies were thus used in a grounded theory approach to develop some alternative quality models. Future research could exploit these proposed alternative models using them to formulate a hypothesis, which might be tested in further case studies.

As stated earlier in Section 2.2, the types of case studies carried out in this research were typically exploratory (based on Yin’s categorisations). It was felt at the onset of the research that stating a hypothesis would introduce a bias towards the topic being analysed, in this case the pertinence of models implied by existing quality initiatives. Without a hypothesis the research would solely follow a ‘grounded theory’ approach, where the research would contribute to the formulation of the hypothesis rather than stating the hypothesis at the outset.

Despite this, there was a realization that the main underlying reason initiating the research was the authors disquiet about the validity of existing quality initiatives in the project environment. Hence it was valid to present a hypothesis as the research's first objective. These dilemmas were further compounded by the fact that the host organizations used for the research did not use a common quality initiative and were relatively diverse in comparison (their size, type of projects, marketplace etc). Therefore it is important to differentiate between the case studies to identify whether they prove or disprove the hypothesis, contribute to the formulation of further theory, or contribute to both.

As stated, the formal quality system in case study No 2 Balfour Kilpatrick (Chapter 8) was used to test the initial hypothesis, as it was the only case study where the project organization operated a 'formal' quality system (ISO9002). The roles of the CRC and db Houston case studies (Chapter 7 and 9 respectively) with their 'informal' quality systems provided background and evidence on what were the key drivers of quality in a project management environment reinforcing the findings in the Balfour Kilpatrick case study. The purpose of the London Ambulance Service case study (Chapter 10), which was created from secondary data sources, was as a triangulation point for the research to examine whether or not some form of quality management system or technique would have has an impact on the project outcome. The scale of participation and roles of each of the case studies is also discussed in Section 2.3.3.

These case studies provided an opportunity to explore what would be beneficial to project organizations as a system to enhance quality between projects. These case studies were providing the basis for the ideas and theory's that would lead to the alternative model in the second primary objective, '*To develop an alternative model as a basis for the management of quality in projects; this model will aim to rectify any deficiencies, identified in (1)* [the first objective]'. This objective had to be carried out using an alternative methodological approach. The second objective could not be fulfilled by the use of a hypothesis without the knowledge gained from the outcome of the first objective. Methodologically the approach taken with these case studies was more akin to 'grounded theory', where the researcher carries out the research without any preconceived hypothesis. Thus by using a grounded theory approach to investigate existing models and to formulate an alternative model for the management of quality in projects, future research might then make use of this work to formulate and test a hypothesis regarding the proposed alternative model.

2.2.1.1 Defining Grounded Theory

According to Gill and Johnson[8] grounded theory approach can be defined as,

> "The outcome of inductive research, that is, theory created or discovered through the observation of particular cases."

Attributed to Glaser and Strauss[9], grounded theory is seen as a relevant approach to generating theory, even from a limited number of cases,

> "Since accurate evidence is not so crucial for generating theory, the kind of evidence, as well as the number of cases, is also not so crucial. A single case can indicate a general conceptual category or property; a few more cases can confirm the indication."

For formulation of ideas and theories into the role of quality in project management there must be some investigation as to what happens at present in PM organizations. As discussed, the author had reason to doubt the validity of existing quality initiatives in a project environment and from this a hypothesis had been formed, but in the project organizations without a recognisable quality initiative there was a need to find out the role of quality in these organizations. Without an explicit quality system what did these organizations do to ensure they provided a 'quality' project? For the researcher the scope of the investigation of quality in projects had to broaden to include the complete project lifecycle. Therefore data was being collected prior to the formulation of the theories expounded in the later chapters (not withstanding the case studies supporting role for the researches first primary objective).

2.2.1.2 Case Studies vs. Questionnaires

According to Blaxter et al[1310] questionnaires are one of the most widely used social research techniques. For this research designing and constructing a questionnaire that contained valid and unambiguous questions on quality would have been very difficult without the respondent being able to put their answers in context. Questionnaires would only be answered by a limited number and type of personnel not necessarily sufficiently qualified to answer, thus excluding a large percentage of the possible other data sources, including the opinions of other personnel, observations, environmental factors, and the chance to discuss and relevant incidents that may have occurred during the course of their projects. Gill and Johnson[11] concur with this viewpoint, believing that questionnaire data can be of questionable reliability. It was felt that gathering data by questionnaire was not a holistic enough approach and the perceived disadvantages of having a small number of case studies to theorise from were far outweighed by the amount and quality of data collected. Another reason for avoiding questionnaires at this point in the research was the large element of exploratory research necessary, which required a more flexible approach to data gathering. As discussed in Section 2.2 the research carried out was more exploratory as explanatory. Whilst questionnaires were not suitable during this stage of the research, due to level of information required, it is possible that they could be used in later work, following the outcome of this research. Once the scope of future research based on the proposed alternative model has been synthesized enough to formulate specific and suitable questions, it may be possible to utilise questionnaires as a method of data collection.

Yin[12] puts forward the view that when there are questions to be asked that are of an operational nature with a timescale, case studies are a preferred research method. Rather than a ‘snapshot’ of the research topic what is required is a holistic picture of all the events and variables including any interactions that took place. Using a questionnaire to analyse a project would be fraught with problems. A number of questionnaires would have to be carried out over the length of the project lifecycle, which would be difficult logistically and may prove detrimental to the relationship with the researcher. Therefore although this case study research approach does not sample a large number of projects, its validity lies in the depth to which a topic is studied. As shown in the following extract Gummesson[13] argues that traditional methods of data collection are not particularly different whilst the researcher carrying out action research is surrounded with an abundance of data collection opportunities:

> “For example, the traditional distinction between field research (data obtained through questionnaires, interviews, observations, and participation) and desk research (the study of existing documents) seems to me to be increasingly artificial and is of little substance to the action scientist. The latter find themselves surrounded by a continuous flow of data: answers to questions, informal conversations, discussions at meetings, and the examination of existing documents and those that emerge out of an ongoing process such as budgets, plans, memos, reports, slide presentations, letters, faxes and press commentaries. The fact that some of the data appears on paper, film, or on a computer monitor while other data is communicated orally or by body language is not particularly important. It is the conversion of this data into information and conclusions that is of interest.”

2.3 Information gathering

2.3.1 The use of ‘preunderstanding’ as a starting point

The decision to utilise the experience gained by the author in the construction industry was initially taken to facilitate access to information. This allowed the observation of situations where the author’s previous knowledge could allow identification of processes, which had a marked effect on the quality of the work, or operations carried out. Indeed it was quickly realised that if there was an area where some service could be offered, the integration and thus access to information was achieved in a far more satisfactory manner than by using other research methods.

It was also recognised that the use of knowledge and past experience (what Gummesson[14] describes as 'preunderstanding') was not sufficient on its own, an empathy and a need to identify where and when it was appropriate to offer advice or opinions was also important, to prevent the alienation of the various 'players' in the host organizations. The formulation of Gummesson's[7] 'preunderstanding' is illustrated in Figure 2.1. To observe organizational politics was part of the research process, but to become involved in them was not. The assistance offered and taken was usually of a functional nature, which enhanced the relationship between the researcher and the company.

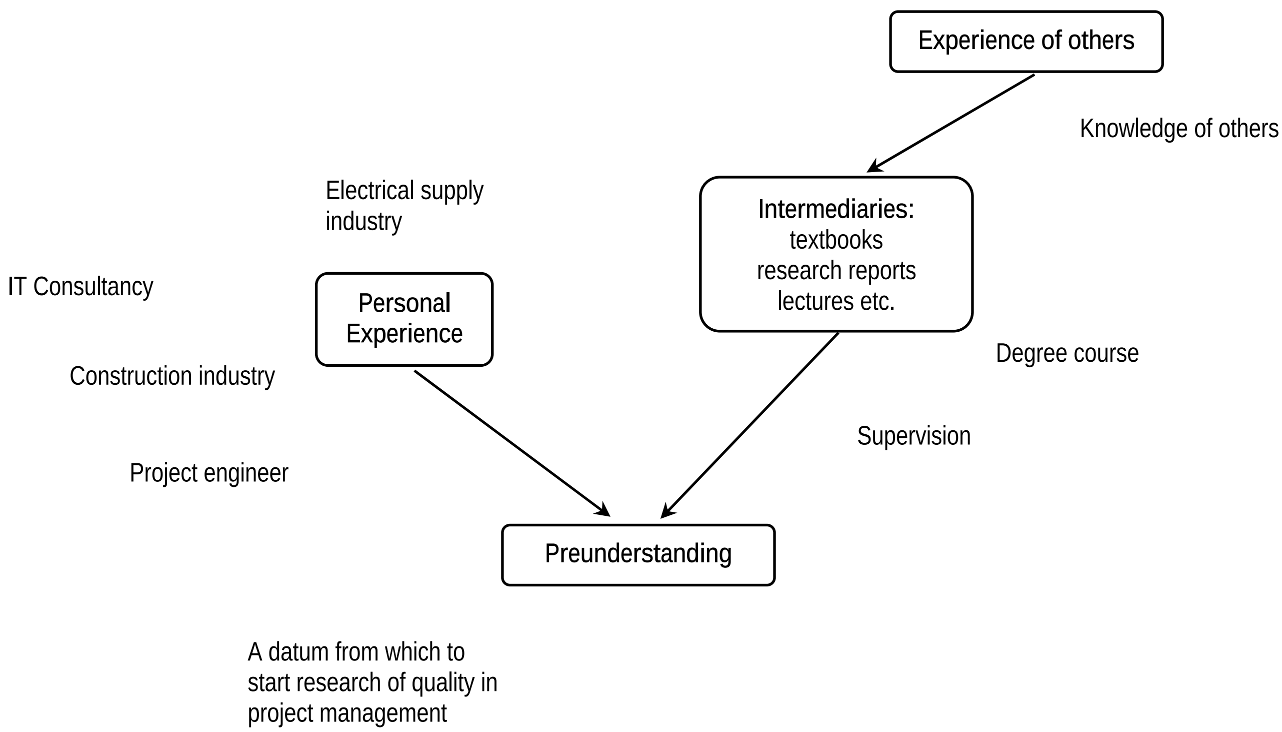

Figure 2.1 Sources for Preunderstanding (adapted from Gummesson)

In the process of examining types of qualitative methodologies, it became apparent that by using the authors previous experience and knowledge as a type of datum from which to access information, was a valid form of research. Indeed the role of researcher/consultant as advocated by Gummesson[15] appeared to be very appropriate. In his study of qualitative methods Gummesson[16] reinforces and expands this by outlining the attributes and elements required by a researcher in this role:

- The need for researchers to have had experience of 'decision making' and 'responsibility'
- Personal experience being an essential part of the gathering and interpretation of information
- Have the ability to change their preconceived view of the situation, if reality dictates it. To 'use their preunderstanding but are not its slave'.
- The researcher/consultant must be mature, open and honest.

An underlying theme in this type of research appears to be the need to be able to have a 'feel' or 'empathy' for the organization and the people involved. To achieve this aim, the researcher must obviously devote time to being in the organization (observing at as many levels as possible) what the organization does, how it does it, and the interplays and scenarios that can take place. From this, a holistic picture of the organization can be constructed, which can facilitate the analysis of its strategies or operations. There is a strong argument for this type of participatory research technique, in that the researcher becomes part of the organization, successes and failures can be experienced first hand, which can be far more informative and should be more accurate.

2.3.2 Participant Observation and Action Research

The main information gathering approaches used in this research has been 'participant observation' and 'action research' to aid the access to valid data. The choice of case studies was also partly determined by the available skills of the author, which facilitated the data gathering method used.

2.3.2.1 Defining Participant Observation

Participant Observation (PO) has been described by Vinten[17] as an integral feature of Action Research. According to Easterby-Smith et al[18] it has been developed from the area of ethnographic research where researchers would live with tribal cultures to develop an understanding of the indigenous peoples way of life. In management research organizations are viewed as the ‘tribal cultures’ under investigation. PO is based on subjective interpretation and as such is open to criticism for lacking scientific rigour. Gill and Johnson[19] neatly summarize what was a key reason for the use of PO in this research with the following,

> “This field role usually enables a great deal of depth in research since it allows the researcher to get very close to the phenomena of interest ‘catching reality in flight’ by experiencing the often hidden experience … participant observation can enable the researcher to penetrate the various complex forms of ‘misinformation, fronts, evasions and lies’ that are considered endemic in most social settings, including business. … discovered it can enable access to what people actually do (the informal organization), as opposed to what they might claim they do and which official sanctions impel them to do (the formal organization).”

In Chapter 8, the Balfour Kilpatrick case study, there is a clear example of the difference between the ‘informal’ and ‘formal’ systems used to implement quality. Discovering this difference using other means would have been very difficult. The key objective of this research was to investigate the pertinence of existing quality initiatives in a real project environment. One of the rationales behind this objective was the notion that there was a mismatch in application of quality initiatives and the project management environment; therefore using PO was essential to determine the validity of this hypothesis.

2.3.2.2 The criteria for participant observation and the relevance to this research

Collins[20] succinctly describes the two approaches open to the researcher when carrying out 'participative observation':

> "A standard approach to participant observation treats the options available to the researcher as lying between complete participation-with associated difficulties of observation and total concentration on observation with hardly any participation."

Due to the complex and sometimes esoteric nature of the topic i.e. quality, a large amount of time and effort had to be invested in putting forward the current views, hypotheses and thinking in quality management to the party being interviewed (contrary to many quality management text not every organization has been exposed to quality management or its systems). This usually led to the informant giving their opinions on quality, how they measured or defined quality, and how they achieved this quality in practice. Interviews were frequently carried out on an ad hoc basis, which provided the flexibility to obtain sufficient time with key personnel despite being time consuming for the researcher. This approach provided a more relaxed environment for the interviewee, which the author believed, led to more accurate data. Blaxter et al[21] describe the various properties of an unstructured interview as naturalistic, autobiographical, in-depth, narrative or non-directive. This method of data collection although occasionally haphazard and time consuming was of far greater validity than for example the use of a survey by questionnaire.

When does Participant Observation become Action Research? Both methods depend on gathering qualitative data (and sometimes quantitative data), through the presence and participation of the researcher in the organization being researched. The difference appears to be in the levels of 'active intervention' that occur between the researcher and the organization. Figure 2.2 illustrates a scale of participation based on Junkers Continuum (cited

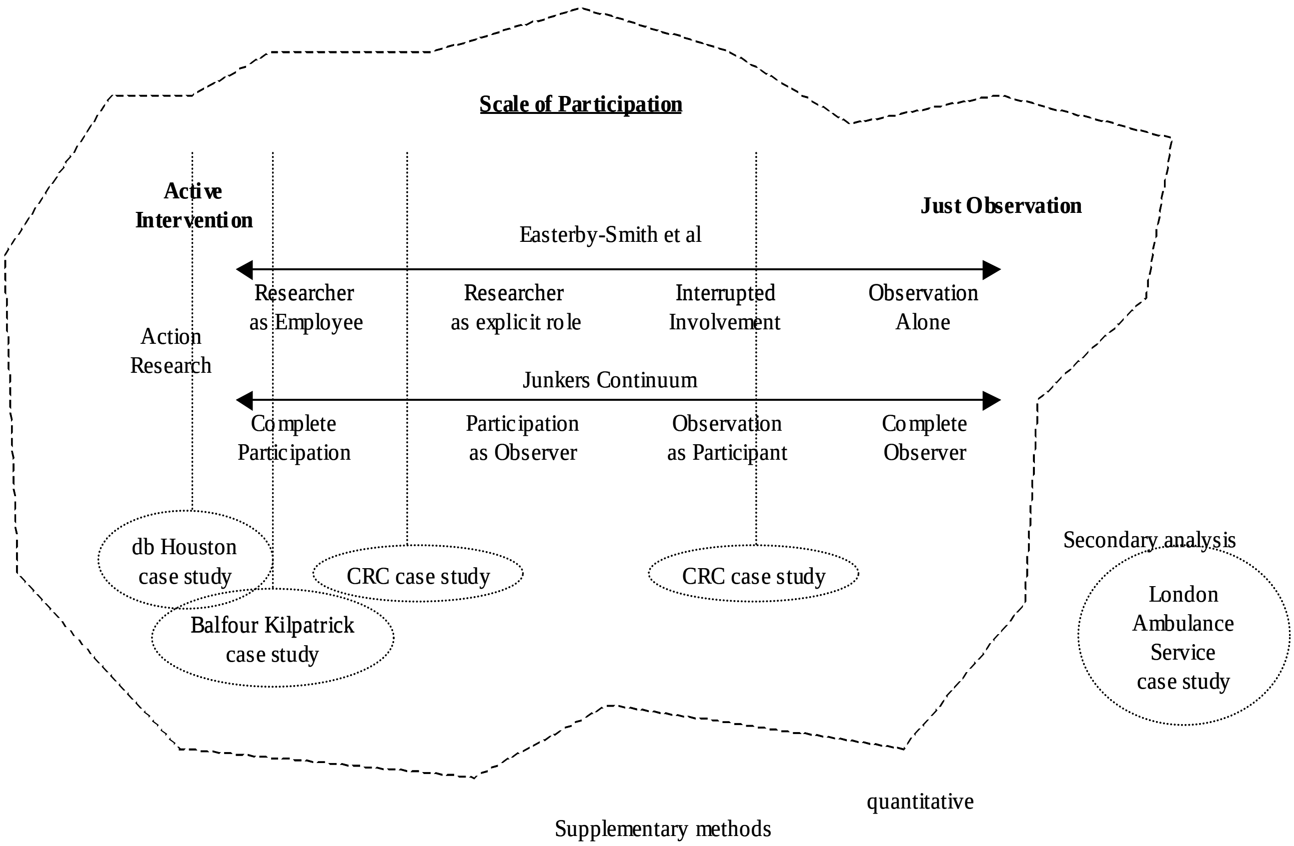

Figure 2.2 Estimating the scale of participation using Junkers Continuum & Easterby Smith

in Vinten[17]) and Easterby-Smith's[22] classification of research roles. The case studies used in this research are placed along the scale in relation to the activities carried out by the author. The boundary shown on the diagram denotes the supporting methods that supplemented the primary data collection methods, which in this research was the London Ambulance Service case study (Chapter 10). This case study is used for the purposes of triangulation, and will aim to conclude whether or not some form of quality management system or technique would have either have successfully terminated the project or chosen a more suitable consortium.

2.3.2.3 Defining Action Research

The action research approach cited by Boon and Ram[23] comprises three main features: intent to take action on an organizational issue; an explicit concern with theory formed from the characterisation or conceptualisation of the particular experience; a process of continual reflection. It is primarily the second of these features that has created the basis for the majority of this research, in the context of project management, and again was evident at one of the case studies (Chapter 9 Case Study No.3 db Houston.). The 'explicit concern with theory' was expressed in Chapter 1 as the first objective of the research: "To investigate the pertinence of the models implied by existing quality initiatives in a real project environment and their possible contribution to future project success."

Some authors give preference to the term Action Science over Action Research. Argyris et al[24] reason that action researchers can restrict themselves to more traditional methodologies based on positivistic approaches, which as Rubenowitz[25] (cited by Gummesson) explains is often considered as the correct way to carry out research:

> "The predominant research tradition in the social and behavioural sciences has been of a quantitative, empirical nature. This research tradition can be considered to be still prevalent. It is based on the statistical analysis of data collected by means of descriptive and comparative studies and experiments. This approach is usually termed positivistic."

Whilst these differences are worth highlighting they have not exposed any fundamental differences between the two terms therefore for the purposes of this research the term action research will be used. Gummesson presents eight criteria based on a synthesis of two other studies for the use of action research (science) in management research. Table 2.1 presents these criteria and briefly puts them into the context of this research.

2.3.2.4 Action Research in Practice

It became apparent that to access relevant and useful data, the author would have to integrate into the organization in a way that engendered a mutual respect and trust. In the course of carrying out research in a small construction company, the opportunity arose whereby the author could contribute in a practical operational capacity to a current project. Indeed, having been involved in a similar type of industry it was initially very difficult to remain a dispassionate observer when certain activities were taking place. In the first case study a type of compromise was reached which as described earlier involved the author only getting involved in technical issues that were of a functional nature. The later case studies involved the author in a more in depth capacity.

In the first case study (Chapter 7) the participation of the author and the role in which he played increased as the relationship between the two parties developed. The following categories used by Gummesson[26] describe the types of role that the researcher can assume in a host organization (including examples from this research),

> <u>Practical/Advisory Role</u> - This involved using knowledge and expertise from the author's previous occupation to carry out specialised tasks on a particular project. The events are listed in approximate chronological order and although it is perhaps not apparent from the descriptions given, the involvement and 'access' to data increased as the relationship developed between the two parties.
>
> Prior to an exploratory excavation for a disused pipeline the author carried out a cable search to try and locate any live apparatus in the vicinity of the excavation, two 11,000Volt cables were found. A recommendation regarding the method of pipe removal due to the proximity of the live cables was also given. This was because of the alarming nature in which a subcontractor was removing the pipeline, which could

have resulted in an operative or a member of the public being injured. Advice on the location and depth of other cables (underground and overhead) was also provided during the Lidl project described in Case Study No.1, Chapter 7, Section 7.5.

The author provide IT hardware and software advice when upgrading office equipment as well as providing some basic training. The demonstration of a current project management package was very interesting because of initial research into project management software packages and their usability. It demonstrated the lack of built in quality measurements in these applications. The primary use of the package was in the compilation of tender documents and proposals where Gantt charts were extensively used. Recent legislation in the form of Construction Design and Management (CDM) regulations has put further onus on organizations to produce documented programmes, which may increase the popularity of these types of software applications.

<u>Contributory/Team member Role</u> - This role involved the author becoming part of the 'team' in which decisions were being made. This role did give any tangible control to the author, but it did allow him to contribute ideas, influence decisions and witness the processes that led to actions being taken. An example of this was during the formulation of an alternative strategy and proposal on a project for Railtrack (Case study No.1, Chapter 7). In making valid contributions to the process, the researcher was able to become part of the 'team' that were trying to solve a particular problem to allow an objective to be met.

In the second and third case studies the author also was heavily involved in the project process, as a project engineer and as an assistant systems engineer. These roles are described in detail in Chapter 8 and 9.

It could be argued that if the researcher is in the position to become part of the process then he/she will alter the dynamics of the situation therefore any data collected will be distorted because of their involvement. Edstrom et al[27] endorsed that the researcher could influence the behaviour of the informants, but that this lessened as a relationship was established providing that both sides could see that it was a mutually beneficial process. It should be noted that Edstrom's study into a construction company was carried out using researchers who on the whole were maintaining a neutral position and just observing. This 'fly on the wall' technique initially appears to offer an incorrupt method of data collection, but it is expensive and it is debatable whether any researcher can be unobtrusive enough to actually allow normal day-to-day activities to take place:

> "We are aware that human systems that are the subject of observation and study are liable to be influenced ...However, this influence tends to decline as confidence is gradually built up between the researchers and those who are affected by the study. The possibilities of establishing a spirit of trusting cooperation are particularly favourable in relation to longitudinal studies, provided that the researchers have succeeded in persuading all the parties involved that it is in their mutual interest."

Table 2. 1 Comparing the criteria for Action Research and the relevance to this research

	Criteria for Action Research	Meeting the criteria in the context of this research
1)	Action research always involves two goals: solve a problem for the client and contribute to science. That means that you must be both a management consultant and an academic researcher at the same time.	Provide engineering expertise, IS training and advice to the three main case study host organizations, whilst investigating the prevalence and importance of quality initiatives in project management.
2)	During an action research project those involved – the researcher/consultants and client personnel- should learn from each	The author as a 'change agent' was in the position to expose the host organization to theories and techniques that in some cases it previously had not had access to. In addition

	Criteria for Action Research	Meeting the criteria in the context of this research
	other and develop their competence.	providing explanation for underlying quality theory that was behind quality initiative (e.g. the implementation of ISO9000 in Case Study No.2)
3)	The understanding developed during an action research project is holistic.	The use of complete projects, allowed a holistic perspective to be taken on the project process and the role of quality in that environment. Whilst reflecting on present quality practices in project management the concept of the learning project organization was formulated.
4)	Action research requires cooperation between researcher/consultant and the client personnel, feedback to the parties involved, and continuous adjustment to new information and new events.	Described as an 'iterative cyclical process' by Gummesson, in this research the cooperation between researcher/consultant was very good, with continuous feedback between all parties. In Case Study No1 the host organization would contact the author to update him on important developments that they believed would be useful for this research, leading to a useful long-term relationship being formed.
5)	Action research is primarily applicable to the understanding and planning of change in social systems.	The application of quality initiatives in Project Management produce changes to the social systems found in the PM environment, therefore this research meets this criteria on those grounds.
6)	There must be a mutually acceptable ethical framework within which action science is used.	In this research all the participant were aware of the research being carried out, although as Gummesson describes there are situations were it is acceptable, indeed necessary in some situations to carry out a research project that can produce conflicting or controversial studies in relation to one or more groups of the research topic
7)	Preunderstanding of the corporate environment and of the conditions of business is essential when action research is applied to management subjects.	Possibly the most important point in relation to this research, and elaborated further in the following section, preunderstanding of the environment studied provided unparalleled access to original data.
8)	Action research should be governed by the hermeneutic paradigm although elements from the positivistic paradigm may be included.	In essence action research should not be evaluated as per existing research methodologies. In this research the decision to carry out case studies on particular topics was governed by a number of factors (e.g. the ability of the author to offer a valid service) that may appear to be unconventional when compared to more traditional research methodologies.

2.3.3 The Roles of the Case Studies

In analysing the research techniques carried out in this research a combination of action research and participant observation was used. Table 2.2 categorises what techniques were used in each case study. The scale of participation shown in Figure 2.2 is also displayed.

Table 2. 2 Classification of Case Study Roles, Information Gathering Techniques and the Relation to the Objectives

Case Study	Role of Case Study	Information Gathering Technique	Relation to Objectives	
CRC Gabions	Observe complete projects to determine the role of quality in a project organization without a explicit quality system In this grounded theory role this case study provided support for ideas generated later on project learning	Participant Observation – researcher as explicit role and interrupted involvement	Used to determine what drives quality in a project environment	Provided a case study to focus on the topic of quality in project management
Balfour Kilpatrick	Determine the relevance of an existing quality system in a project environment providing evidence to refute or confirm the research's main hypothesis.	Participant Observation – researcher as employee	Investigating the pertinence of the industry standard quality system in a real project environment and its contribution to project success	Provided a case study to focus on the topic of quality in project management
db Houston	Investigating the quality criteria in a project company which has a service element in its projects Investigating how a project organization satisfies the 'real needs' of its customers. In this grounded theory role this case study provided support	Characteristics of Action Research - researcher as employee	Used to determine what drives quality in a project environment (as for CRC case study)	Provided a case study to focus on the topic of quality in project management

Case Study	**Role of Case Study**	**Information Gathering Technique**	**Relation to Objectives**	
	for ideas generated on the use of SERVQUAL as a valid model for measuring quality in projects			
London Ambulance Service	Case study of a project which failed for which there was a large amount of background material in the public domain	Secondary 'desk based' research	Case study used as a triangulation for primary case studies	Would a quality system or technique resulted in the early termination of the project or a better choice of consortium?

Each of the three primary case studies all contributed to the development of an alternative model either based on the positive and negative attributes discovered. Additionally these case studies will support the third research objective of '…*focussing on the topic of quality in project management to provide a useful contribution to the existing project management body of knowledge*'. In the case of the action research technique it could be argued that the level of change produced in the host organizations was not enough to warrant this title, yet making organizations aware of the models, techniques and theories that affected the quality of their projects was believed to be very beneficial in itself. Indeed, by introducing these theoretical concepts it has (in the case of db Houston and Balfour Kilpatrick) become a catalyst for change in analysing how they carry out certain aspects of their business.

2.3.4 The difficulties in developing an alternative model

The two topics that form the backbone of this research are Project Management and Quality Management. At the outset various proposals were put forward as a means of achieving the second of the primary research objectives, which was to develop an alternative model as a basis for the management of quality in projects. This model would encapsulate the difficulties and unforeseen problems that were encountered during the activities in a project, and the methods used to overcome them (whether they were successful or not). The 'project quality model', would attempt to provide a database, or repository of information that could be used in future projects. The construction of the model was to be based on a combination of inputs,

- The author's own experience as a project engineer,
- Existing well documented case studies taken from literature,
- Proposed fieldwork carried out in the course of this research,

In the event, the 'model' arising from this research is a proposed way forward, rather than a rigorous, structured validated model. Projects can be viewed as either successful or failures depending on what viewpoint taken e.g. the Channel tunnel appears to be a technical success, but it has been viewed as a financial failure due to a variety of factors. To investigate and examine these variables are possible but the length of time and resource needed would be prohibitive. Also organisations of any size are not particularly forthcoming about their failures, and this appears to be especially true for project orientated environments like for example, the construction industry. This comes as no surprise considering the increasingly competitive marketplace, where unsuccessful projects can jeopardise future orders. It has been the author's experience that companies will even take on projects, which will be financially unviable just to stay in the marketplace.

Accessing sensitive data that highlights failure in a project is very difficult, indeed in many cases the data does not exist, except in the experiences of the people carrying out the project. The very nature of projects means that they are usually staffed by a unique project team that is disbanded on the completion of the project. The experience that they have gained over the course of the project remains with them, but if they leave the organization this qualitative (and very important) data goes with them. What is needed is a mechanism that provides feedback between projects. The proposed quality model attempts to examine how this data could be captured and utilised preventing the haemorrhage of knowledge from the project organization. Creating a knowledge database from the captured data would promote a feed forward mechanism to improve the success rate of future projects.

2.4 Conclusion

The case study approach utilising participant observation and action research appears to have been the most appropriate way of acquiring presenting original holistic data allowing the topic of quality in project management to be explored in considerable depth. These techniques allowed unprecedented access (and confidence), which would not have been gained from interviews alone providing greater honesty and improved quality of data for the purposes of the research. The dilemma over what comes first the theory or the data has hopefully been explained satisfactorily. It is recognized that there is typically a compromise in most research methodologies, and as Pettigrew (cited in Gill and Johnson[28]) comments of the research process,

> "[It is] characterised in the language of muddling through, incrementalism, and political process than as rational, foresightful, goal-directed activity".

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Chapter 3

Quality Systems in Theory

3.1 Chapter Synopsis

This chapter examines the theoretical arguments behind the research and provides the framework of ideas upon which it is based. In particular, the role of the quality management system used by the ISO9000 set of standards, its merits and shortcomings and whether or not this type of system produces a valid and useable form of feedback between projects. The case study in Chapter 6 is an example of a project that was carried out by an organization approved to a recognised industry wide quality standard ISO9002: 1994, Quality Systems – Model for quality assurance in production, installation and servicing. (ISO – the International Organization for Standardization). The ISO9000 standards are a generic group of standards formulated with the purpose of providing ‘guidance for quality management and models for quality assurance’[1]. The standards are intended to be independent of any one industry or economic sector. There are 52,000 businesses registered to ISO9000 in the UK[2], and in many industrial sectors it has become a prerequisite to be allowed to tender for new contracts. Quality systems have largely been developed to support operations management. Several have been transferred and applied in project management. This chapter describes the relevant systems; later chapters will analyse their potential in project management.

This chapter has the following objectives,

- To define the theoretical concept of the quality management system, specifically the template provided by ISO9000.
- To outline the theoretical role of the ISO9000 quality system in the context of project management in particular it’s objectives and its role in promoting feedback between projects.
- To extend the framework of ideas and theory introduced in Chapter 1 that contributed

to the formulation of the researches primary and secondary objectives.

3.2 Defining the Quality Management System

The terms Quality Management System (QMS) or increasingly the Quality System (QS) are used to describe an explicit, controlled, documented system of procedures. The QMS is designed to ensure the customer only receives a conforming product or service[3]. Traditionally, the QMS is a standalone function in the organization, devolved from other aspects of the business. Whilst Munro-Faure[3] sees the QMS as one element of Total Quality Management, Oakland[4] actually gives a far broader definition of the quality system,

> "… an assembly of components, such as the organizational structure, responsibilities, procedures, processes and resources for implementing total quality management."

This demonstrates the ambiguity between various texts as to the scope of what constitutes a quality management system. Additionally, this led to the absence of the term in the 1997 versions of the ISO9000 standards[5]. Whilst Munro-Faure's definition is more simplistic, the impact of the system it describes is commensurate with Oakland's fuller definition. Therefore the fact that most quality literature typically outlines the documentation used to create a quality system it does not reduce the impact it creates when implemented in an organization. Regardless of this, the majority of quality management literature still refers to the QMS; therefore it is still valid to attempt to give a definition of the concept.

3.2.1 The Purpose of a Quality Management System

The purpose of the QMS is to create a mechanism that looks after the well being of both the organization, and the customer, by a symbiosis of the customers needs (both perceived and actual) and the organizations needs (internal and external). An attempt by the author to conceptualise this relationship is shown in Figure 3.1. According to Munro-Faure[6] an

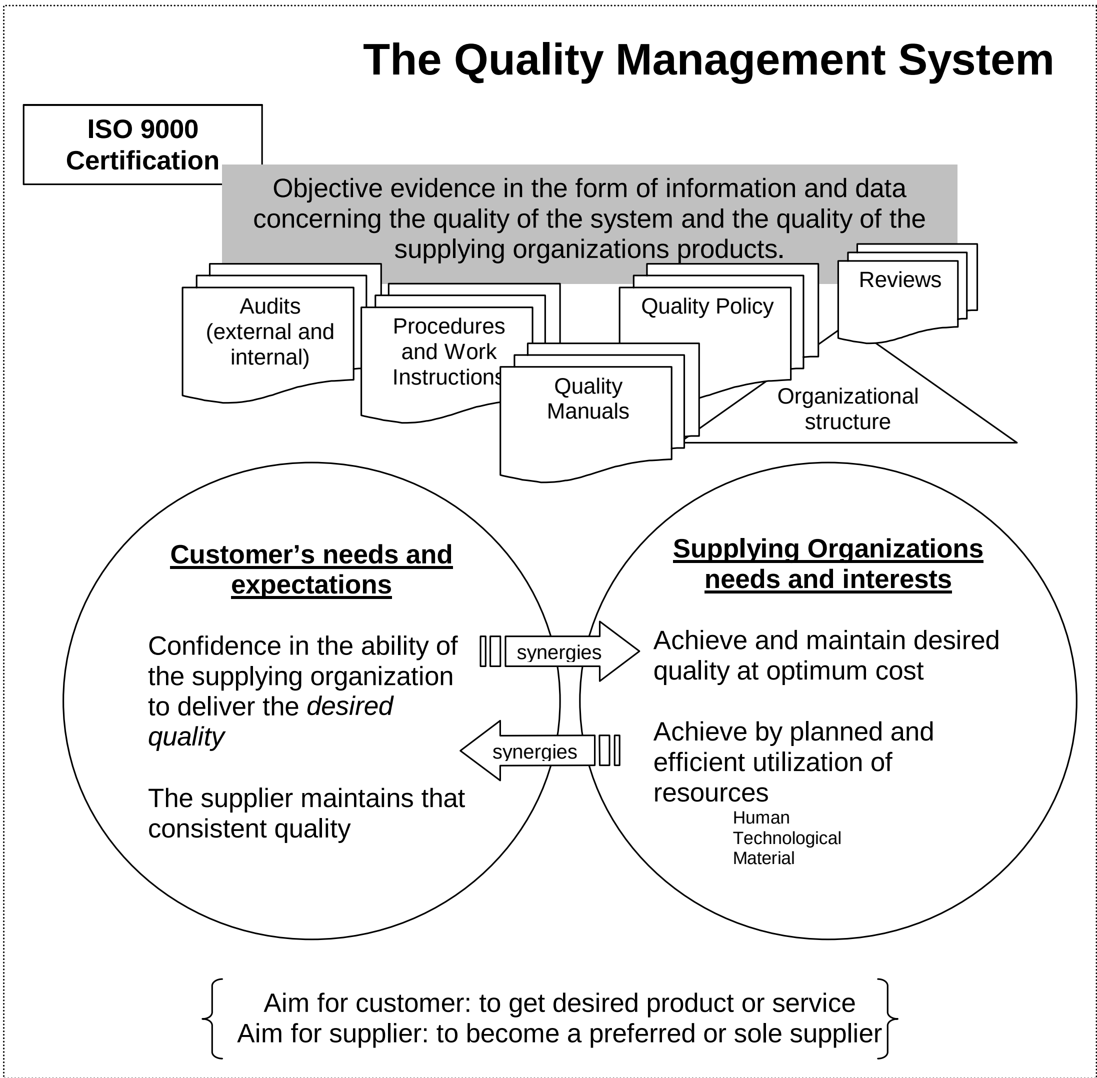

Figure 3.1 Theoretical Requirements of the Quality Management System

organization implements a quality management system to document and control its activities to provide assurance to its customers that the company is committed to quality and is able to supply products and services in accordance with their requirements. The implemented quality management system seeks to address the shortfall resulting from the customer receiving products or services that does not meet their expectation; it attempts to make the feedback process more formal and explicit. Being unable to supply the customer with the desired quality of product has been the raison d'être underpinning the whole quality management movement, quality, or the lack of it, being seen as the reason for the failure of Western organisations in the global marketplace. The domination of Far East organizations and products in the world due to their superior quality is well documented and has led to the quest for a way that provides a 'Holy Grail' of quality. The approach taken by the quality management profession in the UK and the government[7] has been to sponsor and promote the implementation of quality initiatives in particular the ISO9000 series of standards.

3.2.2 Quality Management Systems in Project Management Literature

Existing information in project management literature on the effects of generic quality management systems on project management organisations is generally standardised. In project management literature the theme of 'controlling and managing quality' is a common one and is invariably followed by the need to implement a quality system to achieve this aim. Theories and reasoning why quality systems like ISO9000 should be applied are reiterated frequently by project management text often without discourse to the actual effects or problems to the organisations themselves. Maylor[8] gives a typical description of the ISO9000 standards and the requirements that he believes influence the project manager,

- The need for a quality manual to describe how the system works.
- The need for regular meetings with the customer to determine the approval of the customer/sponsor and to review requirements.
- Design becomes a process rather than an art and is expressed as such.
- The need to audit the system regularly.
- People are adequately trained to carry out their tasks and can prove this by producing certification e.g. National Vocational Qualifications (NVQ's) etc.

These points reproduce what is in the standard itself. It is acknowledged that Maylor[9] does identify and warn of the ‘thousands of working hours’ that approval to the ISO standard process can take, but there is no mention as to the effectiveness of the system itself. The example given by Maylor in the context of project quality is of the manufacturing company JCB, which may indeed carry out projects but is primary function is production in a relatively stable environment. Although perhaps not directly relevant to this research it is interesting to note the mention of NVQ’s, as a qualification to enable verification of personnel’s competence. In an earlier piece of research[10] for the Institute of Quality Assurance in 1994 the author carried out a survey to determine the membership profile of its members. The IQA were particularly interested in the take up of the relatively new National Vocational Qualifications amongst its members. The survey carried out in 1994 showed that only 5% of the respondents had some form of NVQ. Unless there has been a substantial increase in the uptake of NVQ’s or there is a compulsory element involved in obtaining the qualification (as in the social and health care sector) it appears unlikely that it would have a significant impact on the ability to verify the ability of the holder. Analysis of the impact of the ISO9000 series of standards on project management organisations has not been found in the literature examined in the course of this research; the Balfour Kilpatrick case study of provides a rare example of such an analysis.

3.3 The International Organization for Standardization and the ISO9000 standards

The International Organization for Standardization (ISO) is a global alliance of national standards bodies (e.g. Institution of Mechanical Engineers, Ministry of Defence). These are the ISO members. The ISO has technical committees on which relevant ISO member bodies can be represented. The technical committees work with governmental, non-governmental and other international organizations. Standards have to be approved by 75% of the ISO membership before becoming ratified. The main ISO9000 standards are shown[11] in Table 8.1. ISO9000 itself is the guide to the other three main standards.

Table 8 .1 The main ISO9000 standards

ISO 9000:1994, Quality management and quality assurance standards (made up of 4 parts) Part 1: Guidelines for selection and use Part 2: Generic guidelines for the application of ISO9001, ISO9002 and ISO9003 Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software Part 4: Guide to dependability management
ISO 9001:1994, Quality systems – Model for quality assurance in design, development, production, installation and servicing.
ISO 9002:1994, Quality systems – Model for quality assurance in production, installation and servicing.
ISO 9003:1994, Quality systems - Model for quality assurance in final inspection and test.

The latest vision and mission statements produced by the ISO committee responsible for revising the ISO standards are as follows[12]:

> "Our vision is that, through its world-wide acceptance and use, the ISO 9000 family of standards will provide an effective means for improving the performance of individual organisations and providing confidence to people and organisations that products (goods and services) will meet their expectations thereby enhancing trade, global prosperity, and individual well-being…Identify and understand user needs in the field of quality management, develop standards that respond effectively to the expectations of users, support implementation of these standards, and facilitate meaningful evaluation of the resulting implementations."

In summary the ISO believe that the ISO 9000 standards improve performance, lead to better products and services and produce beneficial standardisation across industries and countries.

In the context of project management that is assumed to mean that the systems the standards produce should create a positive benefit in the life cycle of the project including its execution phase and to the project organization. It appears that the quality system is attempting to formalise the feedback process, by giving it some form of structure and framework for the organisation implementing it. What was of particular interest to this research was the usefulness of the feedback available between each project and the mechanisms employed to gather, assimilate and distribute the data for use by the project organization.

3.3.1 Timescales of Feedback – the key to Quality in Project Management?

A critical factor in project success is the speed with which an organisation reacts to environmental factors at both the operational level and at a strategic level, which is determined by feedback. This affects the quality of the project management, which can ultimately lead to the success or failure of the project (as demonstrated in Chapter 8, Section 8.22.3). Continuous improvement is the philosophy behind Total Quality Management (TQM), which can be only achieved through feedback. Any positive benefits achieved within a project are gained by 'immediate action feedback' i.e. the reaction to an event or incident in the project environment, and subsequently the longer-term gain of knowledge through experience. This is the knowledge and experience that project personnel gain through the course of the project and is carried by them throughout their careers. If the organization is to gain from this it has to harness this knowledge and create a feedback (or feed forward) route to contribute to future project success. In essence to become a learning organization as espoused by authors like Senge[13]. The questions that have to be asked of ISO quality systems are as follows,

- Do the quality systems created, give effective feedback over the course of a single project or is it a process, which is only beneficial over the longer term involving several projects?

- Do they respond quickly enough to provide feedback in the project management environment i.e. between projects?

To answer these questions the main case study of the research (Chapter 8) is used as a case to examine ISO9000 in a project organization. By studying the complete project process, the effectiveness of ISO9000 can be gauged and the outputs that are created by the quality system can be examined to determine their applicability in providing valid feedback between projects. Whilst the timescale of the research can only encompass one project in its entirety, the organization used in the case study has operated the ISO quality system for a number of years; therefore evidence of feedback from past projects should be available to suggest whether or not the quality system has been effective feedback has been available from past projects.

3.3.2 ISO9002 - A model for quality assurance in production, installation and servicing

The main purpose for the quality system standard ISO9002 is its use as an external

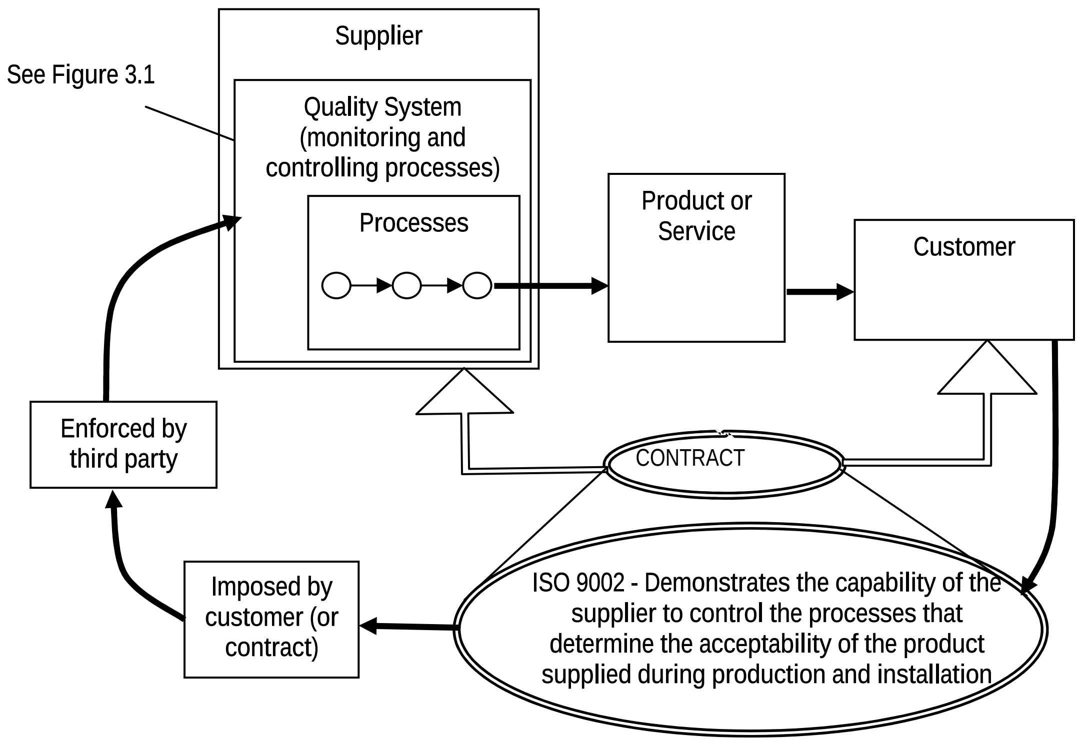

Figure 3.2 ISO9002 its position between supplier and customer

contractual verification of the capability of the supplier to implement a system. This system monitors the processes that constitute the product or service that they provide. Figure 3.2 illustrates the position of the ISO9002 standard in the contractual relationship between the customer and supplier. The monitoring and controlling of processes by the quality system in theory should lead to a product or service that will meet the customers' needs. Mayler [14] gives two more reasons for having a quality system in place, protecting the organisation from legal liability (both professional negligence and product liability) and as a prerequisite for tendering for business. Are these attributes valid? Further investigation would be needed to find evidence to suggest that an implemented quality system can reduce the liability of an organization, although Seddon[15] regards the use of a ISO9000 standard in contractual disputes between customer and supplier as untenable because the standard 'does not and cannot guarantee the quality of the product…' During the course of this research no evidence was found of companies using ISO9000 certification as a legal defence in cases of liability.

Bounds, Yorks et al[16] make a distinction between the terms 'systems' and 'processes' of Figure 3.2 believing that managers (and some authors) treat them as one and the same. Their view is a system is made up of many different processes, all of which create complicated relationships with each other and are not easy to illustrate with diagrams or flowcharts. It is difficult to illustrate these relationships although not impossible. Therefore it is a valid and important point to distinguish between 'systems' and 'processes', as project management is ostensibly about managing processes in a system. This is important as the failure to manage a process in a project very seldom goes unpunished, due to the interdependency of all the processes.

3.3.3 Alternative Models to represent Project Management

The emphasis of Quality Management on the need to adopt a systemic view and foster constructive forms of feedback advocated an examination of the merits of methodologies such as Systems Thinking (ST) and System Dynamics (SD) which are underpinned by their origins in control engineering and the principles of feedback. As will be seen from these methodologies in Chapters 5 and 6 the graphical representation of systems is conceivable although it arguably remains peripheral to the existing mainstream traditional project management environment. Another form of representing systems is Soft Systems framework developed by Peter Checkland.[17] This methodology was created to identify intractable problems and provide solutions in real life organisational systems, which are illustrated by modelling the interactions in a 'Rich Picture' as shown by Figure 9.3 in Chapter 9.

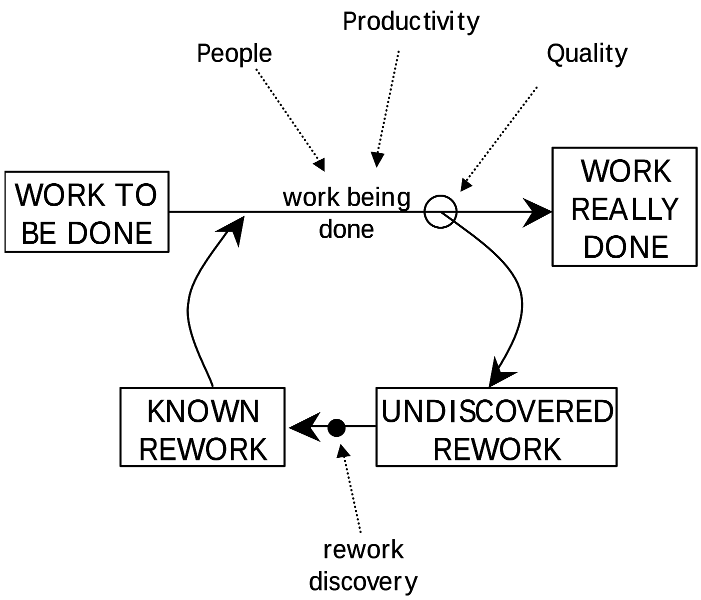

Figure 3.4 The Rework Cycle (Cooper 1993)

It is claimed[18] that that there is a need to radically overhaul existing graphical project management tools like CPA or PERT, which despite having made the media transition to personnel computers are still incomplete as a way of representing the project, the project management environment and its many interactions, in particular the feedback so critical to quality management. Applications typified by products like Microsoft Project whilst useful for frontline project management, tend to be primarily scheduling tools and do not provide an ideal medium for capturing the essence of the project. Cooper[19] expands this viewpoint by branding these tools as ‘misleading’ because they operate under the erroneous assumption that projects do not work as a sequential sequence of tasks, but ‘in an iterative process of accomplishment’. By assigning a generic model of project behaviour called a ‘rework cycle’ to project activities, an estimation can be made as to the real effect of project decisions which are typically based on more conventional PM thinking. Figure 3.4 reproduces the structure of rework cycle[20], and explicit illustration of quality in project management.

What is interesting about the rework cycle is the inclusion of a quality quotient, which attempts to simulate a real world project situation where no task is carried out completely correctly. It should be noted that the projects that Cooper[20] describes in his articles are typically complex development projects, which are ‘dominated by design/engineering

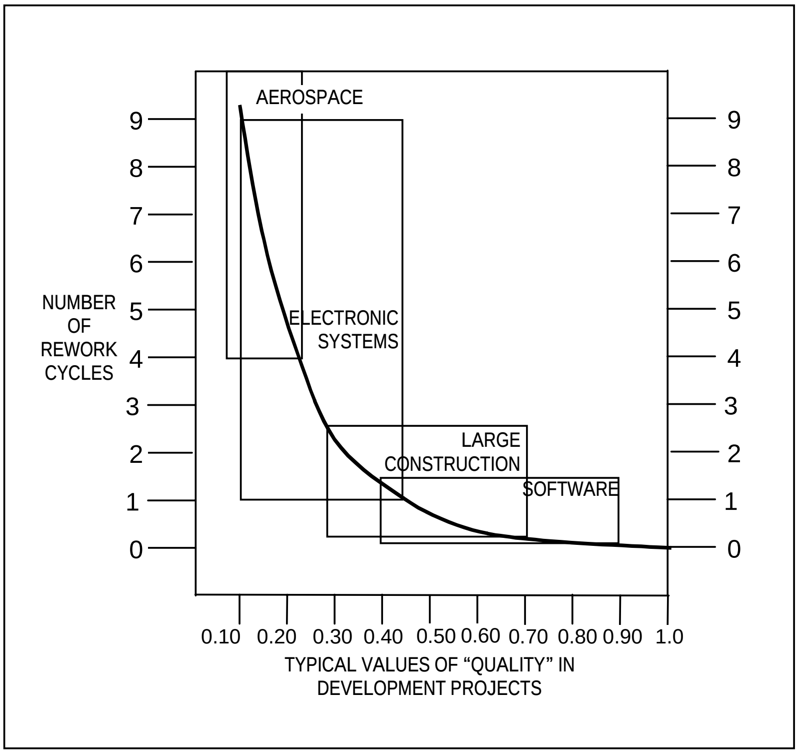

Figure 3.5 Quantifying Quality (Cooper 1993)

activity to develop a new product or system’. Figure 3.5 reproduces the graph that quantifies the quality quotient in different development projects in different industries. The form of the empirical data used to create this graph is not specified, which appears to leave a gap in the concept of quantifying quality. Whilst the primary case studies in this research could not be classed as development projects, the concept of the ‘rework cycle’ appears to be a viable alternative in representing quality in the project life cycle. The rework cycle appears to focus on the consequences of both detected and undetected rework of activities in a project, rather than between projects, although there is recognition that by identifying the true causes of project failure, future projects can be enhanced[19],

> “…so long as we attribute blame exclusively to individual project circumstances as though they were unique, we prevent ourselves from learning true systemic causes and transferable project management lessons.”

The concept of the learning from past projects shall be investigated further in later chapters.

3.3.4 The continued influence of manufacturing on the ISO9000 standards

In the 1994 version of the ISO9000 standard the considerations for implementing a quality management system are described as regards its significance to the customer and to the organisation involved. Although not readily apparent it is assumed that these considerations are given to strengthen the justification behind implementing a quality management system. Table 3.2 summarizes these considerations, which are somewhat idealised and do not identify more pragmatic issues, like for example the cost of implementation, the maintenance of the system, its efficiency as a feedback mechanism and the effects on the day to day running of the organisation.

Table 3.2 The significance of ISO9000 to the Customer and the Organization

	Customer	Organisation
Benefit Considerations	Reduce costs, improve fitness-for-use, increased satisfaction, growth in confidence	Increased profitability, Market share
Cost Considerations	Safety, Acquisition cost, operating, maintenance operating and repair costs, Disposal costs	Marketing and design deficiencies, Unsatisfactory product, rework, repair, replacement, reprocessing, Loss of production, Warranties and fields repairs
Risk Considerations	Health and Safety people, dissatisfaction with product availability, marketing claims and loss of confidence	Deficient products which lead to loss of image or reputation, loss of market, complaints, claims, liability and waste of human and financial resources

Although generic the categories terminology still reveals the manufacturing origins that dominate these standards. Arguably this is further evidence of an inherent manufacturing bias in the standards is in the definitions used. The term ‘product’ is a result of activities or processes, which may encompass “a service, hardware, processed materials, software or a combination thereof” and “ A product can be tangible (e.g. assemblies or processed materials) or intangible (e.g. knowledge or concepts), or a combination thereof.” It is perhaps pedantic to make this point, but if the standards are to be seen as truly generic is it not better to differentiate? This simplification of definition appears to actually alienate service and project orientated industries. It may simplify the collation of the standard as a whole but the question must be asked does it simplify it for the “non-product” based industries to use?

3.3.4.1 Contracts to Promote trust between the Customer and Supplier

In the philosophy of Total Quality Management the generation of trust between the supplier and customer is seen as paramount to the well being of both parties. The need for some form of quality contract between the two parties in addition to their contractual commitments (the delivery of products or services to the satisfaction of the customer) could be construed as an indication of a lack of trust, something that has typified customer/supplier relationships of many projects especially in the construction industry. This is an anomaly that Seddon[21] has identified, illustrating the contrasting approach taken by the Japanese, who integrate their suppliers and customers into their system as opposed to keeping them at arms length.

3.3.5 Quality systems and Weber's Bureaucracy Model

The ISO quality system implemented in the case study in Chapter 6 places a heavy emphasis on documentation, with documented procedures for every item and activity. The responsibility for carrying out these procedures rested with one person, the project engineer. Trying to complete every procedure and its subsequent documentation plus coping with the actual day-to-day running of the project highlighted a conflict of priorities. Wilkinson and Wilmott[22] raise this question and ask if quality initiatives remove people from 'productive activity' and increase the pressures of those in 'continuing employment'. Conversely, Nicholas[23] recognises that conflict can have positive effects, better idea generation, innovative problem solving, clarification of viewpoints and positions, and can often provide an opportunity for people to test their capacity.

The conflict witnessed in this research and described in greater detail in Chapter 8, exposed compatibility issues with the existing quality system within the project environment. To manage a project successfully, (even a relatively small project) requires an awareness of what is happening on the project site, awareness of what resources are going to be needed, when they will be required and how they will influence the other processes. When an implemented system does not contribute to the overall goals of the project, then it is quickly seen as a superfluous activity, consequently it is relegated to being a task that can be ignored.

3.3.6 The short feedback loop within a project

Projects revolve around the programme and the project team has to invest the majority of its time to achieve the completion of activities in the required sequence that will complete the project. Timescales are constantly changing; suppliers do not always deliver on time, subcontractors' change, and customer's change the timescale, a myriad of permutations can evolve for any project. In response the project team has to constantly change the programme, discuss alternative scenarios, revise contingencies plans, and take rapid decisions when the need arises – the short feedback loop. As discussed earlier in the example of the rework cycle of Section 3.3.3 this loop is often iterative. In many ways this is the complete anti-thesis of a quality management system, which appears to have more in common with parts of the 'bureaucracy' model of Max Weber.[24]

3.3.6.1 Parallels

Weber, a German sociologist at the turn of the century, advocated a bureaucratic organisational model as being highly efficient[25]. The model outlined the characteristics needed to achieve this, which included specialization of tasks, routinization of activities, rules and regulations to guide behaviour, a clear chain of command, specification of authority and responsibility, and a rational, impersonal climate that imposed a sense of duty. Whilst it is not suggested that the quality system is modelled on this theory, it does have many similarities. Demarcation of functions, activities and decision making, are prevalent in an implemented ISO9000 quality system. In Chapter 6 the case study organization's quality manual contained a 'job function guide' and the first procedure described the need to detail and define 'key employees' job descriptions and responsibilities. This on initial inspection would appear to be a useful to both employer and employee, giving a datum from which both can ascertain their position in the organisation, what they should be doing, what training or qualifications are required and most importantly how that employee can effect the quality of the ‘product’. Yet in practice the procedure is given perfunctory application, only enough detail is entered to comply with the standard i.e. to meet the requirements of both the internal and external audit bodies.

The demarcation of personnel in a project environment is frequently blurred, primarily due to the limitation on resources; therefore the emphasis is on flexibility (not a recent concept in construction projects). In demarking personnel the emphasis is on limiting responsibility, which could create an inward looking and defensive mentality. The outcome of this is that personnel do not look outside their own sphere of influence, once they have achieved their own objectives and goals (i.e. their tasks or activities). They do not want to get involved in other processes which are interrelated with their own but which may be crucial to the project’s success. The emphasis with industry standards like ISO9000 is that demarcation is encouraged, to define responsibility, scope and authority, with the purpose of providing accountability and tracability in the organization. The rationale behind demarcation draws parallels with the classical ‘mechanistic’ view of systems, where fragmenting and optimising the different components in the system prior to reassembly is perceived to be the best way of improving performance.

3.3.7 The long feedback loop between projects

For continuous improvement to take place in a project organization there has to be feedback between projects, i.e. the knowledge gained from one project must be harnessed to improve the subsequent projects. Despite the fact that projects are unique, there are generic project activities that take place and these activities can be refined through the knowledge gained in previous projects. Additionally there is knowledge to be gained from non-generic activities, as they often demand unique methods of implementation, which may be transferable between projects. This is a major theme discussed in later chapters.

3.4 Conclusions

The theoretical argument of this chapter centres on the appropriateness of existing quality systems like ISO9000 and their value in the project environment, the mechanistic principles and structures that such systems impose, and what they achieve in respect to improvement between projects. If existing quality systems do not capture the uniqueness and turbulence of the project management environment, due to their mechanistic conception in manufacturing industries, can an alternative model for quality in projects be sought in the systems field? Both these issues shall be examined in subsequent chapters. The theoretical role of quality management systems is to provide a system of continuous improvement, both within a project, the short feedback loop and between projects, the long feedback loop. By determining the role of the quality management system in a project environment, it is believed that an accurate conclusion can be reached on the validity of such systems in improving future project success.

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Chapter 4

Quality Management Initiatives and the potential for Project Management

4.1 Chapter Synopsis

The industry wide quality management system that shall be examined in the main case study Chapter 8 has evolved from a long history of quality initiatives. All quality initiatives are based on the premise of improving organizational effectiveness and success irrespective of whether it is a product or a service that is provided. The initiatives have been developed in an operational environment but they may well be as valuable in project management. A main theme of the thesis is to consider whether the initiatives are valid in this context. Included in this chapter is an outline of the reasons why quality has become an integral part of management thinking and the role played by the influential ‘quality gurus’. A brief discussion of the techniques used in some of the major quality initiatives and an introduction to existing ‘quality models’ will also be covered. The topic of quality has many different (and overlapping) areas and it is outwith the scope of this research to cover all of them in detail. Therefore this chapter aims to provide an overview of the main theoretical quality initiatives prior to considering the needs of project management. Later chapters will examine the relevance of these quality initiatives to project management. Finally this chapter shall examine the potential of the quality systems in project management and whether the potential might be realised. Following the four case studies subsequent chapters will examine the relevance of these quality initiatives to project management.

4.2 Why Quality?

Beckford[1] presents three arguments for the rise in prominence of quality in present day management thinking. He divides the reasoning for organizations pursuit of quality into three, the economic imperative, the social imperative and the environmental imperative.

4.2.1 The economic imperative

The economic imperative charts the changing expectations of the customer (or consumer) and the supplier. From post war times when demand for products and services could be satisfactorily achieved, due to low customer and supplier expectations, to more recent times where the customer has high expectations of the product and service supplied. The growing change in customer expectation was seen as the main driver for change in production, coupled with the increasing cost of labour and power. Juran and Gyrna[2] also highlight the growing prominence of product quality in the perception of the public mind as one of the major forces that have had an impact on quality. The changes in customer expectation forced organizations to examine the ways in which they worked, leading to different strategies to reduce the total cost of production. Exporting manufacturing capability to countries that could provide cheaper labour or introducing new working practices combined with new technology were some of the ways in which industry tried to reduce its production costs. As Beckford[3] points out, work appears to follow low production costs, therefore any economy that can produce goods and services with the same reliability and at a lower cost will be in a better position to survive. Beckford concludes,

> "The economic imperative for quality is then essentially quite simple. The imperative is survival for the individual organization and ultimately the total economy"

Peters[4] when promoting the strengths of a project-orientated organization highlights this economic imperative referring to projects as the 'ultimate accountability models'. This topic is discussed further in Chapter 6, Section 6.4 and Chapter 12, Section 12.3.3.

4.2.2 The social imperative

The 'social imperative' is defined by Beckford as,

> "..the responsibility of all managers to minimise waste of costly human resources and maximise satisfaction through work for their subordinates in order to support social cohesion within their own sphere of influence"

Despite the works of management writers and practitioners, Beckford highlights the failing of both academics and managers to embrace different work methods and techniques that attempt to eliminate the inherent waste of human resources prevalent in most organizations. If this waste is reduced or eliminated he believes it would lead to a 'satisfied workforce, a commitment to the organization and a society more at ease with itself.' Evidence of a need for a different approach is confirmed by Scottish Enterprise[5] who cite a survey of British managers carried out in the 1980's that revealed,

> "…over 60 per cent took little or no joy in their work and would rather be doing something else but felt trapped. They had lost or never had a personal vision. Their pleasure had died, quality of working life was not possible and quality of product or service was irrelevant."

4.2.3 The environmental imperative

Beckford's last imperative focuses on the need for individuals and organizations to acknowledge that the earth's resources are finite and as such must be preserved wherever possible. A contributory step in achieving reduction in environmental waste is to ensure that organizations are run as efficiently as possible, which correlates directly to the objectives of many quality initiatives. For example Munro-Faure[6] list one of the benefits of a Quality Management System (QMS) as reduced operating costs through the elimination of waste and increased efficiency as a result of eliminating non-conforming processes. This concept whilst possibly idealized by Beckford does reflect an environmental awareness that is becoming a mainstream consideration by organizations in all industries. A quality initiative cited by Wilkinson et al[7] at British Steel's Teeside works has led to a number of improvements in the environmental management of the plant primarily in response to the increasing public and corporate awareness of environmental issues. Like Beckford's earlier observations on the rise in consumers' expectations, it appears that there is a growing expectation that organizations as well as individuals have a responsibility to reduce their impact on the environment.

In common with other commentators on management thinking Beckford concludes his perspective of the pursuit of quality that it must be seen as an overriding concern for every aspect of every organization.

4.2.4 Historical imperatives of quality

4.2.4.1 Chronology of Quality and its Management

The history behind quality and the management of quality has its underpinnings in manufacturing. Prior to this in Europe from the Middle Ages products and services were delivered by skilled craftsmen e.g. carpenters, blacksmiths, shoemakers etc. Contact with the customer and complete lifecycle of the product was very direct. The craftsman created a bespoke product for a customer that was known. The product was designed and created from raw materials; the quality was inspected as it was produced and it had to be functional to be accepted by the customer. Therefore the links between the customer, the supplier and the product itself were very strong. Following the American Civil War Thomas Jefferson established Honore Le Blanc's concept of interchangability[8]. Eli Whitney[9] used this concept to develop a system of manufacture that would allow an unskilled man to produce a rifle that before had only been produced by a craftsman. This was achieved by creating a system of manufacture based on templates and standardised machinery, to create a consistency of product. If the parts for the rifle were manufactured to a consistent standard then they could be manufactured at different locations and once assembled still produce a working rifle. This system made high demands on the manufacturing process and it took a number of years before it was perfected. The problem was one of variation: Whitney had underestimated the amount of variation that would be present in the process and its subsequent effect on quality. What this heralded was the need to have control of the quality of the parts produced to ensure that there was the consistency for the parts to fit when assembled.

The introduction of mass production and Taylor's[10] concept of 'scientific management' removed the close link between the customer and the supplier. By decomposing production into a number of small tasks a need was created to ensure that products were being manufactured correctly. Independent 'quality control' departments were set up to inspect the products and approve or reject them. In the 1920's at the Bell Telephone Labs a group was formed to develop new theories and methods of inspection to improve and maintain quality. This is where the term the term 'Quality Assurance' was first used and a number quality methods were developed e.g. control charts, sampling techniques, and economic analysis tools.

In World War 2 the US military adopted a system of statistical sampling and the imposition of strict standards to be met by suppliers. This became the basis for many of the military quality standards that were eventually adapted for use in the civilian world.

In the 1950's Deming and Juran (both had been influenced by work at the Bell Telephone Labs by Shewart) introduced statistical quality control techniques to the Japanese, who embraced the concept of quality improvement. In the West especially the United States there was no perceived need for quality improvement. As Evans and Dean identify quality was not an issue in the post war economy, therefore the US concentrated on marketing, production quantity and financial performance.

The 1960's and 70's witnessed increasing Japanese domination of large sectors of world trade in manufacturing. As Flood[11] explains, the Japanese switched commercial interests from 'competition in productivity to competitiveness in quality' creating massive rises in exports to the detriment of Western economies. During this period US Military standards were used as a template to develop standards for NATO. From these and its own quality drive the UK also developed its own military standards. In 1979 the British Standards Institute (BSI) published BS5750 a generic standard that could be applied to a wide range of organizations. This formed the basis for the ISO9000 series of standards, which shall be examined in greater detail in later chapters.

1982, the Department for Trade and Industry (Dti) ran the "British National Campaign for Quality" to raise awareness of the need for quality in UK organizations. In 1987, BS5750 was revised and became the ISO9000 series of standards, which reflected its incorporation of international requirements.

Despite the collapse of the Pacific rim tigers and the faltering of the Japanese economy (with the possibility of the rest of the world following suit) Total Quality Management (TQM) and the ISO9000 series of Quality Standards are still being heavily touted as being the prerequisite for organizational survival in an ever increasing market.

The most recent stage in the evolution of quality is Total Quality Management (TQM).

This general management philosophy aims to attain continuous improvement through customer satisfaction. TQM has been described by Wilkinson and Witcher[12] as a quality-led company-wide management, where quality becomes a way of life which permeates every part and aspect of the organisation

Figure 4.1 adapts Flood's evolution of quality thinking[11] to represent the progression of quality theory to its present stage of Total Quality Management (TQM)

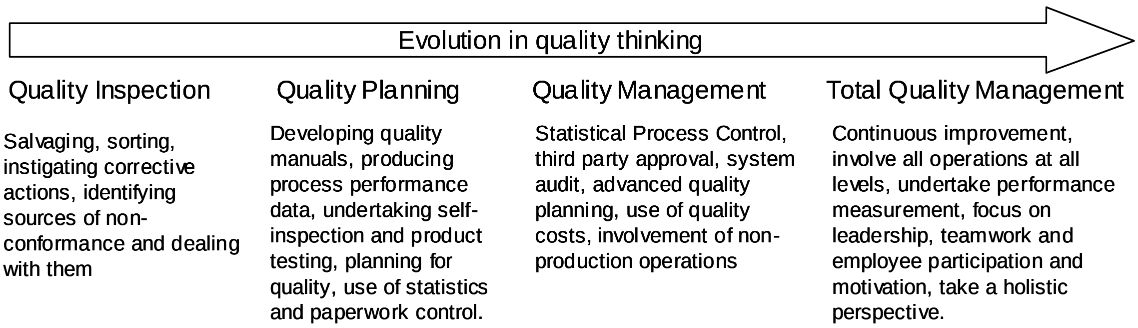

Figure 4.1 The evolution of quality thinking (adapted from Flood[11])

4.2.5 The Guru's

Quality's history and theory is associated with a number of 'gurus'. These are people who have managed to encapsulate, assimilate and distribute theory based on their work and experiences in the field of quality. In some cases the impact of their work has been considerable. Using three of the gurus the following sections give brief outlines of their contribution to the quality field. As recognized by Flood there are seven gurus whose writings have had a significant influence on the quality movement, although for the purposes of this research it was not deemed necessary to document them all. Flood does not include Oakland who has been seen as the UK's own quality guru who moved from academia to consultancy where he has successfully promoted quality initiatives to many organizations including the UK government[13].

4.2.5.1 Deming

Arguably the most well-known and respected quality guru, Edward Deming began his career at Western Electric (prior to it becoming AT and T Bell laboratories). It was there that he was inspired by the work done by Walter Shewart on statistical control of processes and its related control charts. As described in an obituary for him by the Institute of Quality Assurance (IQA)[14] much of Deming's management philosophy emanated from these concepts and he believed that they could be universally applied to all types of organization.

In the 50's and 60's Deming along with Joseph Juran have been attributed with providing the impetus and direction for Japan to rebuild its shattered post war industry using quality techniques and methodologies rejected by the US at the time. Deming became a national figure in Japan with recognition from the highest levels. The Deming Prize for industry created in his honour is awarded to companies that have successfully applied 'company-wide quality control'.[15] His philosophy and teachings were not recognized in the United States until 1980. Demings philosophy was based around 14 ' admonitions' or points for management that had been created with the purpose of curing seven deadly sins and overcoming the four obstacles that thwart production. Demings fourteen points have been reproduced in Table 4.1.

Table 4.1 Deming's fourteen points for management (adapted from Oakland[16])

1. Create constancy of purpose for improvement of product and service.
2. Adopt the new philosophy: Mistakes and negativism are unacceptable.
3. Cease dependence on mass inspection.
4. End the practice of awarding business on price tag alone.
5. Improve constantly and forever the system of production and service
6. Institute training. Teach workers to do their jobs.

7. Institute leadership. Help people to do a better job.
8. Drive out fear
9. Break down barriers between staff areas
10. Eliminate slogans, exhortations, and targets for the workforce.
11. Eliminate numerical quotas
12. Remove barriers to pride of workmanship.
13. Institute a vigorous program of education and retraining. Stress teamwork and statistical technique.
14. Take action to accomplish the transformation.

Deming is also synonymous with the Deming Cycle – Plan, Do Check Action, which is examined in greater detail in Chapter 12 (Section 12.3.1). Beckford interprets Deming's definition of quality as 'a function of continuous improvement based on reduction in

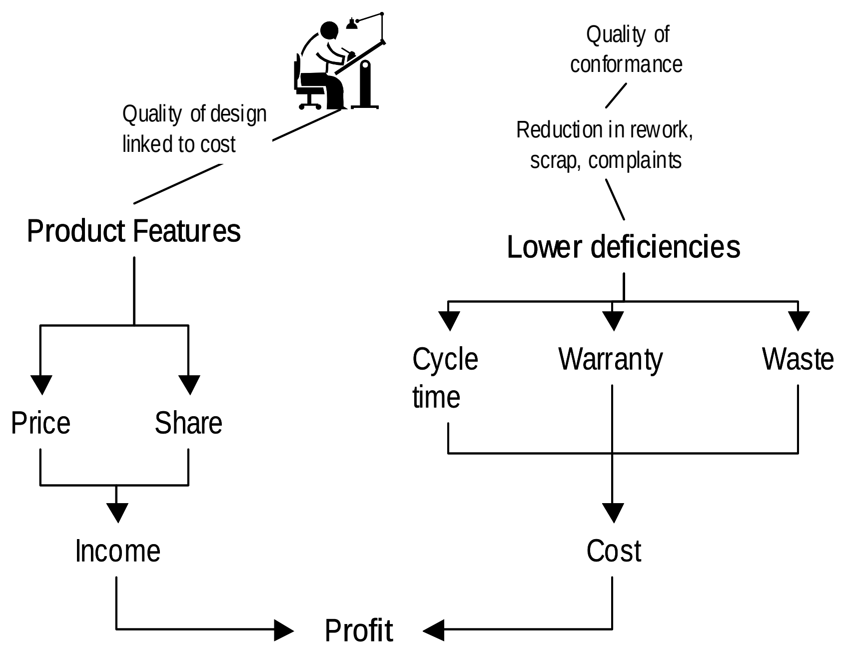

Figure 4.2 The relationship between product features, lower deficiencies, income and cost

variation around the desired output'. Deming's approach is an all encompassing one, demanding a change in management thinking and organizational culture.

4.2.5.2 Juran

Like Deming a product of Western Electric, Juran was also instrumental in helping the Japanese rebuild their economy into the dominant force that it is today. Juran's short definition of quality is 'fitness for use[17]'. He develops this further to define the scope of the customer internal for interdepartmental contact and external for customers outside the organization. Customer satisfaction is defined by two components, product features that have an impact on sales income, and freedom from deficiencies, which has an impact on costs. Figure 4.2 adapted from Juran and Gyrna[18] illustrates the interrelationship between features, income, deficiencies and cost. A prolific contributor to quality management theory with a number of books Juran has been described as providing ' the greatest contribution to the management literature of any quality professional' (Logothetis[19] as cited by Beckford).

Juran's philosophy (summarized and adapted from Evans and Dean[8]) is defined by the following key features,

- Quality programs are designed to fit into organizations existing framework
- Demarks the organization by 'language' management communicate by income and cost, the workforce communicate by things.
- Use the lever of quality cost to make management aware of quality problems
- Increase conformance to specification by eliminating defects
- Use statistical tools to eliminate defects

His solution to addressing quality problems the 'Quality Trilogy[i]' is quality planning, quality control and quality improvement. In Chapter 12 Figure 12.6 illustrates the quality trilogy via a control chart and examines the applicability of random variation in project

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[i] A trademark of the Juran Institute.

management. For the purposes of this research Juran appeared to be more applicable than the other gurus, a point reinforced by Dale[20] when he characterizes Juran's focus of approach as project management.

4.2.5.3 Crosby

Crosby's quality philosophy is encapsulated in his Absolutes of Quality Management outlined in Table 4.2.

Table 4.2 Crosby's Absolutes of Quality Management[21]

1. Quality is defined as conformance to requirements not as an intangible concept like superior or luxurious.
2. Problems occur in all functional areas of an organizations therefore they should not be classified as quality problems
3. It is more cost effective to carry out an operation right first time
4. The cost of quality is the only performance measurement
5. The organization must strive to achieve zero defects

According to Crosby's biography[21] he started work on an assembly line where he decided to pursue a career, which would 'teach management that preventing problems was more profitable than being good at fixing them'. He worked his way up to corporate vice president of ITT and from there formed his own consulting organization and 'quality college'. Like Deming and Juran, he has written some very well received books in particular 'Quality is Free' and 'Quality without Tears.' To achieve improvement in quality Crosby advocates a fourteen-step programme, which is a mixture of quantitative and qualitative actions. These steps reinforce his three key viewpoints that quality initiatives involve management leadership, meeting the criteria and prevention of problems.

4.2.6 Comparing Deming, Juran and Crosby

Various critiques of the quality gurus have been made. Table 4.3 adapts the views of Flood[22], who is also cited as a source for Beckford on the strengths and weaknesses of arguably the three best known quality guru's Deming, Juran and Crosby.

Table 4.3 Comparing Deming, Juran and Crosby (adapted from Flood)

	Strengths	Weaknesses
Deming	Systemic functional logic, identifies the stages and interrelationships and the mutual dependence linking an organization and its suppliers	Action plan and methodological principles seen as too vague
	Management is seen to come before technology	Despite recognizing the importance of motivation and leadership these topics are not dealt with in enough detail
	Leadership and motivation of employees are recognized as important	Deming's principles and methods do not have an approach to deal with the inevitable politics and coercion that exist in organizations and he recognizes
	Emphasis on statistical and quantitative techniques	
	Different approach taken depending on culture of country	
Juran	Believed that quality should move away from propaganda and slogans and concentrate on real issues of management practice	Like Deming, is seen to have a shortfall in referring to literature on motivation and leadership
	Key to quality is identifying and satisfying both internal and external customers.	Rejects 'shop floor' initiatives, fails to appreciate worker input.
	Heavy emphasis on management participation and responsibility	Based heavily on control principles with little on the human aspect of organizations
Crosby	Clear approach that is supported by a number of easily used tools and techniques	Approach appears to rest the responsibility of poor quality on the workers. Creates the perception with management that they only need to initiate quality not actively participate.
	Appreciates the role of the worker in quality initiatives	Slogan based approach that is criticized for being too heavily marketed which does not outline the difficulties that will be faced by organizations in implementing a quality initiative.
	Quality problems do not exist i.e. poor management creates poor quality	Crosby's 14-stage methodology management and goal orientated and neglects his own philosophy of releasing the workforce from externally generated goals.
	Creative approach to delivering the message that quality is essential for success	Zero defects is often misinterpreted as meaning zero risk thereby stifling innovation.
	Seen as a great motivator and starter for quality programmes	Philosophy assumes an open and conciliatory culture in the workforce does not account for non-open culture.

In conclusion the guru's have played a significant role in shaping quality theory. In Japan Juran and Deming's quality theory was embraced and transformed into practice, leading to the country's eventual economic strength. In the West the theory was largely unheeded until the late seventies when there was a realization that quality was a key issue for industrial success. Although there are some philosophical differences in approach the message from all the quality gurus is fundamentally the same. Quality has to be an integral part of any organization if it is to succeed in the long term.

Given that the pursuit of quality is now instilled in most organizations the fundamental question for this research is whether existing quality systems and techniques achieve these objectives in project management? What is important in the context of project management and this research is finding out the success of existing quality systems in improving the conduits of feedback that will enhance future project success. Is a formal quality initiative relevant or necessary in some organizations?

4.3 Quality Initiatives and Techniques

The following sections will provide generic descriptions of the main quality initiatives and a number of techniques.

4.3.1 Total Quality Management (TQM)

The most encompassing quality initiative is Total Quality Management (TQM). TQM epitomises all the fundamental concepts of quality and its management. Although there is frequent debate on the definition of TQM and what it encompasses the following definition by Dale[23] displays the commonality of many quality texts,

> "…TQM is the mutual co-operation of everyone in an organization and associated business processes to produce products and services which meet and, hopefully, exceed the needs and expectations of customers. TQM is both a philosophy and a set of guiding principles for managing an organization."

Total Quality Management is a conglomeration of initiatives and methods, which encompasses many existing and new areas. TQM is identified as being top of the hierarchical pyramid in terms of quality initiatives with a stepwise progression similar to the one shown in Chapter 1. The four progressive steps used to define the quality hierarchy are Inspection, Quality Control, Quality Assurance and Total Quality Management. Figure 4.3 reproduces Dale's evolution of TQM, which very effectively summarizes the hierarchy of existing quality theory. Although almost identical to Figure 4.2 it was noticeable that

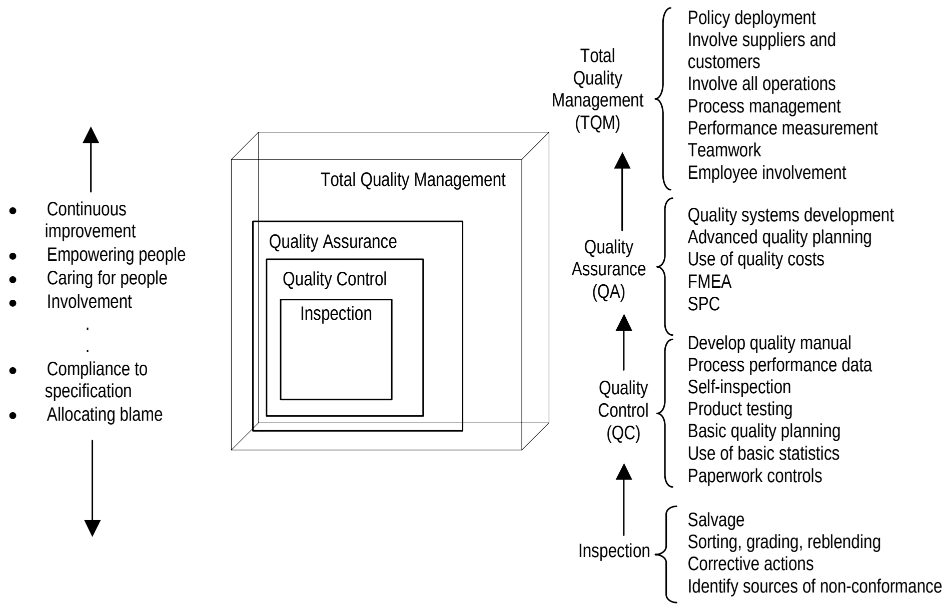

Figure 4.3 The four levels in the evolution of TQM (Dale[22])

Dale segments the hard and the soft approaches to TQM, aligning 'compliance to specification' in the same direction as 'allocation of blame'.

This appears to be a common attribute with many quality texts whereby the 'hard' side of the organization has a negative connotation. Wilkinson et al[12] actually believe that TQM needs to be separately validated from other quality initiatives like quality control and quality assurance because of the totality of its impact on the organization and the fact that it is 'a new approach to corporate management itself'. The two sides to TQM can be identified as the 'soft' qualitative characteristics, which can be equated with,

- Customer orientation
- Culture of excellence
- Removal of performance barriers
- Teamwork
- Training
- Employee participation.

And the ‘hard’ characteristics centred around,

- Systematic measurement and control of work
- Setting standards of performance e.g. benchmarking
- Using statistical procedures to assess quality
- Based on production/operations management type of view

As pointed out by Wilkinson et al[12], the hard side of TQM arguably involves less discretion for employees. This viewpoint whilst valid does tend to demonise certain facets of TQM many of which are more technically based subjects and display the manufacturing roots of a great deal of quality theory. As evidence of the importance of the soft side of TQM, Powell’s[24] study identified the key drivers, which make TQM a success in some organizations and not in others. The results showed that success depended on executive commitment, an open organization culture and employee empowerment whether or not the organization practiced TQM. Additionally certain components that contributed to TQM were not ranked as importantly as expected, benchmarking, training, process improvement and flexible manufacture, typically the ‘hard’ tools and techniques. The shift towards the softer side of TQM in quality management thinking is possibly a reaction against the viewpoint of TQM as a management of processes and outputs typified by the following description from an earlier British Standard:

> “in the TQM culture, all business activity is related to processes and therefore the cost model should reflect the total costs of each process rather than an arbitrarily

defined cost of quality[25]'. BS 6143:Part1: 1992;"

Bounds et al[26] epitomise the academic theory on the definition of TQM, by stating that there is no consensus on what constitutes TQM but there is agreement that it is a useful strategy. Adapting from Dale[27] the characteristic 'key elements of TQM' an outline of what constitutes TQM can be provided in the following sections.

4.3.1.1 Senior Management Commitment

The implementation of TQM has to start from the top otherwise the quality initiative will not succeed. This top down approach is to ensure that quality is part of the organizations strategy as well as being an operational issue, and that it has to be taken seriously. This is reiterated in existing quality standards and throughout quality literature.

4.3.1.2 Planning and organization issues

The following checklist of characteristics could be defined as the infrastructure that has to be in place to facilitate the TQM process. Of particular interest to this research were the topics in the last four points as shall be discussed in later chapters,

- Quality is seen as a strategy that is built-in to the organization and its business objectives.
- The implementation of polices using designated resources to ensure that targets are reached.
- Creating designs with product and service quality incorporated in them and implementing prevention based schemes.
- Creating Quality Assurance procedures that facilitate closed loop correct action.
- Planning the implementation of a quality system that takes into account the business environment in which it is being used.
- Create an infrastructure to support the quality system, providing the personnel with the necessary responsibility and authority to impose the system.

- Facilitate the standardization, systemization and simplification of procedures, work instructions and systems.

It is apparent that what is being advocated, as a framework for the TQM process is in fact a quality system.

4.3.1.3 The use of tools and techniques

Tools and techniques are promoted in TQM for the purpose of problem solving to support the process of continuous improvement. They are seen as part of an empowerment process that advocates employees being facilitated with the requisite tools to allow problem solving to take place. The purpose of this is to engender a feeling of involvement in the employees, which will increase quality awareness and promote a positive change in attitude to continuous improvement. Section 4.3.2 outlines some of these tools in more detail.

4.3.1.4 Education and Training

Dale advocates a company wide training and education policy in quality management concepts, commensurate with the organizations continuous improvement philosophy. It must be in context and provide the employees with the skills to use the tools and techniques described in the previous section. Evans and Lindsay[28] provide the following example of quality training,

> "At Wainwright Industries, associates are fully engaged in quality training efforts beginning with their first day on the job. During new associate orientation, senior managers explain the importance of quality and customer satisfaction and outline the companies approaches to continuous improvement. Follow up sessions are held 24 and 72 days after the start of employment. The company invests up to 7 per cent of its payroll in training and education. All associates take courses quality values, communication techniques, problem solving, statistical process control, and synchronous manufacturing."

4.3.1.5 Involvement of personnel and teamwork

TQM philosophy requires that an organization look on its personnel as assets. To maximize the benefits from these assets people must be involved in the process of continuous improvement. This requires a devolvement in power and responsibilities of certain management functions to allow the workforce to take ownership of their own processes. Paradoxically, there is a need to make personnel aware of their position in the organization, what impact they have on other processes and where the limits are to their responsibilities.

Teamwork is encouraged as a means of maximising the output and value of personnel as well as fostering commitment and participation. Oakland[29] promotes teamwork to change the independence of individuals where there is little sharing of ideas and information, into the interdependence of teamwork, which is seen as essential for continuous improvement and problem solution. The outcome of promoting teamwork is to distribute knowledge, for which Oakland provides an interesting analogy:

> "Much of what had been taught previously in management has led to a culture in the West of independence, with little sharing of ideas and information. Knowledge is very much like organic manure- if it is spread it will fertilize and encourage growth, if it is kept closed in, it will eventually fester and rot."

From the viewpoint of project management teamwork has always been an integral part of the project environment therefore this is not a new concept, but the important issue for this research and addressed in later chapters is the viability of existing quality initiatives to provide an effective vehicle for feedback and dissemination of information.

4.3.1.6 Measurement

Any process in an organization has to be able to be measured to allow factual improvement; therefore TQM encourages measurement to ensure that improvement is actually taking place. This is commonly referred to as benchmarking and it can be carried out internally between departments or business units, or it can be carried out externally, using practices from organizations in the same industry or from different industries. Benchmarking provides a datum by which organisations can compare themselves. This involves comparing different parts of the organisation with similar parts of other organisations, which are viewed as 'best-in-class'. Chevron[30] when trying to reduce the amount which it spent on capital projects, discovered that it did not have a capital project management process, therefore it started by carrying out two benchmark studies, one quantitative and one qualitative. The findings revealed that Chevron spent 12% to 15% more to build plants than the industry standard and 25% to 30% more than the best-in-class. Benchmarking is seen by Dale[31] as providing the milestones for assessment of both progress and feedback.

Digital Equipment Scotland Ltd at South Queensferry[ii] (now owned by Motorola) as a U.S company in the UK were particularly interested in the recipients of the Malcolm Baldridge National Quality Awards. Digital examined the operations of recipients of the award to see if they could learn anything from them and to use as a benchmark. This quality award is presented annually in the United States to organizations that are seen to have excelled in quality and productivity; a maximum of two organisations in each of three categories (manufacturing, service, and small business) may be selected each year. A detailed evaluation is carried out on submitted written material, followed by various site visits. Juran & Gynra[32] highlighted the key conclusions from a US agency that reviewed 20 companies that were high scoring applicants for the award:

"1. In nearly all cases, companies achieved improvements in employee relations,

[ii] The author interviewed the quality manager at the South Queensferry facility for a previous study in 1994.

productivity, customer satisfaction, market share, and profitability.

2. Six common features contributed to the improved performance: customer focus, senior management leadership, employee involvement and empowerment, an open corporate culture, fact-based decision making, and partnership with suppliers.

3. The companies required an average of about 2.5 years to realise the initial benefits."

This last conclusion is interesting in lieu of the criticism levelled at quality management by project management organisations that it takes too long to implement which is possible in a production environment but not in a project environment. This shall be investigated further at a later stage in the study. Digital promoted quality as an organization by offering a quality award open to groups or individuals operating in Scotland. The performance criteria that are promoted by quality awards like the Baldridge Award and the European Foundation for Quality Management Excellence model are now briefly examined.

4.3.2 Quality Awards

4.3.2.1 The Deming Prize

To encourage organizations to adopt quality initiatives governments have promoted quality awards. In Japan The Deming Prize is awarded each year by the Union of Japanese Scientists and Engineers to organizations and individuals who have made outstanding achievements in applying Deming's 14 principles (or admonitions) in the course of their business. The award is based on ten major assessment criteria

- Policy and objectives
- Organization and its operation
- Education and its extension
- Assembling and disseminating of information
- Analysis and standardization

- Control and quality assurance
- Effects and future plans.

Organizations are required to submit a detailed description of their quality practices, which are then scrutinized in conjunction with site visits to determine their suitability for the award.

4.3.2.2 The Baldridge Award

Similar to the Deming Prize the Malcolm Baldridge National Quality Award was created

Figure 4.4 Baldrige Criteria for Performance Excellence Framework: A Systems Perspective (Baldrige National Quality Program)

in the 1980's in America to encourage organizations to improve their performance. There are criteria, which have to be met to be applicable for the award, and like the Deming Prize it is largely based on self-assessment. Indeed this self-assessment is seen as the most useful part of the exercise as it forces organizations to carry out some critical analysis of their business that in turn allows feedback to given from the Baldridge National Quality program. The program gives additional purposes for the criteria[33]:

> "In addition, the Criteria have three other important roles in strengthening U.S. competitiveness:
>
> 1. to help improve performance practices and capabilities;
> 2. to facilitate communication and sharing of best practices

information among U.S. organizations of all types; and

3. to serve as a working tool for understanding and managing performance, planning and training."

At the Digital production facility mentioned earlier it was the sharing of best practices from other organizations that was of particular interest to their quality manager. In the 1999 Criteria for Performance Excellence[31] there are seven categories,

1. Leadership
2. Strategic Planning
3. Customer and Market Focus
4. Information and Analysis
5. Human Resource Focus
6. Process Management
7. Business Results

The framework that connects and integrates these categories as shown in Figure 4.4. The Baldrige award criteria change annually to reflect any advances in the way that quality can be enhanced.

4.3.2.3 European Quality Award

The European Foundation for Quality Management (EFQM) was formed in 1988 by 14 leading Western European countries and in 1991 in partnership with the European commission created the European Quality Award (EQA)[34]. There is two parts to the award the European Quality Prize and the European Quality Award. The prize is given to the organizations that meet the EQA criteria and the award is given to the best of these. As pointed out by Evans and Dean[35] the key differences with the EQA and its American counterpart the Baldrige award are emphasize on criteria that affect society as a whole which is perhaps a reflection of the awareness of the impact that organizations can have on both the environment and society in general,

- people satisfaction
- customer satisfaction
- impact on society
- business results

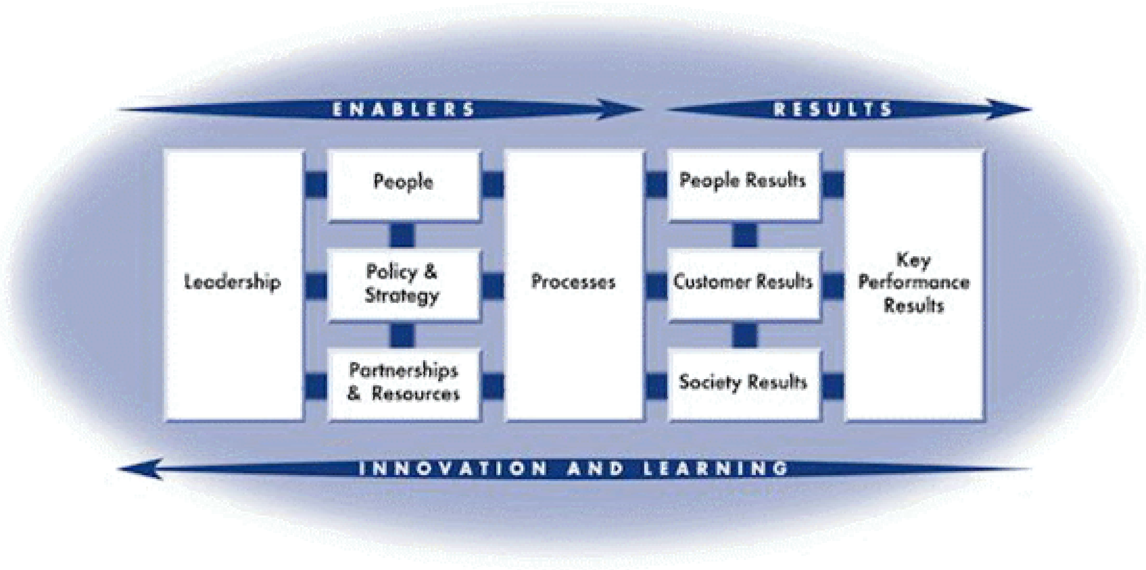

Figure 4.5 The European Foundation for Quality Management Excellence Model (EFQM[33])

The EFQM model is illustrated in Figure 4.5 and shows how ‘enablers’ produce the ‘results’. This produces a framework of key criteria that can be measured to assess organizations applicability for the award.

There are similarities with all of the quality awards in that they have similar criteria, are based on self-assessment (backed up with an audit) and are modelled around the concepts and theories that are found in TQM. It is interesting to note that Deming[36] did not believe that the Baldrige Award was a useful vehicle to promote quality awareness because of its ethos of competition, however Evans and Dean[37] outline an organizational example that highlights the similarities of the key criteria used in both ‘models’.

4.3.3 Feedback

Tracking of causes of errors that generate defects in measurable terms i.e. feedback is a key principle in Quality Management. The premise is that if something cannot be measured, then its performance cannot be controlled and improved. The ability of an industry (in this example the building industry) to provide this feedback can be obstructed as shown in the article by Cornick[38]:

> "The identification of errors and their cause is discouraged because of contractual and professional liability and consequently a positive approach to 'feedback' cannot exist."

The article points out the need to determine 'production requirements to achieve design solutions' at the design development stage to prevent a situation where these requirements are not being met. The advantages of this are highlighted by Cockerill on maintenance considerations in a new plant[39]. By implementing maintenance systems and strategies at the design and development stage of the building of a new plant savings that can be made.

4.3.4 Creating a Continuous Improvement Culture

TQM is attempting to create a shift away from quality as a separate function to an attribute that is integral to the organization's processes. To achieve this quality theory advocates creating a continuous improvement culture in which all the organization's personnel can contribute. Culture is defined by Clutterbuck and Crainer and cited by Beckford[40] as:

> "A set of behavioural and attitudinal norms, to which most or all members of an organization subscribe, either consciously or unconsciously, and which exert a strong influence on the way people resolve problems, make decisions and carry out their everyday tasks."

Creating or changing a culture is identified as being the most difficult part of a TQM initiative, and as discussed by Flood[41], although quality protagonists argue for the formation of 'ideal corporate cultures' they do not comprehend the depth and the detail that it takes to create one. Flood in contrast to other quality management authors appears to identify problems with existing interpretations of how quality cultures should be implemented. His criticism is centred on organizations that attempt to impose cultures that are 'mechanical-coercive' based on early scientific management and bureaucracy theory that also utilise the organizations existing hierarchical power structures[39],

> " The most glaring evidence is use of the company's organizational hierarchical tree as the structure down which quality will spill. As we have seen, this implements quality using a formal power structure. It plays against and sees off many concepts and principles of quality management"

Flood[42] believes that this way of implementing a continuous improvement culture dominates and needs to be changed to a 'viable and socio-cultural systems thinking' approach. Systems thinking and its applicability to quality in project management is examined in Chapter 10.

4.3.5 TQM:Further Tools and Techniques

TQM has a number of different components that contribute to its philosophy, Kanji and Asher[43] document 100 methods for TQM although many of these originate from other disciplines. The following sections describe a few of the key methods that are promoted as part of the TQM process of continuous improvement.

4.3.5.1 Quality Costs - the cost of conformance and the cost of non-conformance

Quality related cost is formally defined as:

> "Cost in ensuring and assuring quality as well as loss incurred when the quality is not achieved (British Standard BS4778)"

The principle behind quality costs is to implement prevention rather than cure throughout an organisation with the objective of reducing operating costs, internal failure costs, external failure costs and to provide the customer with exactly what they required. The cost of non-conformance is the total cost associated with doing something wrong. For example if a car manufacturer sells a car with a defect, the cost of non-conformance could be listed as follows:

- The cost to recall the car from their owners e.g. advertising, admin, uplift of car, supply of courtesy car, etc.
- The repair to the car e.g. the mechanics time (including time that mechanic could have spent on, the part costs, the overheads of the garage, securing the car.
- The costs to return the car to its owner,
- The cost of legal action if an owner has an accident that is directly attributable to the defective part,
- The intangible costs of lost reputation, loss of customer loyalty, reputation, and the decline in the morale in the workforce.

This is a simplistic example, but the theory can be applied most aspects of an organizations operation. Munro-Faure outline other non-conformance costs including for example excess inventory, excessive debtor days, obsolete stock, engineering changes, overtime, and

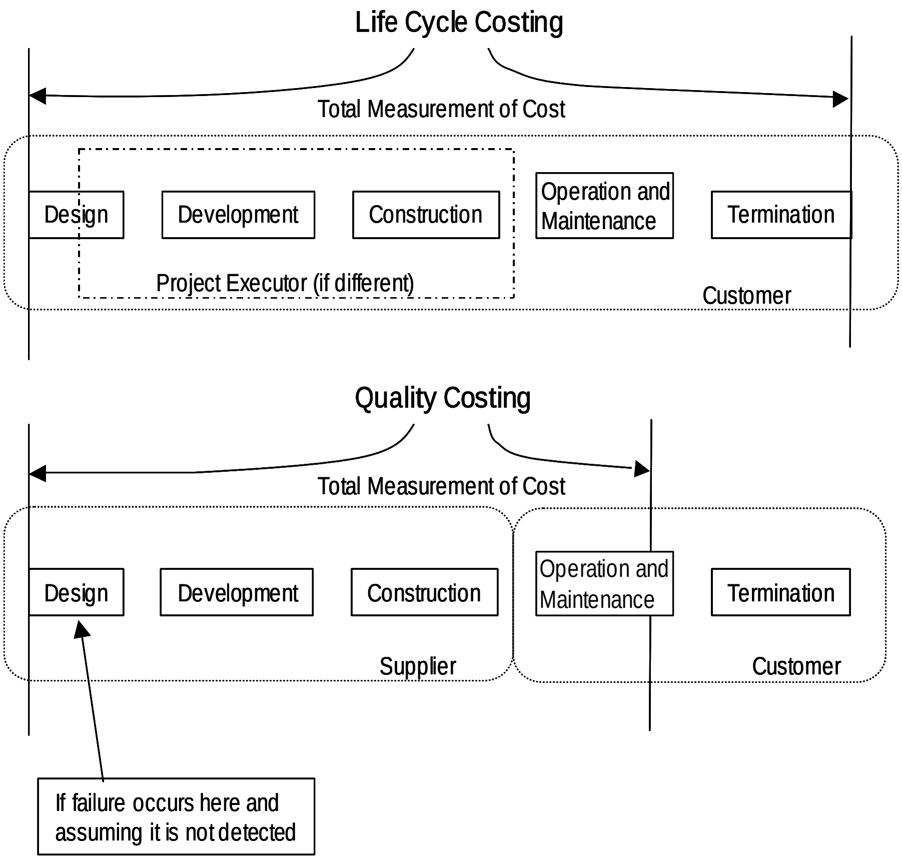

Figure 4.6 Comparing LCC and Quality Costing

excess capacity, all of which are usually the result of an inefficient system, process or work practices. The problem with some of these definitions is their obvious bias towards relatively stable manufacturing environments. There is no apparent recognition of the more dynamic environmental effects that can reverse the fortunes of a project. Also there seems to be no recognition that the political/legal environment can change which may have a dramatic effect on a companies operation. For example the fate of Concorde and the Channel Tunnel[41] was held in the balance several times due to change of legislation and or government when both were under construction. And although there is the likelihood that there will be great waste there is no discussion in quality management about the need to cancel work or a project because of the circumstances that have evolved at the time. Morris and Hough[44] discuss the need for the recognition of project termination and give various well-known examples including the initial attempts to create the Channel Tunnel. The reason that the oil company Chevron[45] spent 12 to 15% more on capital projects than its competitors was that when it started building a new plant only 35% of the design was completed as opposed to an industry average of 60%. Therefore Chevron had to retrospectively make corrections on site that could have been fixed at the design stage.

There appear to be parallels between Life Cycle Costing (LCC) as described by Shtub et al[46] in project management and quality costs in quality management, in what they are trying to achieve i.e. the total measurement of a part of the business. Both are measurements of the total costs incurred by an event (in the case of LCC the lifespan of a project and with quality costs the total cost of a failure) The differences arising in the cross-over points between supplier and customer and the interactions between them as shown in Figure 4.6.

4.3.5.2 Quality Function Deployment (QFD)

Quality Function Deployment is a planning tool matrix used to help businesses focus on the needs of their customers when setting design and manufacturing specifications. Juran and Gyrna[47] describe QFD as a technique for 'documenting overall design logic'. Still primarily a tool for manufacturing organisations there is evidence that it is being used in other sectors. A phrase attributed to the benefits of QFD is 'better designs in half the

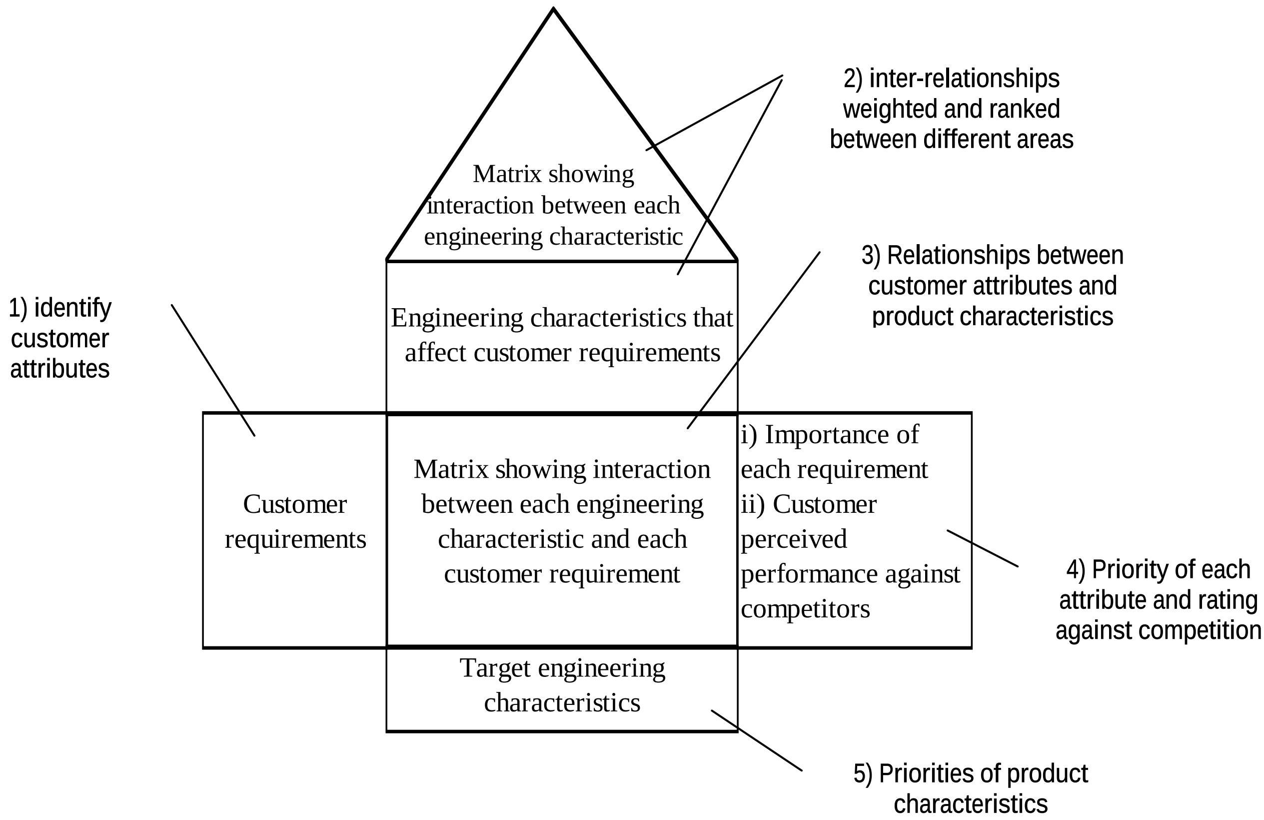

Figure 4.7 The House of Quality (adapted from Munro-Faure)

time'[48] First developed in Japan it is a relatively new technique in which every project starts by understanding the requirements of the customer and prioritising them. During the project various considerations like for example design, sales, processing, assembly, complexity, investment, cost, and other practical examples are examined relative to the clients needs. Any critical requirements are highlighted as a means of keeping the project focused. The idea behind this technique is to 'market in' the aspects what the customer wants during the design stage and throughout the project. The mainstay of QFD is the 'house of quality' the matrix used to show the relationship between the client and the engineering characteristics as shown in Figure 4.7. The matrix also illustrates the other constraints imposed upon the manufacturer/supplier, which could limit the product/service to customer, for example manufacturing capability, material or manpower constraints.

4.3.5.3 Functional Analysis (process analysis)

Functional analysis (also known as process analysis) is the process of identifying 'value added' functions. This technique is aimed at all departments in an organisation, to

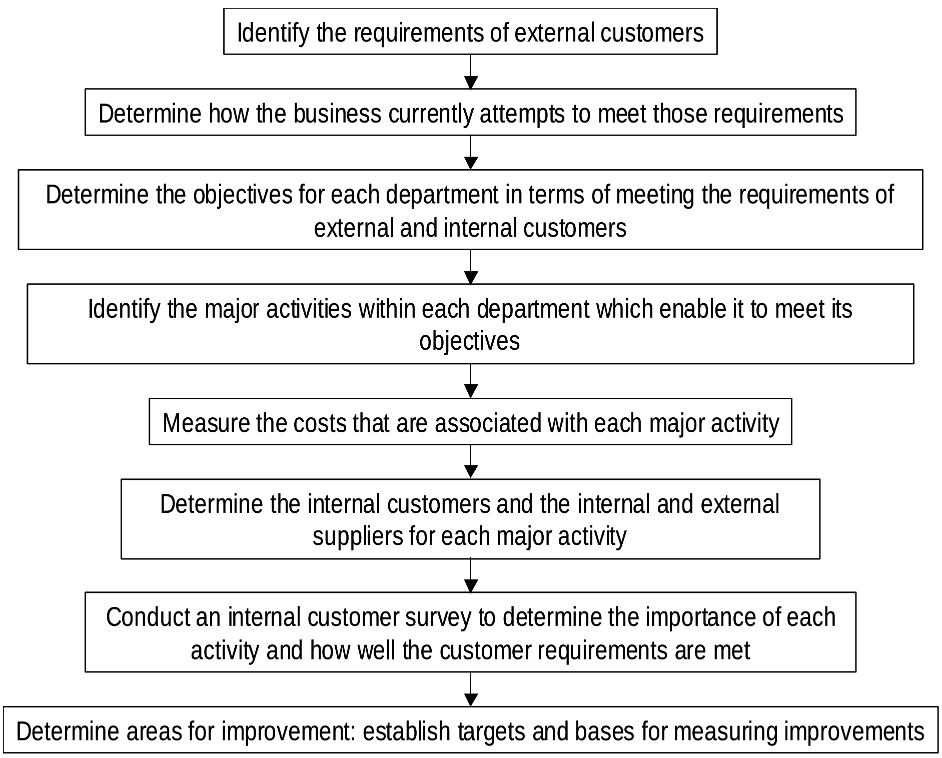

Figure 4.8 The functional analysis method (Munro-Faure)

emphasis the part they play in achieving the objective of satisfying the external customer. The common thread of measuring the existing process and determining how to improve it is the main part of functional analysis. An internal customer is the definition used to describe the interrelationships between different functions inside an organization. Like project management there is a decomposition of the overall process and then an analysis of the interactions between the constituent parts. The flowchart in Figure 4.8 from Munro-Faure[49] illustrates the steps of the method. By identifying the value-added parts of the overall process the aim is to discard anything superfluous, i.e. activities that do not contribute to the overall objectives of the business and concentrate on the activities that do.

4.3.5.4 Cause and Effect Diagrams (Ishikawa diagrams)

Cause and Effect diagrams or Ishikawa diagrams (the originator of the technique and another quality guru) assists in pinpointing the source of problems or defects by tracing the fault back to its cause. A basic cause and effect diagram is shown in Figure 4.9, illustrating

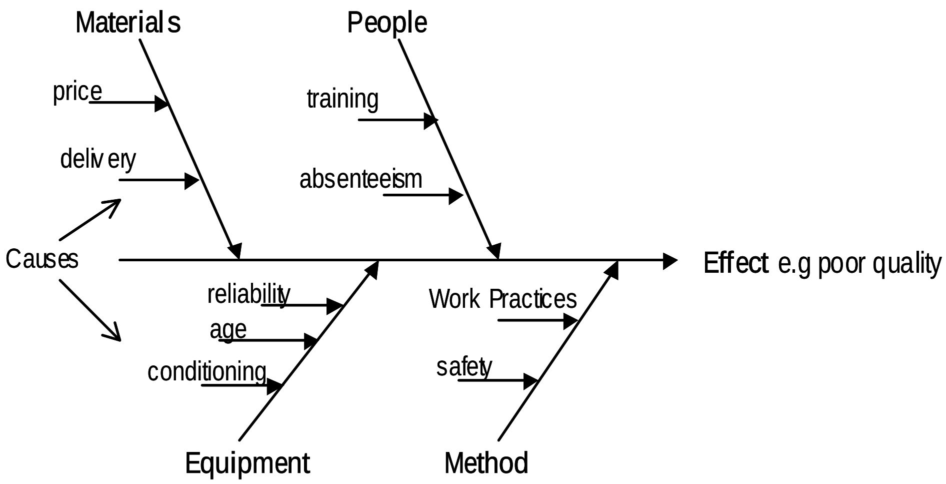

Figure 4.9 Example of a cause and effect diagram

how the technique should help to pinpoint (in this case) the cause of the effect, which is poor quality. Dale[50] believes that cause and effect diagrams are best suited to situations where there is one problem and the possible causes are hierarchical in nature. The benefits of cause and effect diagrams are their usefulness in ordering possible causes under generic headings and for patterns or trends to be identified. A large number of causes on one branch would indicate there might be a problem at that point in the operation. Cause and effect diagrams are often used in conjunction with brainstorming techniques and Pareto analysis (associated with the rule that suggests that 80% of any problems can be attributed to 20% of the causes). Figure 4.10 illustrates an example of a graph of a Pareto analysis from Betker[51], showing the types of defects that affect a soldered joint. It can be seen from the histogram the largest percentage of defects is caused by insufficient solder. Obviously eliminating this problem first would produce the most marked results in reducing the number of defective joints.

4.3.5.5 Brainstorming

Brainstorming is a method used to elicit the opinions of a group of people in relation to a problem or to a concept. It allows the generation of ideas in a free flowing manner to try

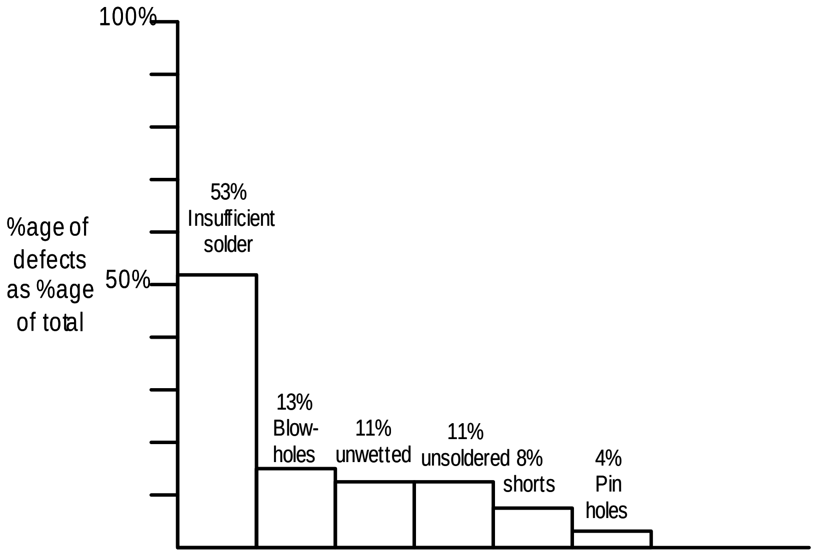

Figure 4.10 Pareto analysis of solder defect types (Betker, 1983)

and produce an optimal solution that takes into account all the variables present. The usual form of a brainstorming session involves a small group of people with a common problem or objective, one person facilitates the session by writing ideas (key words, sketches, flow diagrams, etc) from the group onto a white board or similar. Debate then takes place on the different topics to try and create a solution to the problem. Kanji and Asher[52] present eight basic rules that provide some formalisation to the ‘brainstorming’ technique, and point out that there may need to be some gathering of factual data to allow decisions to be taken. The case study in Chapter 7, (section 7.3.5) provides an example of brainstorming observed during the course of this research.

4.3.6 The Focus of Quality Initatives

Total Quality Management has been examined as the overriding quality initiative that is implemented by organizations and used in most of the latest theoretical literature. This presupposes that organizations either are striving to implement TQM or have already. Yet, during the course of this research there was little evidence of TQM. The implementation of quality initiatives appeared to be lower down the evolutionary scale with the focus on Quality Assurance and Quality Control with particular emphasis on implementing the ISO9000 group of quality standards.

4.3.6.1 Quality Assurance and the Quality Management System

The main task of Quality Assurance (QA) involves the development and support of the Quality Management System (QMS). The QMS has a key role in any organization wide quality initiative (including TQM). The QMS is a system put in place as an interface between the organisation and the customer, with the aim of looking after the 'well-being' of both i.e. the profitability and survival of the organisation and satisfaction of the

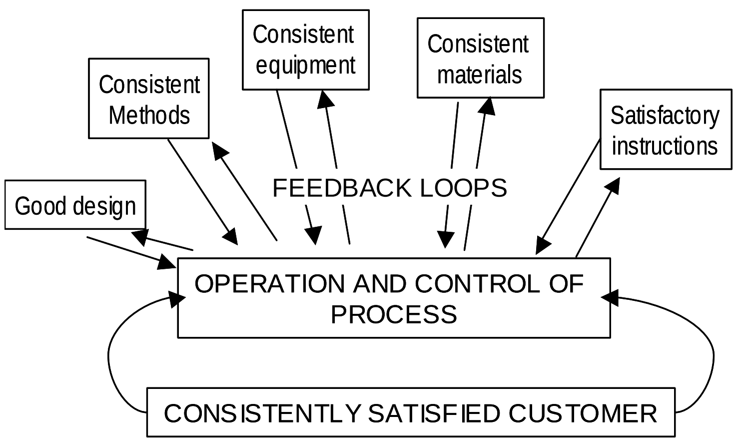

Figure 4.11 The role of the quality management system (Mortiboys and Oakland)

customer. Whilst seen as an interface between the customer and the supplier in reality the system is implemented in the supplier organization. The quality management system's purpose is to ensure that the company is achieving the objectives set out in the organisations quality policy as shown in the main case study in Chapter 8.

The system is one of control, where information and data are collected from the customer and company and used to shape, change, and improve the quality of the service or product provided in relation to the risk, cost and benefits accorded to the company. Figure 4.11 adapted from Mortiboys and Oakland[53] illustrates a series of sub-systems that all have feedback loops to facilitate the control of the process. The quality system used in each of these sub-systems must be appropriate to the type of activity and product or service being offered. The International Standards Organisation (ISO) Standard 9000 Series sets out the methods by which a management system, incorporating all the activities associated with quality can be implemented in an organisation to ensure that all specified performance requirements and the needs of the customer are fully met. These methods are a guide and as such have to be tailored to suit the individual circumstances and needs of the organisation using them. Part of the feedback loops in a quality management system consists of the need for an audit and review facility. This facility has two functions. The first is to determine whether the people in the organisation are operating according to documented procedures or instructions (something which has given rise to a lot of debate in management literature). The second is to ascertain whether the system meets its designated requirements. The quality management system is meant to be dynamic to improve and evolve in line with the changing needs of the organisation.

4.3.6.2 Quality Audits

The definition of a quality audit as given in the British Standard BS4778/ISO 8402 is as follows:

> "A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives"

Quality auditing is a management tool for achieving the objectives set out in an organisation's quality policy. There are three kinds of quality audit,

Quality Audits

First Party	Second Party:	Third Party:
(or internal quality audits) Audits carried out within an organization, using its own staff, to give the management the assurance that their quality systems are operating effectively	Audits normally carried out by the purchasing organization to provide assurance that the suppliers quality systems are capable of providing, or sustaining, the delivery of suitable products or services.	Audits carried out by independent agencies accredited to NACCB (the accreditation body), and provide a purchaser with assurance on the effectiveness of a supplier's quality systems.

Figure 4.12 Defining the three types of Quality Audit

Auditor(s) hired to act on behalf of a company or regulatory body may perform any of the audits shown in Figure 4.12. From an organizations viewpoint what they hope to achieve by using quality audits is as follows:

- To obtain factual input for management decisions;
- To obtain unbiased management information;
- To know factually if the company is at risk;
- To identify areas of opportunity;
- To improve communication and motivation;
- To access individuals performance based on facts;
- To assess status and capability of company equipment;

- To assist with the training of company staff.

As the need for companies to have industry-recognised quality accreditation like ISO 9000 has increased (frequently due to tender requirements) the number of people and companies offering quality-auditing services has also grown. This has led to problems in the standard of auditing which can fluctuate depending on the capabilities of the auditing team. Also the auditing team has to have some industry specific experience to be able to fulfil some of the

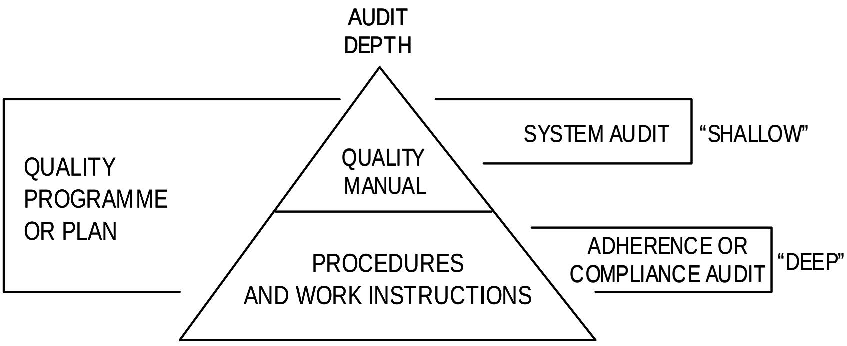

Figure 4.13 The areas encompassed by quality audits

criteria listed previously. Auditors only audit the quality of the systems in place and not the specific mechanics of the procedures themselves, but this would appear to defeat the purpose of being able to give creditable feedback to the management. Quality audits have been developed for a manufacturing/production environment and as such they rely on repetitive, stable environments for implementation. The benefits or otherwise to projects from using the auditing mechanism and its role as vehicle for feedback is examined in the main case study in Chapter 8. Figure 4.13 illustrates the areas covered by quality audits which all revolve around the quality management system. A key role of the audit function is vendor evaluation. This is to determine whether it can supply the required standard of products or services that an organisation needs (the responsibility for quality lying with the supplier, in theory allowing the customer to reduce or stop inspection of supplied items) The rating of the vendor can involve first party and third party audits not only to determine its ability to supply the product/service but also to assess its own quality systems and its economic and financial stability.

At the Electricity generating power station project Heysham 2, R.M McMillan[54] of the CEGB cites the strong resistance and apathetic response to the objectives and presence of formal Quality Assurance (although it eventually came to be accepted) Measurement by an external agency can lead to resentment and suspicion. Suspicion is possibly not unique to this particular project. Quality techniques and methodologies all seem to be encumbered by this in built ability to produce resentment (whether justified or not) from all types of organisation and profession. It is speculative to suggest that organisations/professionals would respond better to 'quality' if it was a self measured type of monitor, a performance indicator that did not involve the continual questioning of the ability of the organisation without looking at the all the circumstances that led to a particular outcome. It seems that audits whether 'external' or 'internal' immediately start from a point of mistrust on both sides. The audit in theory should illustrate the need for an improvement in or a continuation of the systems employed by an organisation. The audit is an equivalent of the quality control inspector. The audit only gets a snapshot in time of the whole picture, and therefore the information gathered could be flawed by one extraneous factor or deliberately manipulated to suit the audit. The feedback from an audit is the data, which should drive the engine of 'continuous improvement', but if this data is flawed, the resultant recommendations will also be flawed. Quality Assurance and ISO9000 are examined in greater detail in Chapter 8, which allows the theory to be contextually applied to one of the research case studies.

4.3.7 Quality Control

As defined in the introduction Quality Control (QC) is the 'operational techniques and activities that are used to fulfil requirements for quality'. QC is the functional part of quality, the aspects of quality that are primarily aimed at operational improvement. QC provides the tools and techniques to achieve this. Its roots are in manufacturing and therefore have a larger emphasis on technical issues than other quality initiatives. Caplan[55] summarizes the five stages of quality control, in the context of manufacturing as,

> “1 Set the quality standard, or quality of design, required by the customer.
>
> 2 Plan to achieve the required quality. This will involve:
>
> a) Planning methods
>
> b) Planning equipment
>
> c) Obtaining satisfactory materials
>
> d) Selecting and training operators,
>
> e) Planning inspection and shop floor quality control.
>
> 3 Manufacture right first time.
>
> 4 Correct for any quality deficiencies, i.e. defective work such as scrap, etc.
>
> 5 Provide for long-term quality control and planning.”

Caplan[54] also defines the meaning of control, as the ability to work to a plan, be able to compare what has been done to that plan, and if there has been any divergence from that plan the activity ‘feeds back’ instructions to realign the activity with the plan. Therefore a QC system has traditionally been based on a continuous ‘feedback’ of information. Chapter 12, Section 12.3.1 examines in further detail the traditional role of feedback as part of a quality control system and its relevance to project management.

4.3.7.1 Statistical Process Control (SPC)

A main part of QC, Statistical Process Control (SPC) is the control of a process by

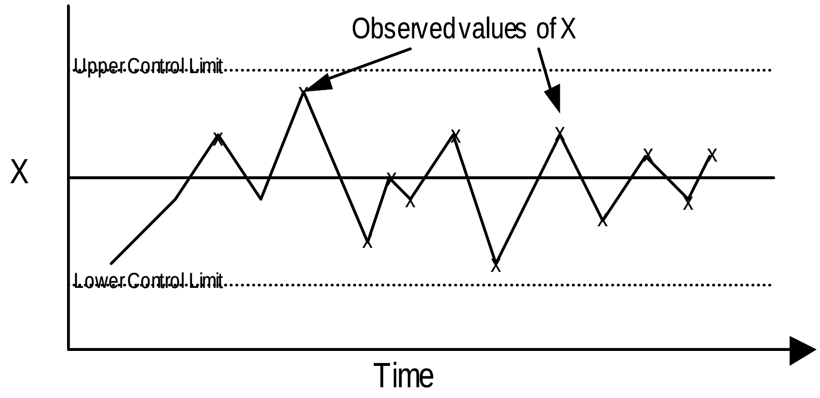

Figure 4.14 A statistical process control chart

statistical means to reduce the quantity of defective products, which are produced. The main objective is to reduce the amount of variation in the process. The control chart is the main tool in SPC. The type of measurement can be averages, ranges, the percentage of product non-conforming, or the number of non-conformities. An example of an averages SPC control chart is shown in Figure 4.14. As described by Juran and Gyrna[56]

> “ a state of statistical control only exists when only common causes of variation exist in the process.”

The advantages of this are the stability of the process that makes it possible to predict its behaviour. Leading from this is the ability to reduce the chance of instability by analysing the variables and reducing the control limits applied to the product or service. Chapter 12 (Section 12.3.2) examines the concept of variation in the context of the case studies carried out.

4.4 The Potential of Quality Initiatives in Project Management

4.4.1 Advocating change in project management

Some authors are suggesting the embracing of quality techniques as the only way that projects organisations will prosper. Indeed Morris[57] predicts a crucial change in projects in terms of,

"*attitudes* and fundamental concerns over *performance*"

He describes quality management (in particular Total Quality Management) as a 'revolution' and one, which has helped Japan in its massive post-war growth. It is interesting to note that this text addresses the main historical 'sacred cows' of project management that would have to be challenged to implement TQM in projects namely,

- The abandonment of competitive tendering.
- Develop 'learning organisations',
- Analyse inefficiencies/errors over the whole production/project process,
- Produce quantifiable data to analyse,
- Develop long term relationships with contractors and suppliers,
- The use of statistical techniques to assist in risk management,
- Greater attention of the overall environment,
- The needs and input of the 'owner' of the project,
- Utilising 'best practices',
- A team approach to project design and production,
- Selection and training of personnel to promote positive attitudes throughout the organisation,
- The implementation of design control and a 'better definition of the management required at the front-end, strategic stages of a project'.

Morris[57] believes the principles of Total Quality will probably become the dominant philosophy guiding best project management practice. Certainly there is evidence of the benefit of some of these approaches. Anderson[58] illustrates the positive correlation between project managers' managerial attributes and project success i.e. the implication being that if an organisation chooses the right person for the project initially it will have more chance of success. He also points out that project management training is often 'ad hoc' and takes place 'on the job' whereas it should take place prior to a person's installation in a management position. In this research there was evidence of this in two of the case studies.

4.4.2 Attitudes and Perceptions

It has been recognised that the advent of quality management has brought about fundamental changes in the way that organisations operate. Quality techniques have been embraced by manufacturing industry and with some apparent success. However, the use of quality techniques in project management appears to have been kept to a minimum, in conjunction with a reluctance to embrace the ethos behind total quality i.e. continuous improvement. There maybe a number of reasons for this:

- A project takes a finite time and is usually too short to implement production derived quality techniques,
- The project environment is one of ever-changing conditions, negating the use of techniques that depend on measuring and altering a finite number of variables,
- The well defined boundaries between client, service provider, financier, user, and sub-contractor has led to a confrontational culture in which the avoidance of liability has become the main objective e.g. the Channel Tunnel Project,
- The use of temporary multi-functional teams in a project means that quality management training is an unnecessary and a wasteful cost,
- Existing quality standards do not adequately support project situations,

- Quality management controls and procedures stifle innovation,
- The documentation involved in quality management increases bureaucracy.

These possibilities are mentioned in detail in the context of the case studies in later chapters. In the majority of available project management literature the role of quality in project management is still seen as one of quality control i.e. the establishment and function of inspection procedures for incoming or outgoing material. The prevalent attitude encountered on quality in project management is exemplified by the following statement from Turner[59] who adapts quality guru Crosby's famous quality phrase 'quality is free' into,

"Quality is free, but not in the lifetime of a project"

It can be difficult to justify implementing a technique that will be of more benefit to future projects than the current one (when the costs have to be borne by the present project).

4.4.3 Quality initiatives,quality systems and their potential in PM

The emphasise of discussion of quality initiatives reflects the apparent potential of TQM in PM as identified when considering the potential for quality systems in PM. The introduction (Chapter 1, Section 1.3) described and defined three hierarchical levels of quality in project management,

1. Meeting the specification – the bare minimum to meet customer requirements.
2. Meeting the real requirements – the stage at which the project supplier actively identifies and implements the best project for the customer.
3. Learning and improving from the project experience – the ability of the project organization and its stakeholders to create feedback, store and disseminate knowledge with the aim of increasing future project success.

As stated earlier quality has now become a strategic management topic, to examine what the potential for quality initiatives hold for project management, the scope of the initiative has to be defined. The key part of any quality initiative (in particular TQM) is the Quality Management System (QMS) as described earlier in Section 1.3.2.1. Through the case studies carried out during this research an evaluation can be made of the theoretical and

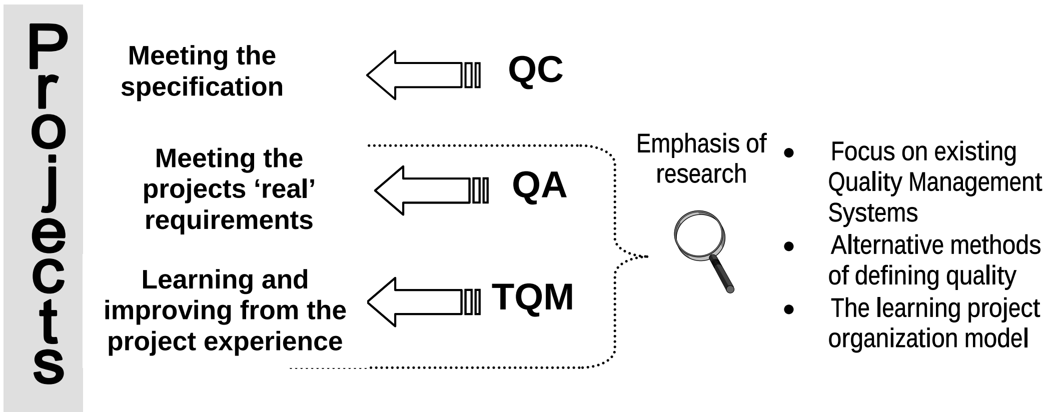

Figure 4.15 Updated mapping of quality initiatives to project definitions

practical role of the QMS and its potential for project management. Figure 4.15 represents an updated mapping of the diagram first shown in Chapter 1 (Figure 1.3) and illustrates the areas on which this research has been primarily focussed, typically examining the role of existing quality systems in project management, alternative methods of defining quality and the concept of creating a learning project organization model. Whilst creating some form of scope it has to be recognized that like many theoretical quality definitions there is a number of interpretations as to what form a quality management system can take. Oakland's[60] definition of a quality system is that it is 'an assembly of components, such as the organizational structure, responsibilities, procedures, processes and resources for implementing TQM.' He also recognises the importance of the relationships between the different entities and how the system should be analysed in a holistic manner (Chapters 9 and 10 on Systems Thinking and System Dynamics examines further the importance of interactions). Kanji and Asher[61] define a quality management system solely in terms of ISO9000 standard, describing its purpose as a demonstration to an organization's customers and independent assessors that there is an effective quality management system in place. What is relevant to this research in all the definitions of quality management systems is the emphasis on formalizing operations to ensure consistency, and the concept that by achieving this it will ensure consistent quality for the customer. Consequently if the QMS can provide this feedback system to achieve consistency can it operate in a project management environment that will always contain some degree of uniqueness?

The key underlying drivers to examining the significance of quality systems in projects were,

- Did they provide suitable feedback to facilitate future project success?
- Did they reduce risk? i.e. reduce the threat to the project and clients success.
- In project organizations where there was no identifiable quality system was there the need for one?
- Were there other possibly more effective forms of creating a quality system?

4.5 Conclusions

This chapter is based on a literature review and has provided an overview of quality, its history, its initiatives, its models and the areas of potential for project organizations that this research is attempting to address. As illustrated by the philosophy of TQM, the theoretical topic of quality appears to have moved away from its roots in QC and manufacturing, towards a more idealised culture based concept. Yet despite this its underpinnings are still based on earlier quality initiatives that revolve around a quality system, implemented with the aim of creating a repeatable, consistent process.

The project management world appears to have been slow in the uptake of quality techniques and methodology although this is perhaps understandable given that there has been a dearth of specific standards to support project situations although Antilla[62] considers that project equals service hence the use of service standards can be a substitute (this is examined later in Chapter 9 Case Study No.3). There is evidence of the need to change but this has emphasised the gaps between the two disciplines. Mikkleson[63] highlights the need for better integration but recognises the need for methods and tools that assist in the creation of quality particularly at the design/development phase of a project.

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Chapter 5

Systems Thinking: an alternative quality model?

5.1 Chapter Synopsis

Feedback between projects is commensurate for future project success, and the primary objective of this research is to examine the pertinence of existing quality initiatives in achieving that goal. Given the importance of feedback in project and quality management it was decided to investigate other areas that encompass feedback as an integral part of their methodology. Having briefly encountered systems dynamics models at the beginning of the research it was felt that a deeper understanding of both it and the topic of systems thinking would be beneficial providing an alternative perspective. The types of tools and techniques that exist at present in project management are generally aimed at scheduling, planning and reporting. The advent of personal computers has seen the development of project management software that emulates and elaborates paper-based techniques. This has increased the availability of such systems to front line project teams. The majority if not all of these tools deal solely with the 'hard' operational or quantitative aspects of project management, for example resource allocation, project planning or design specifications. These project management tools are geared towards hard systems that have been identified by Hicks[1] as having the following attributes:

- Meeting a 'designed set of objectives' i.e. can solve a problem situation.
- They are 'goal seeking'.
- An optimal solution is attainable.

In addition there is an assumption that a project can be deconstructed, the individual components understood which allows the whole project to be managed. It is also assumed that a project has a linear sequence with no feedback.

The qualitative variables (in this context 'soft' variables) that are present in all projects tend to be pushed into the background, something to be left to chance or are assumed that they are fixed variables, for example a particular company policy or strategy, or the behaviour of personnel under certain conditions. As these 'soft' issues are integral with the success of the project, it seems that present project management tools are rather deficient in their scope. Personnel are seen as resource to be scheduled, which is undoubtedly needed, but there is no way of recording the response of those personnel under certain conditions and how that effects the quality of the activity being carried out or the effect on the project as a whole. The process of information gathering for creative feedback is left to become 'experience fodder' for the individuals on the project.

Systems thinking (ST) and system dynamics (SD) encompass methodologies and tools, which identify and model the relationships between both the hard and the soft variables in a business environment. It was decided to examine what systems thinking and the related area of system dynamics had to offer project management. The primary objective for doing this was to examine alternative ways and means by which quality could be measured or illustrated in a project management environment. As part of the systems thinking topic, an alternative model on how organizations learn has also been examined to determine the role of feedback in this process, to determine if this could be practically applied to a project management organization.

The following two chapters examine and briefly illustrate the following topics and their impact, similarity or relevance to project and quality management.

Chapter 5 Systems Thinking –

- Theory, guidelines and archetypes
- Influence diagrams
- Mental Models and the Learning Organization

- Soft Systems Methodology

Chapter 6 System Dynamics

The elements discussed in this chapter shall also be utilised in forthcoming case studies. There is a wide range of opinions in the 'systems movement' as to what constitutes systems thinking and whether system dynamics is a tool or a methodology in its own right, therefore it should be recognised that this chapter is by no means definitive on the topic of systems. The chapter is a selective overview of the relevant topics analysed for this research. Included in this is another systems methodology Soft Systems Methodology (SSM) that according to Richmond[2] although having elements common to systems thinking does not meet with his 'purists' ideal of systems thinking. Despite this view, Soft Systems Methodology has been included primarily to cover the topic of 'rich pictures', which the author believes is an invaluable method of illustrating a systems present state, and clearly is akin to many of the

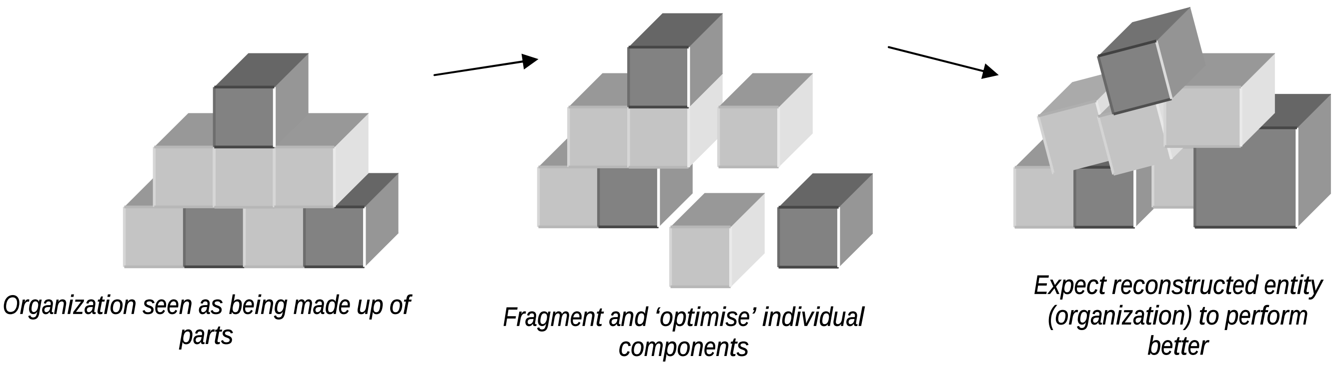


Figure 5.1 Classical View – Mechanistic Thinking

other system methodologies.

5.2 Systems Thinking

5.2.1 An Alternative Methodology

Systems thinking has been born by the need for an alternative or complementary methodology that covers the areas where established analytical based models can not explain. As illustrated by Flood and Jackson[3] prior to systems thinking mechanistic approaches were the 'classical or rational' views of organizations. To increase the performance of an organization it was believed that reductionism and optimisation of the constituent parts would lead to better performance as a whole as conceptualised in Figure 5.1**.** An analogy of this is frequently seen in team sports, when some teams despite having individually brilliant players do not perform well as a whole. When the players do become a team there is a synergy produced that increases the performance of the team beyond its individual capabilities.

5.2.2 Defining a 'System'

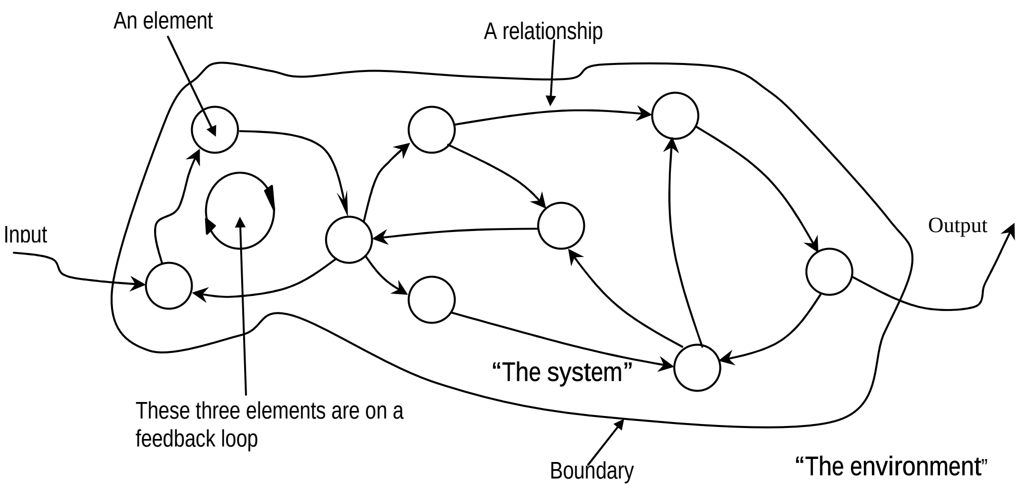


Figure 5.2 A representation of a system (Flood and Jackson)

Prior to defining 'systems thinking' the concept of a system must first be illustrated and conceptualised. Reproduced in Figure 5.2 is Flood and Jackson's[4] general conception of a system, which gives a clear and simple base to define elements of the system.

Flood and Jackson conceive systems to exist in a hierarchy, consisting of other subsystems with the same characteristics as shown in Figure 5.2. Additionally they have created metaphoric classifications for systems and their attributes. The rationale behind this approach is to make the recognition of problems in a systemic environment easier and more coherent thus leading to the choice of an appropriate systems methodology to solve the problem. Later in this chapter Table 5.1 provides a summary of these systemic metaphors including their strengths and weaknesses and their relevance to quality and project issues. The full range of systems methodologies analysed by Flood and Jackson is beyond the required scope of this chapter.

5.2.3 The origins of Systems Thinking

Systems thinking originated from the biological sciences and has also been present in other subject areas. Balle[5] gives a historic example of engineering theories on feedback control that point to a 'systems thinking' approach in 1867, and like Flood and Jackson he appears to maintain the view that 'systems thinking' emerged in the 1940's. Since then, it has grown and developed to be applied to a wide range of disciplines including management and organizational related areas.

5.2.4 The theory of Systems Thinking

The following personal definition of 'systems thinking' by Richmond[6] although esoteric does capture the essence of what system thinking is, and in conjunction with his operational

Systems Thinking is a…..
- *Paradigm*
  - *Vantage Point*
  - *Set of Thinking Skills*
- *Learning method*
  - *Process*
  - *Language*
  - *Technology*

Figure 5.3 Richmond's operational definition of systems thinking

definition (illustrated in Figure 5. 3) plots a route for newcomers to the field to follow:

> "…systems thinking is the art and science of making reliable inferences about behaviour by developing an increasingly deep understanding of the underlying

structure."

There is a wide range of ideas, opinions and techniques allied to system thinking, gestalt therapy, cybernetics, chaos theory, general systems theory, soft systems methodology to name a few, but they all have a common thread, systems behave in a generic manner and this behaviour can be identified and articulated. It is pointed out by Balle[7] that systems thinking is not 'holistic' in the sense that there is any connection between remote far flung objects (his examples include trying to connect a crab, the ozone layer, and capital life cycle together). Rather it is in the 'understanding' that what is causing our immediate problem may not be in the immediate vicinity, and therefore the solution may not be in the immediate vicinity.

To describe and model systems some form of medium is needed, the 'language', which is synonymous with systems thinking, is "system dynamics" developed by Forrester at the Massachusetts Institute of Technology. Flood and Jackson[8] describe system dynamics as a 'theory of information feedback and control as a means of evaluating business and other organizational and social contexts'. System dynamics will be examined in greater detail in the next chapter.

5.3 Guidelines to Systems Thinking

Balle's text Managing with Systems Thinking[9] gives a general overview of the systems thinking process and how to harness it in a practical situation. His three guidelines to systems thinking are:

1. Focus on the relationships rather than the parts.
2. Detect patterns not just events.
3. The use of circular causality.

These three guidelines shall be used as a loose framework in the following sections to discuss and explore the practicalities of systems thinking.

5.3.1 Focus on the relationships rather than the parts.

System thinking examines how structure influences behaviour, with importance being placed on interrelationships. This has similarities to Total Quality Management (TQM) which constantly stresses systems that promote interrelationships between the various parties in and around an organization. The ISO9000 series of quality standards refer to the Quality Management System (QMS) as a prime example of a system, which is in place to create symbiotic relationships between customer and client i.e. its basic function, is to provide a system, which benefits not only the customer but the organization as well. In project management the practice of creating closer ties with the customer is typically viewed as mutually beneficial (as shall be discussed in the first case study in Chapter 7 and later in Chapter 11). Quality systems that contribute towards this symbiosis and engender longer-term relationships will increase the chance of successful project outcomes as recognised by Morris[10]. In industries like construction and civil engineering, conflict frequently centres on the form of the contract, which prevents long-term relationships between customer and client (as shall be illustrated in Chapter 8, Section 8.6.12.) Initiatives to create better contract conditions and thus improve project relationships are examined in Chapter 11, Section 11.5.3.

5.3.2 Detect patterns not just events

In the organizational environment (i.e. the organization and the internal and external forces acting upon it) system thinking encourages participants to observe underlying trends and patterns in order to 'perceive the forces underlying these events'. Richmond[11] believes that systems thinkers should see both the pattern and the event, as he puts it, the generic and the specific – keeping one eye on the woods and one eye on the trees. He believes that system dynamic practitioners have overlooked 'operational thinking' looking at the 'building blocks of stocks and flows' that make up the infrastructure of a system before adding feedback.

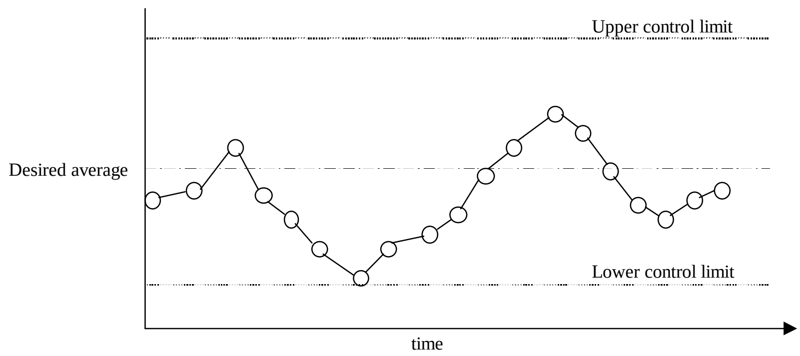


Figure 5.4 Statistical Process Control chart

5.3.2.1 Statistical Process Control

There is commonality between the concept of detecting patterns and the use of Statistical Process Control (SPC) as used in the quality control of many manufacturing processes. Although SPC is firmly rooted in the production line (and ‘hard’ systems) as a statistical method of determining trends and variability in a process over time, its purpose is similar. As Juran and Gyrna[12] describe, SPC detects the difference between random (common) causes of variation and assignable (special) causes. Assignable causes are ones that cause a process to go out of control, and can be traced and rectified. Random causes are inherent in a process and as long as they are within the process limits (and the system is stable) then they are seen as acceptable. By reducing the control limits i.e. the variation in the process the closer the process is to achieving the desired result. In SPC the information is displayed on a control graph measuring for example the desired average number of items produced against what is produced over time and if they are within tolerance (the upper and lower control limits) as shown in Figure 5.4**.** The four basic behaviours illustrated in Figure 5.5 (adapted from Balle[13]) representing growth in systems thinking are:

1. Exponential growth (and decay).
2. Growth and stabilization.
3. Overshoot and rapid response.

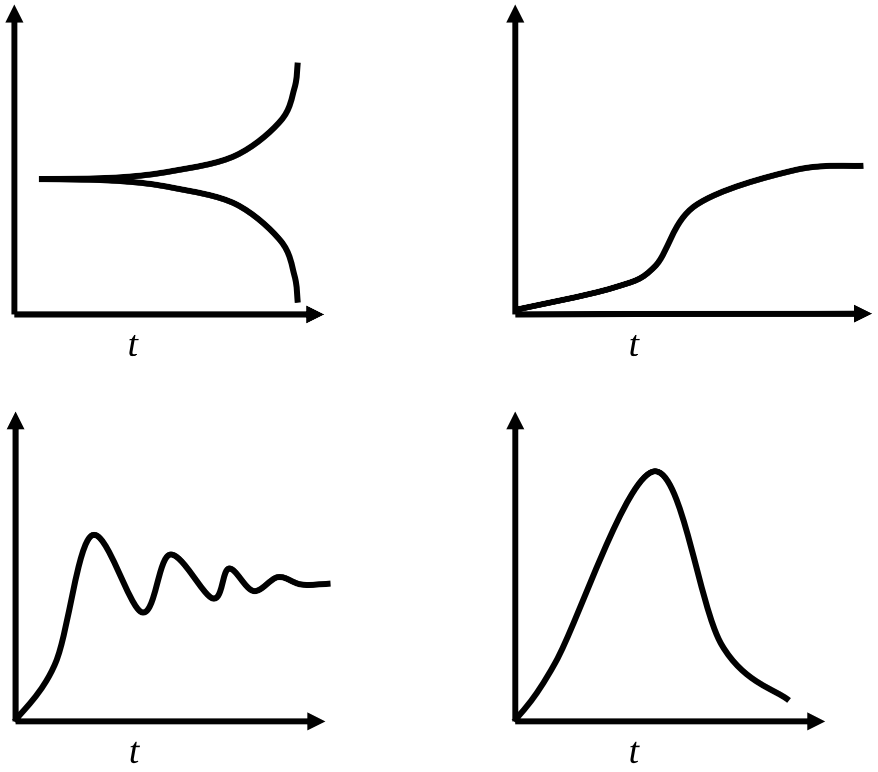


Figure 5.5 Four basic representations of growth (adapted from Balle[12])

4. Overshoot and collapse.

Both systems thinking and systems dynamics analyse the stability of the systems under scrutiny, and although they produce more complex patterns than SPC, their roots can be traced back to the same control engineering principles, applied to a more volatile 'human' environment. Whilst these patterns of behaviour have been identified in project management, for example the 'rework cycle' introduced in Chapter 3, the application of identifying these patterns and utilising them to create beneficial change is not so apparent. This is perhaps due to the transient nature of projects and the limited amount of resources that project organizations commit to improving feedback between projects.

5.3.3 System Archetypes

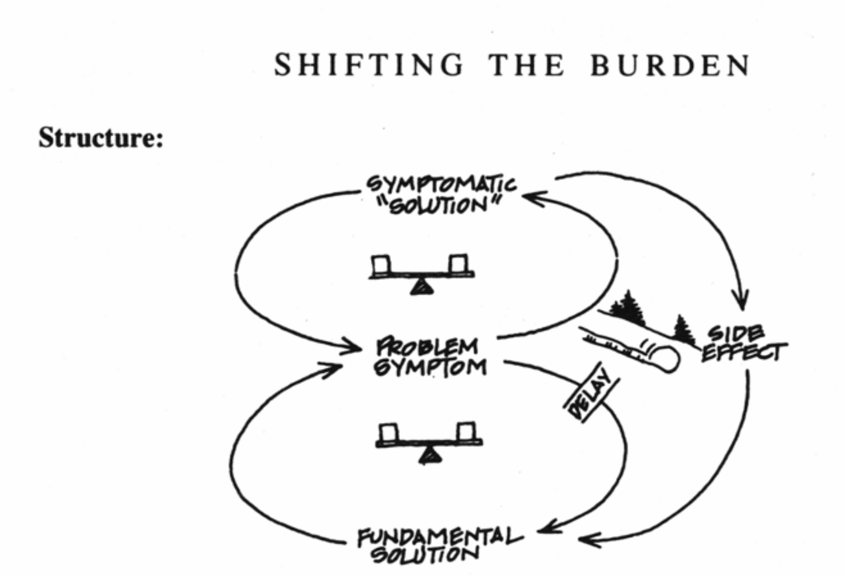
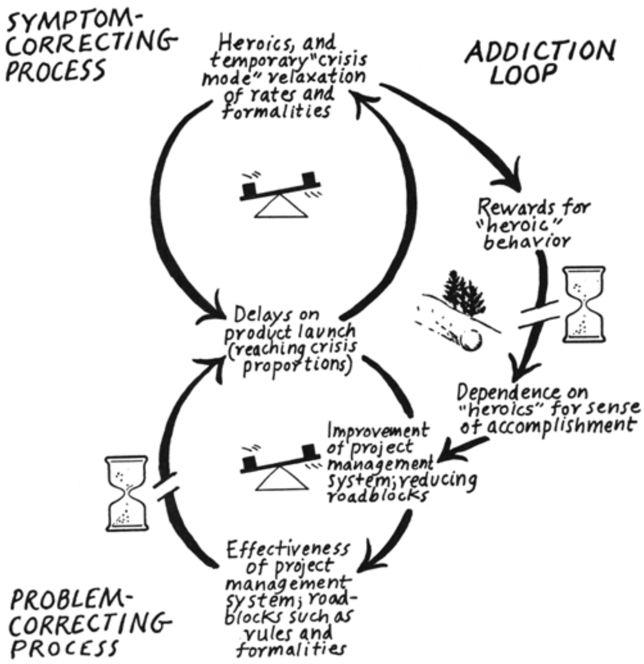


Figure 5.6a) Senge's archetype template for 'Shifting the Burden' situations

The identification of system 'archetypes' is a major part of Peter Senge's influential text - The Fifth Discipline.[14] An archetype is an underlying structure (structure here is meant in the systemic sense i.e. it is referring to the interrelationships between key variables), which can be identifiable in an individual, a situation or an organization. Senge's[15] archetypes are illustrated using causal loop diagrams. These diagrams with their loops and sketches illustrate different types of behaviour and its constituent parts. Reinforcing loops, signified by a snowball going down a hill and balancing loops signified by a 'balance beam' or 'see-saw' combine to produce the complete archetype.

5.3.3.1 An example of an archetype

Figures 5.6a) illustrates Senge's template for the 'shifting the burden' archetype. Figure 5.6b) is an example of the archetype applied to a project management organizational scenario. The scenario illustrates the 'crisis heroism' involved in getting a delayed product launched, obstacles to launching the product are removed and normal operating procedures are disregarded. The diagram illustrates how the 'symptoms' can be addressed, but the 'fundamental' solution (changing the effectiveness of the project management system) will take longer. The consequences of this according to Senge can lead to an addiction to 'crisis heroism'.



The archetype illustrates the relationships, responses, delay and feedback in the context of a project management scenario

Figure 5.6b) 'Shifting the Burden' applied to a project management organizational scenario

System archetypes are seen as 'templates' from which to base analysis of systemic behaviour. One danger highlighted by Richmond regarding using the archetypes in this way is that they are being used by people in a matching exercise rather than in an attempt to generate their own wisdom in systems thinking. This may be the case where it is seen as a quick fix analysis but as a starting point to understanding the rationale behind systems thinking they provide very useful templates. Senge[16] does stress that the archetypes are 'tools for inquiry not advocacy', i.e. by themselves they are not a solution but should help in finding one.

5.3.4 Analogies and Visual Representations

It is very noticeable that systems thinking relies heavily on analogies and visual representations of systems as a medium of knowledge transfer, because of this there is a number of different styles of representing systems although they all basically adhere to similar principals[17]:

> "The eminent mathematician and astronomer Johannes Kepler once remarked, 'Above all, I value analogies, my faithful instructors. They are in possession of all the secrets of nature and should, therefore, be the last to be ignored.' Kepler was probably referring to mathematical analogies, of which there are many. Simultaneous equations, for example, serve many problem areas depending on the meaning associated with the constant coefficients."

Table 5.1 provides a summary of systemic metaphors defined by Flood and Jackson[18] in conjunction with their relevance to quality and project management.

Table 5.1 A summary of systemic metaphors

Systemic Metaphor	Strengths	Weaknesses	Synopsis	Relevance to QM and PM
Machine metaphor or 'closed system' view	Useful for unambiguous tasks Production line repetition No thought human participation Best in stable environment	Exposed in a capricious environment Dehumanising leading to dissatisfaction and boredom	Emphasises the efficiency of the parts as opposed to the whole, typified by theories from Taylor's scientific management or Weber's bureaucracy[1]	Able to see the background of QM standards in a mechanistic system. Although PM does breakdown the parts of a project e.g. activities in a network, it cannot treat them in isolation or the project will fail.
Organic metaphor or 'open system' view	Changing environment Conditions determine survival Promote responsiveness and change Complex competitive environment	Does not recognise 'human' element Interrelationships between entities are often in conflict Change is governed by outside environment therefore little 'proactive development'	Derived from biological sciences, is the first of the 'system thinking' views, sees environment where organizations have to survive (like the natural world) Elements of this system interact with each other, forming relationships and using feedback. The system is part of the environment in which it exists with inputs and outputs to it. Self regulating and 'homeostatic'	Prior to and in parallel with the existing imposed quality systems, the open system is the true reflection of how project management companies survive – the ability to act quickly, change to their environment and surpass competitors.
Neurocybernetic metaphor or 'viable system' view	'Dynamic goal seeking based on learning' Useful in situations with high uncertainty. Advocates creativity	Doesn't always differentiate between the aims of the individual parts and the whole Too radical for existing organizations – would 'upset the status quo' Like open system view doesn't recognise social construction of organizations	Similar to open systems view, except emphasis on active learning and control to counteract the effects of the surrounding environment. Therefore 'aims and objectives can be dynamic rather than static and self-questioning rather than self-regulating. Found in innovative companies and Research and Development activities.	Possibly the type of system that would benefit PM organizations. At present individuals do learn and take control but in an 'unofficial' capacity. The demarcation present in industry quality systems tends to narrow the scope for learning, although the documented framework available can aid the initial training/learning process.
Cultural metaphor	Highlights the difference between 'installed culture' and other cultures Offers different perspectives on the advantages or disadvantages of 'culture'	May generate feelings of manipulation, resentment and mistrust due to ideological control Changing culture is evolutionary not	The 'unspoken but familiar ways of thinking and acting that exists in all firms and enterprises' Culture exists in many various forms and can be determined by country, religion, language etc. In the organization the culture is a	Total Quality Management - TQM is seen as a culture in which the main principles are to create a harmonious, mutually beneficial, symbiotic relationship with your

[1] See Chapter 3 p58 on Weber's theories of bureaucracy

Systemic Metaphor	Strengths	Weaknesses	Synopsis	Relevance to QM and PM
	Attempts to focus on perceptions and values of employees to offer new perspective on organizational change	immediate. Breaks down with political infighting that is seen as 'normal' Gives no templates for organizational structure	'socially constructed reality (of values and beliefs) Determines the organizations ability to cope with change. Quality management theory seen as one area which attempts to manage 'culture' Examples given are high tech Japanese firms and the 'competitive individualism of some American firms'. Culture also applicable to 'machine-like military set-ups'	customer. In achieving this aim applying a Quality Management System is seen as a good start[19]. (A debatable point) In project management the culture is one of being able to deal with change and adversity as a matter of course. This may engender an element of risk-taking that is not as apparent in more stable production type cultures.
Political metaphor	Highlights all organizational activity as interest based and emphasises the key role of power in determining political outcomes Goals may be rational for some actors and not rational for others Proposes disintegrative strains and tensions in contrast to other systems functionality and order Encourages recognition of the organizational actor as political for both motivational and structural reasons Reminder that all organizations exhibit political activity	Explicit recognition of the politics of the situation leads to further politicisation and generates mistrust. May over-emphasise the need to handle political issues at the expense of other factors, which are essential to organizational health-proper organizational structures, responding to market changes, etc.	The 'political' metaphor examines the relationships between individuals and groups and the pursuit of power in the organizational setting. Three contrasting views (from literature) on the 'character of a political situation' unitary, pluralist and coercive. This Metaphor focuses on three issues interests, conflict and power.	In a project there are a number of different stakeholders, the customer, the project team, the operatives/workforce, subcontractors, third parties (e.g. public) Each group (and each individual in the group) has their own agenda. In a project situation the contractor has aims and objectives not always commensurate with the clients. Politics are an integral part of project management, in negotiations, disputes and in the day to day running of a project. Quality management has a very fixed and traditional view on the power bases in an organization. The initiatives for quality should come from the 'top' and be implemented by those at the 'front-line'

These 'systemic metaphors' are designed to allow analysis of problem situations in a cohesive manner. An organization can be described with more than one metaphor, and if a particular metaphor highlights a particular problem, a specific systems methodology can be applied to it.

As can be seen from the system archetype diagrams the use of visual or graphical representations is prevalent in systems thinking. This allows systems thinking to be conveyed to others (people tend to be more receptive to visual stimuli than text) and promotes the conceptualisation of its theory. An example of this are the diagrams were created by the author to allow him to understand the concept of influence diagrams (Section 5.8). The system dynamics software examined in the next chapter relies heavily on the use of a graphical interface to create models. The concept of a 'repository of knowledge' for project feedback examined in later chapters may also be more productive if it stored images, still and video.

5.4 Systemic metaphors as an analysis tool

5.4.1 Total Quality Management (TQM)

Flood and Jackson[18] use TQM as an example to which they apply their systemic metaphors as described in Table 5.1. They break down TQM into two distinct categories improvement of communication and improvement of control. Improved communication between the different areas of the business internally and with the external customer. Improved control of the workforce by more accountability, management of smaller groups, demarcation of the work to be controlled as a project, or as an operation. Changes in reporting structures are also seen as intrinsic in the TQM process and management information systems may have to change. The overall 'ethos' which TQM should install in the organization is according to Flood and Jackson ownership of the quality problem and participation in resolving it.

From this synopsis they carry out their analogy using the systemic metaphors concluding that TQM is mainly a combination of the following two metaphors 'organic' and cultural' which can exhibit the following problems:

- Organic – open system view, which can lead to situations where there is no mechanism to deal with conflict (due to the emphasis on 'harmonious relations') and the 'social interaction' inherent in organizations.
- Cultural – fosters ideas of 'ideological control, manipulation and mistrust'. Is seen as a quick fix, and can be thwarted by political forces.

Other metaphors at a lesser level are attributed to the different parts of the philosophy, mechanical – referring to the emphasis on control and targets, and neurocybernetic – the use of consultation for organization wide expertise.

In examining the roles of these systemic metaphors it is apparent that when used to describe a philosophy or a problem situation in an organization, every part of the process is open to interpretation in a number of ways. How conclusions are reached as to what metaphors are used must be based on the experience of the particular organization. How is this experience gained? Is it based on a long-term consultation process or a number of ‘snapshot’ visits? In the example of interpreting TQM, the definition of what the philosophy entailed was taken as a basis for what problems could be expected. There almost seems to be an element of prejudgment with which a metaphor can gauge the behaviour of an organization in a particular scenario. TQM was recognized as a culture, but it was not recognized that as such it would be implemented in different ways in different organizations. Therefore, to formulate a series of analogies on one generic definition seems to defeat the problem solving process that the system metaphors are part of. Despite this criticism, the need for such analogies to stimulate critical examination of the organizational environment must be beneficial if it raises awareness.

5.5 Conceptualising the ‘System’

Influence diagrams, causal-loop diagrams, process mapping are similar ways to visualise the relationships and behaviour that exists in a system as in the ‘system archetypes’ just illustrated. Analysis in systems thinking becomes an integral part of system dynamics:

1. Analyse the situation and identify the interrelationships – using systemic metaphors if necessary.
2. Construct an ‘influence diagram’ to illustrate and analyse the relationships and the

behaviour witnessed. This may be as far as is needed for some scenarios, although if there needs to some form of modelling needed then it necessary to use tools like system dynamics.

3. Use system dynamics to model and simulate the ‘system’ in different situations based on the influence diagram and what has been learned from the organization.

Note: this is a simplified outline of the steps required.

5.6 The Core of Systems Thinking - Mental Models

At the start of the chapter ‘Classical thinking’ is defined as a thinking process whereby a problem is broken down into its constituent parts and analysed, which at first appears to correlate with what happens in the ‘classic’ project management world. Projects are broken down into activities, which are broken down further depending on resource or cost until the process reaches what is determined to be a ‘manageable’ size i.e. at a point where a person or a group of people can understand and control the outcome of the project. An explanation of this is that in project management there is an overall linear causality i.e. a sequential chain of events where the manageable parts have to relate to one another for project to succeed. Communication within and between projects is often an area of concern with particular relevance to quality management; thus a better understanding of the mental models used and methods for making them more explicit might enhance communication.

5.6.1 An alternative to ‘classical thinking’

Conversely, mental models are sets of assumptions and perceptions, which colour the way in which a person sees and reacts to a particular situation. According to Balle[20] these mental models tend to have three general rules, consistency, stability, and simplification. To condense these rules, people hold onto their beliefs, theories arguments etc., in a consistent manner, which can in turn effect the way in which they view a situation either individually or as an organization. He believes that because of the lack of awareness of mental models that people are trapped with a narrow perspective and a reluctance to encompass new ideas and thoughts. The answer is (according to Balle) in being able to manage ones own mental models; to reduce the narrowness of thought i.e. to challenge the norm that stifles systems thinking. The author had to challenge his own mental models in the course of this research to ensure that his own pre-understanding did not engulf the action research process described in Chapter 2, Research Methodology.

5.6.1.1 Mental Models in Practice

Senge[21] illustrates the success that the petroleum giant Shell has had in using and managing mental models. The application of these has contributed to successful corporate strategies, which have sometimes flown against the conventional wisdom at the time:

> " Perhaps the first large corporation to discover the potential power of mental models on learning was Royal Dutch/Shell. Managing a highly decentralised company through the turbulence of the world oil business in the 1970's, Shell discovered that, by helping managers clarify their assumptions, discover internal contradictions in those assumptions they gained a unique source of competitive advantage…When the OPEC oil embargo suddenly became a reality in the winter of 1973-74, Shell responded differently from other oil companies. They slowed down their investments in refineries, and designed refineries that could adapt to whatever type of crude oil was available. They forecast energy demand at a consistently lower level than their competitors did, and consistently more accurately. They quickly accelerated development of oil fields outside OPEC. "

Senge does not attribute all of Shell's success to its corporate managing of mental models but he does point out that Shell's continues to experiment with a 'wide variety of tools for "mapping" mental models.' These tools are largely focused at 'soft systems', which are non-quantifiable variables. As concluded by Senge:

> " The common denominator of all these tools is that they work to expose assumptions about important business issues."

5.6.2 Mental Models in Quality Management

In the Fifth Discipline Fieldbook[22], Roberts and Thomson describe what they believe to be the five dominant mental models of quality that some managers hold:

> **Status Quo:** "Quality is not an issue in our organization. We hire only the best people, and our products are as good as anyone else's. We keep them up to our usual standards."
>
> **Quality Control**: "Quality is the process of inspecting and catching mistakes before they get shipped and our customers have to deal with them. We hold people accountable for their actions. Modern QC techniques make it easier to track down their mistakes."
>
> **Customer Service:** "Quality is listening to the customers and solving their problems as quickly as possible at no extra charge. Mistakes and 'bugs' can't be avoided, so we have an 800 number and field service personnel ready to go twenty-four hours a day. We will do anything to satisfy our customers."
>
> **Process Improvement:** "Quality is using statistical process control, reengineering, and other quality tools to understand and eliminate unacceptable variation in our processes, products, and services. We believe people particularly in teams, are a resource for learning about inefficiencies and making changes. We are constantly engaged in improving how we operate."
>
> **Total Quality:** "Quality is a transformation in the way we think and work together, in what we value and reward, and in the way we measure success. All of us collaborate

to design and operate a seamless value adding system which incorporates quality control, customer service, process improvement, supplier relationships, and good relations with the communities in which we operate – all optimizing for a common purpose."

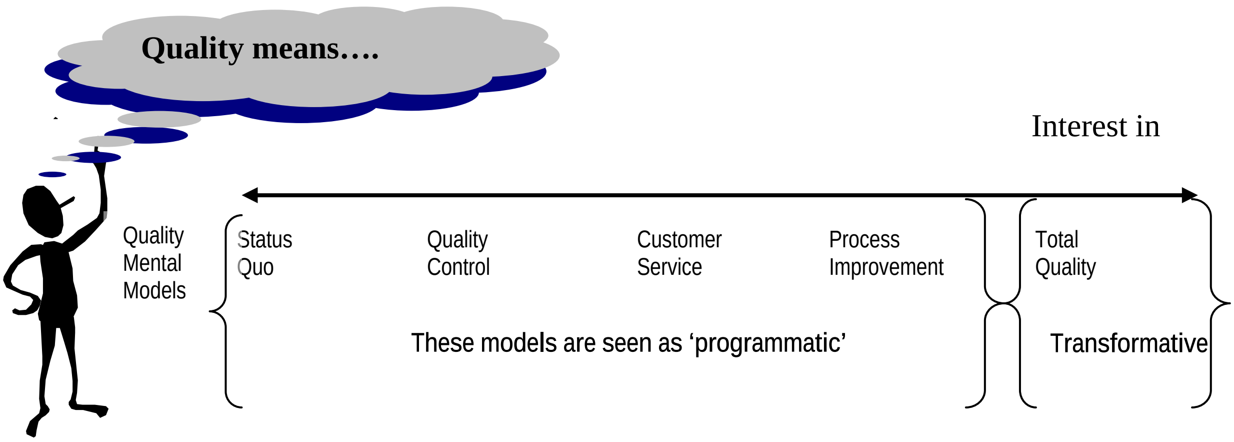


Figure 5.8 The progression from programmatic mental models to transformative mental models

The notion that there is management in organizations with these preconceptions is not difficult and these generic mental models shall be used in context in the case studies. Roberts et. al[21] regard any people (managers) attempting to become a 'learning organization' the nearer they are to the Total Quality model as shown in Figure 5.8. Their summary of the positive attributes of 'Total Quality' is as follows:

- Its uniqueness in its transformational potential.
- Focuses people on the whole system (both 'hard' and 'soft' issues).
- Focuses on collective learning and action.
- Focuses on the peoples own aspiration for improvement.

The failure of 'quality programs' has been attributed to organizations seeing them as an effortless way of improvement without sufficient input from themselves. Figure 5.8

illustrates the 'programmatic' mental models and indeed Roberts et al[23] recognise the thinking behind the implementation of such quality programs. In their opinion it is a lack of shared vision and values that doom the quality programs to failure. If the organization has implemented a 'compliance-based quality effort' management 'has the continual burden of motivating and manipulating people to get on the quality train'. This does tend to lend credence to the idea that if quality based systems like ISO9000 are implemented by an organization for spurious reasons then they will become self defeating, personnel will circumnavigate the system and create an alternate one. Seddon[24] gives examples of this as, where personnel getting their quality system audited would cheat to pass the audit.

5.6.3 Fundamental Differences

Quality management standards and text all stress the need for top management to be the drivers behind any quality effort, which is not dissimilar to the wisdom behind the 'learning organization'; the one crucial difference is that the latter involves the whole organization. In what is referred to, as a 'commitment based effort' by Roberts[25] the people in the organization have the opportunity to be involved in the quality effort, not have it thrust upon them. The following incisive paragraph from Roberts gives clues to the misdirection of existing quality initiatives like ISO9000:

> "If members of your organization are committed, the leadership for relating, measuring, learning, redesigning and standardizing comes from each member. People continually learn and improve their own and others' performance. The management task <u>is to manage ideas, co-ordinate resources, and create a quality work environment-not to generate motivation.</u>"

5.6.4 A Change in Culture

In project management peoples' learning increases with each project experienced, therefore is it possible to create a quality work environment that promotes organizational learning as espoused by Senge and also distributes the knowledge gained? On a pragmatic level this would require a fundamental change in some industries particularly the construction industry from which two of the case studies have been created. The projects that the author has been involved with as a practitioner and a researcher have always involved disparate groups of people being brought together to achieve an objective. This process has created relationships (both genuine and out of necessity), which have crossed the barriers that are erected between the actual doing of the project and the managing of the project. From the relationships the individuals involved produce an entity (a project team) that carries out the project. Unfortunately the social constraints present in most organizations do not want to recognise the benefits of interaction between all of those involved in the project and as such the learning experience benefits the individuals and not the organization. It is recognised that there are many socio-economic factors that have contributed to the present adversarial environment in industry but possibly that could be changed by methodologies like systems thinking which rather than adopting a top-down or bottom-up approach attempt to be 'participative at all levels[26]'.

5.7 Knowledge based experience and Organizational Learning

In the process of researching systems thinking, the author discovered an interesting

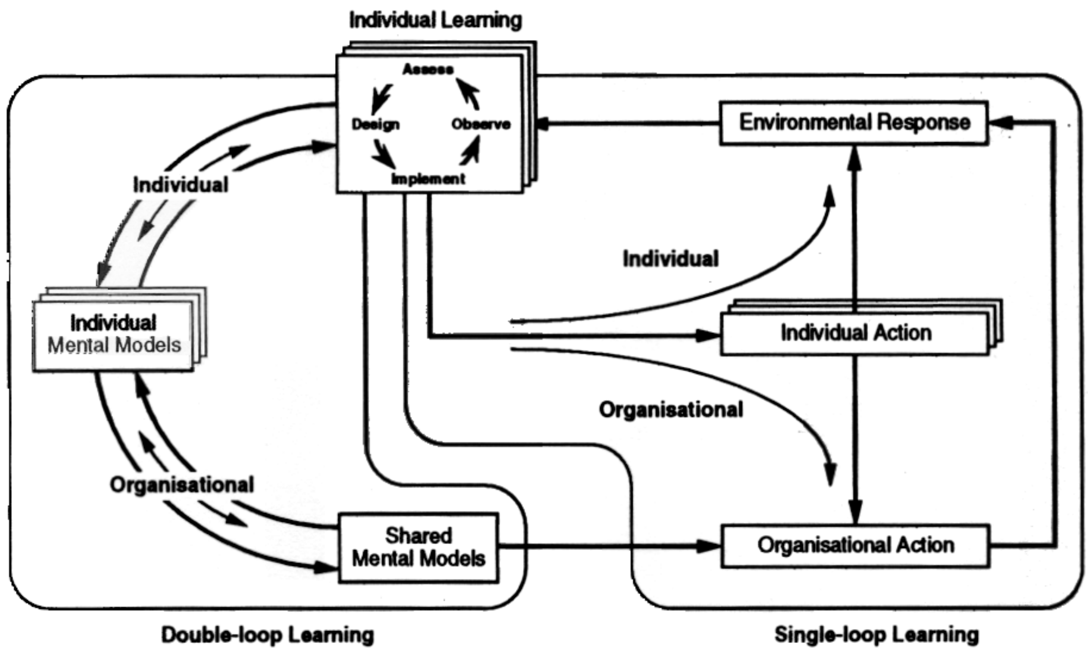


Figure 5.9 Organizational learning cycle (Kim and Senge 1994)

framework for organizational learning, which examines the problems of harnessing knowledge from the experience of individuals or groups and using it to the benefit of the organization. Senge and Kim's[27] article illustrates the problems with organizations failing to learn from experience and proposes a framework for organizational learning. The reasons for the breakdown in learning are also highlighted which in part gives credence to the theory that individuals learn by experience but their learning is frequently lost to the organization.

5.7.1 The Organizational Learning Cycle

According to Kim and Senge[26] in an organizational setting although individual mental

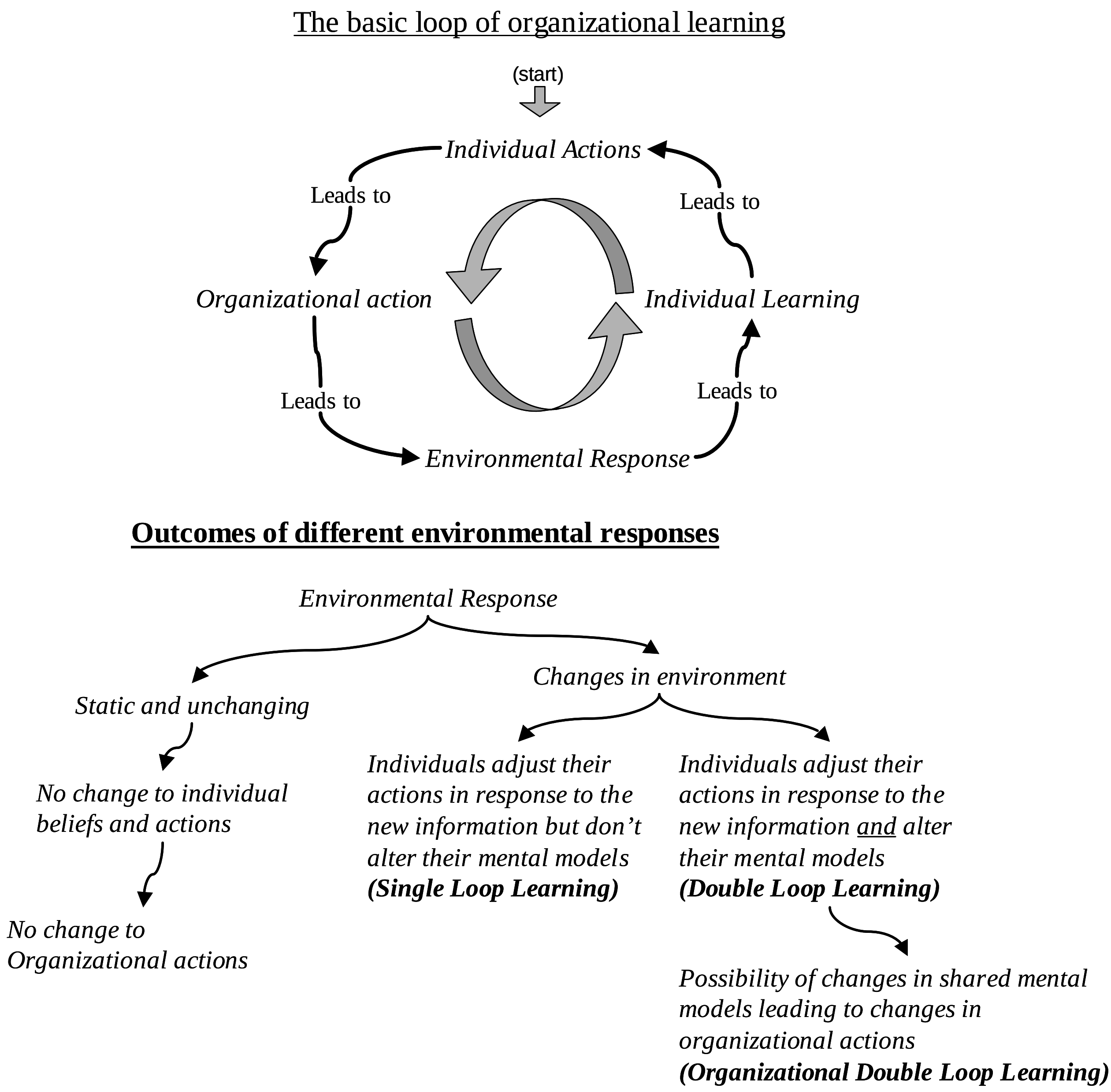


Figure 5.10 Deconstructing the Organization Learning Cycle

models can affect organizational actions they can also be overpowered by existing shared mental models. The recognition of the possible loss of opportunity to the organization by the lack of recognition of individuals mental model changes is seen as being crucial to the further learning of the organization. The ‘organizational learning cycle’[27] is reproduced in Figure 5.9

To fully comprehend the organizational learning cycle the author decided to break it down as shown in Figure 5.10 to highlight the scenarios that the organizational learning cycle describes. As seen from Figure 5.10 the best possible chance of organizational learning occurs when individuals alter their actions and their mental models after changes to the environment. Kim and Senge[26] admit there is also the chance that no learning will take place at all regardless of the scenario. Other breakdowns of learning are shown on the organizational learning cycle (Figure 5.9) and are discussed in more depth in Kim and Senge’s article. Table 5.2 summarises these breakdowns in learning.

Table 5.2 Summarizing learning and learning breakdown (adapted from Kim & Senge[25])

Classifications of learning which lead to a breakdown of organizational learning	Characteristics
Role-constrained learning (March and Olsen[28])	The individual is powerless to change the circumstances due to lack of permission – hence no change to organizational learning. Parallels to Seddon’s ‘command and control’ viewpoint on ISO9000
Audience learning (March and Olsen[27])	“The individual affects organizational action in an ambiguous way.”
Superstitious learning (March and Olsen[27])	Invalid inferences are made about actions that appear to have created an environmental response but have in effect done nothing. Liable to happen in ‘situations of dynamic complexity’ Leads to ‘misperceptions of feedback’ the situation described by Sterman that occurs when there is a delay between cause and effect. Forrester[29] believed the project organization overcomes these problems because of the rapidity of the decision making and the lack of bottlenecks at top management level.
Superficial learning (Kim, D. H.[30])	A problem occurs, it is rectified by the individual but with no change to their mental

Classifications of learning which lead to a breakdown of organizational learning	Characteristics
	model. Associated with crisis management where the problem is solved but the solution is discarded. Hence no benefit to the organization.
Fragmented learning (Kim, D. H.[29])	The times when an individual increases their knowledge considerably, but the organization does not i.e. the link between the individuals mental model and the shared mental models are broken. This can occur when individuals leave an organization or team. Also if the organization is 'decentralized' without 'adequate networking capabilities'. The organization loses the knowledge, hence no contribution to the 'generic project knowledge base' the learning feedback flow.
Opportunistic learning (Kim, D. H.[29])	This can be viewed as a more positive breakdown in learning. This describes the process that happens when a group in the organization bypasses the conventional procedures and controls (including the existing shared mental models) and creates a successful enterprise. Despite their success, they seldom influence future shared mental models (hence organizational learning) as there is unlikely to be a vehicle for their findings to be transferred with. Also no guarantee of 'experiment' working second time around. Action- orientated.

5.8 Influence Diagrams

Influence diagrams (also called causal loop diagrams) are a graphical method of illustrating at a high level the dynamic structure of a system The influence diagram tells the story of the

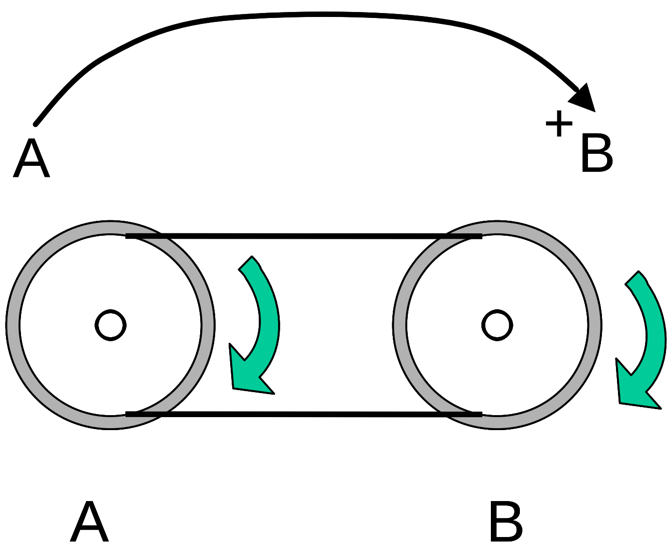


Figure 5.11 Pulley analogy

'dynamic evolution of the system'. Balle[31] compares influence diagrams to a language as both are used for telling a story. Indeed, he stresses the importance of looking on influence diagrams as stories as it helps prevent diagrams being created that have spurious links. As seen earlier the components in an influence diagram can have a positive or reinforcing effect or balancing (negative effect) or a delayed effect. Influence diagrams show all the factors, which the manager (or analyst) considers as being relevant to the problem and how these interact or influence each other, according to cause and effect relationships. By using a simple analogy of two pulley wheels and a connecting belt, the following section illustrates the basic causal loops, which can be used to construct influence diagrams.

5.8.1 Reinforcing influences (positive influences)

If action A is increased then action B is also increased. Imagine two pulley wheels attached by a belt as shown in Figure 5.11. If the velocity of A is increased then the velocity of B shall increase also. Conversely, if the velocity of A is slower then B shall be slower. Note at this point there is no account taken of any effects of delay caused by the connecting belt, it is assumed that it transfers the action immediately. This action is represented in the influence diagram by an arrow with a positive sign at the end to denote the influence between the two entities is increasing in the same direction. Some notations replace the positive symbol with a M for More. Figure 5.12 is Balle's representation of the 'Idea of quality' showing a

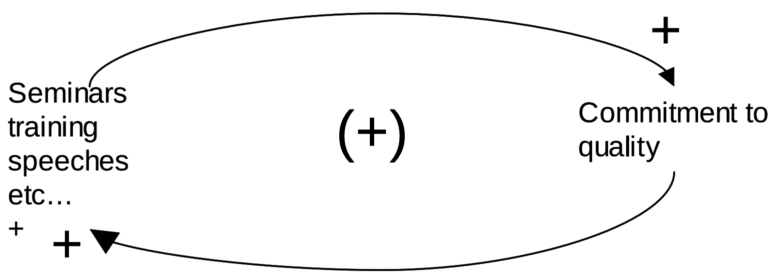


Figure 5.12 The Idea of Quality (Balle)

reinforcing loop demonstrating the beginning of a quality initiative[32].. There is a high degree of enthusiasm for the concept fuelled by seminars, training and other types of motivational programme. At the moment the diagram shows no balancing loop representing the other possible variables and relationships:

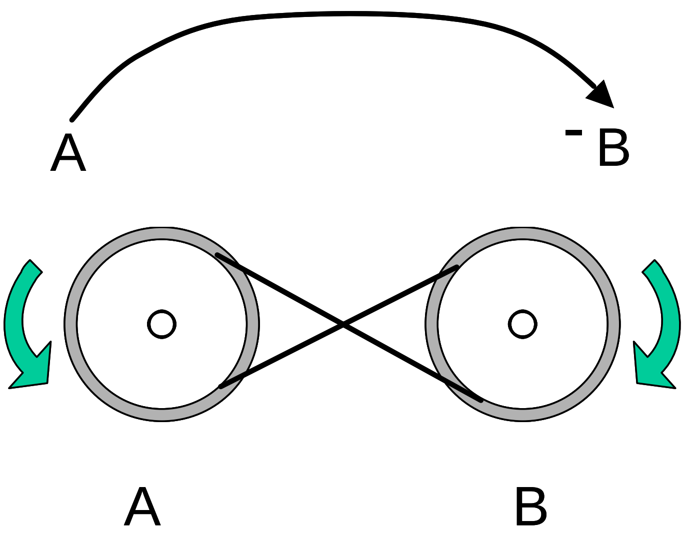


Figure 5.13 Pulley analogy of negative or opposing influences

> "Many quality programmes have failed after having an initial positive effect. Often a big noise is being made about quality-seminar, speeches, training, etc.,-but the structures of goals, objectives, and remuneration are unchanged. At first, the people believe what they are told and are very committed to the idea of quality."

5.8.2 Balancing Influences (negative influences)

With balancing influences, if A is an increasing influence then B is an opposing influence. Using the pulley wheel analogy if A is rotated clockwise then B will rotate anti-clockwise i.e. in an opposite direction to A as shown in Figure 5.13. This is represented by a negative symbol at the arrow or by an O for Opposite influence.

Figure 5.14 illustrates Balle's[33] influence diagram with both types of relationships in relation to the difficulties of applying quality concepts. There is a now a balancing loop, which has slowed down (or balanced) the quality initiative. Balle suggests that after the application of a

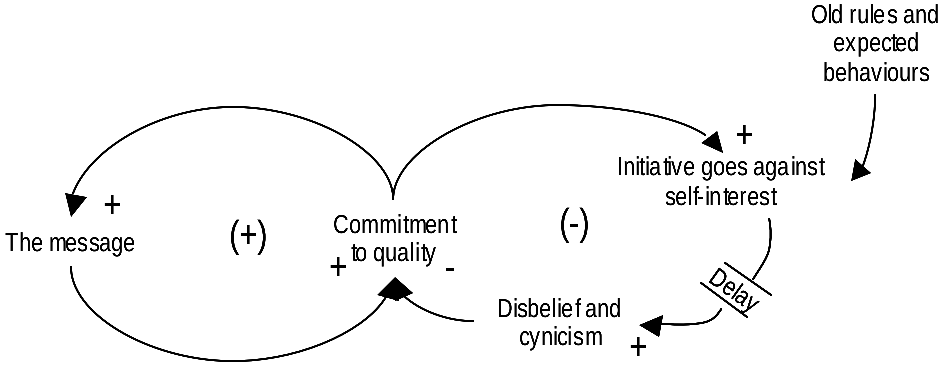


Figure 5.14 The difficulties of applying quality concepts (Balle)

quality system, people will experience the 'hard way' that it is actually against their self-interest to apply the quality concepts they have been taught; for a number of reasons. As he puts it 'quality involves reflection' which means setting aside time to think about how to improve a process. In addition, the lack of empowerment and true commitment from management negates the process before it even gets going. The outcome is shown in Figure 5.15. Every quality programme revival is less and less effective, after an initial growth the overall quality actually reduces. Most of the examples given in systems text show how a positive reinforcing loop in a system will in general create negative results for an organization.

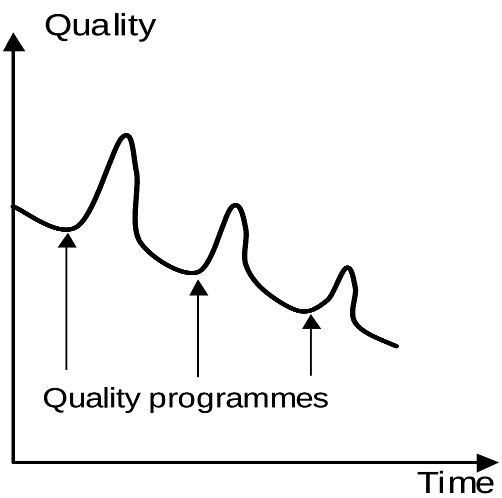


Figure 5.15 The short-term effect of quality programmes not followed up by structural changes (Balle)

5.8.3 Delays

Delays take place between the action and the outcome, i.e. there is a lag between the two. As time is very important in system dynamics, indeed this is where it is believed their is direct comparisons between what this research is trying to achieve and what system dynamics

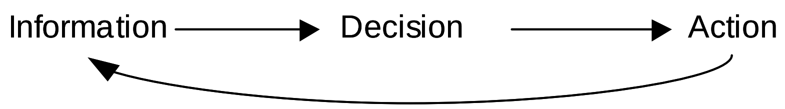


Figure 5.16 Transforming information into action (Forrester)

already has done. Using Forrester's[33] approach to decision making based on the feedback loop shown in Figure 5.16. Management is perceived as the art of transforming decisions into actions. This is where project management has had an advantage over other disciplines in that transforming decisions into actions has been an integral part (and pressure) of being in a project environment. In addition, the time delay or lag between the information, decision and action is forced to be short due to the constraints and sequences usually inherent in a project. Balle[34] cites Forrester's argument that decisions usually compose of three components:

> " perceived actual conditions, desired actual conditions, desired conditions, and corrective actions. In making the reference between perceived and actual conditions, Forrester attempts to take into account the long delays involved in the transmission of information through organizational structures. Something may have happened-but it cannot show for several months!"

The comparison of the structures of the organizations involved in the case studies illustrated the difference in the delay in the decision making process between information, decision and action between a small organization and a large organization. There were a number of examples of this as shall be shown in the forthcoming case studies. The implication with system dynamics is that the magnitude of this delay correlates to the success of an organization or an operational problem. The pulley analogy in Figure 5.17 can illustrate the lag if the belt is made up of an elastic material (arguably all belts have some amount of stretch), which stretches creating a lag in time between the movement of the driving pulley and the influence that has on the second pulley.

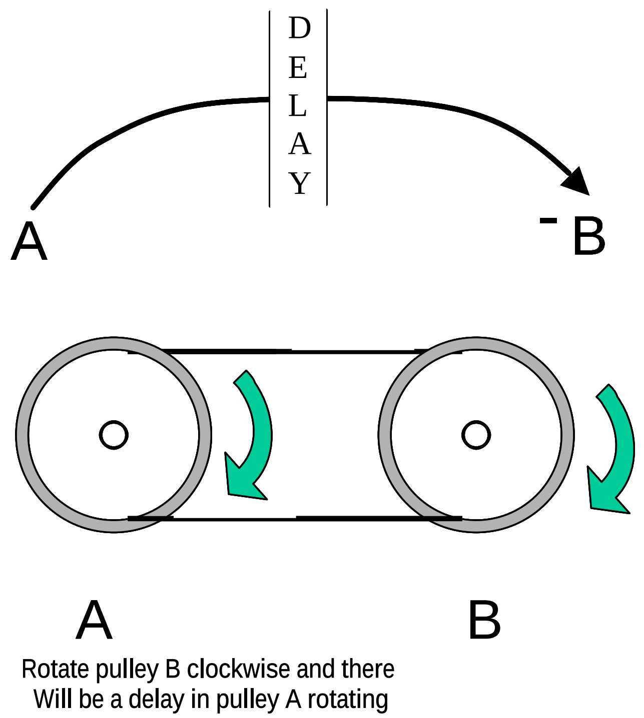


Figure 5.17 **Representing delay in an influence diagram**

5.8.4 An example of a PM influence diagram

The following project management example (shown in Figure 5.18) from a working paper by Rodrigues and Williams[35] illustrates the use of influence diagrams to model the effects of

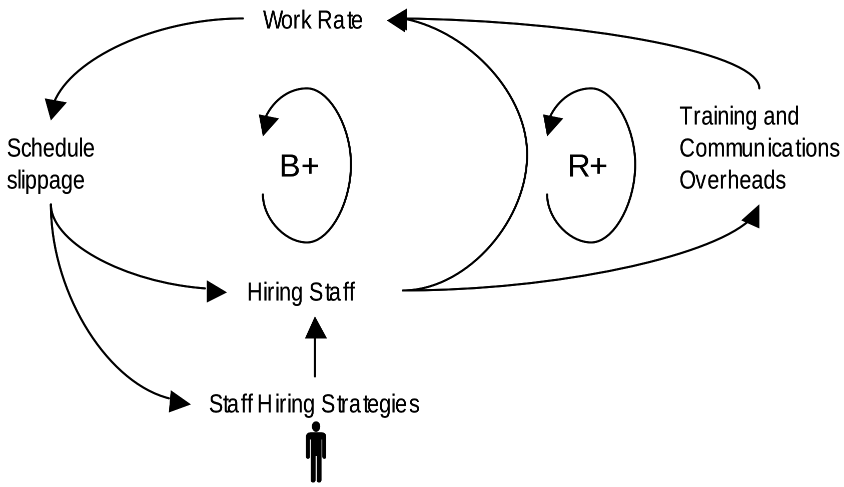


Figure 5.18 Hiring more staff can lead to project slippage (Rodrigues and Williams)

hiring more staff to complete a project. The influence diagram illustrates how;

1) Hiring more staff can increase schedule slippage

2) Skipping QA efforts can increase schedule slippage

3) Schedule pressure over workers can increase schedule slippage.

5.9 Soft Systems Methodology by Checkland

Systems thinking is an integral part of the Soft System Methodology (SSM), which was developed as a problem solving strategy for highly complex and interrelated problem situations. These problem situations as discussed before needed to be viewed in a holistic way rather than being broken down into constituent parts as in a more conventional analysis. This need for an alternative to analytical thinking is an aim that the 'systems movement' described by Hicks[36] is striving to achieve. This 'abstract meta-science' called 'systems thinking' is a way of trying to create an image of a system, or a conceptual system which like

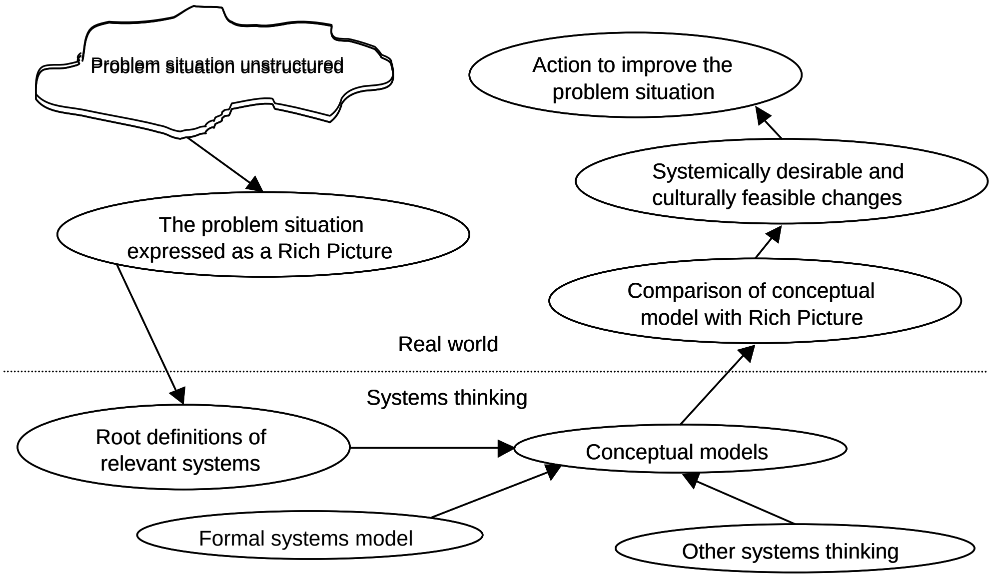


Figure 5.19 The Stages of Soft System Methodology (Hicks)

a real world system has properties and attributes. Unlike the real world system, this conceptual system is not as constrained by the boundaries of a real world environment, and the importance is placed on the inter-relationships. To illustrate this concept of the real world and systems thinking the following diagram showing the stages of Soft System Methodology has been reproduced[37] in Figure 5.19 As can be seen from the diagram the initial problem is expressed in the form of a 'rich picture' i.e. a graphical holistic picture, which encompasses the immediate problem and the surrounding environment. Figure 5.20 is an example from Hicks of a rich picture used for a case study. This form of illustrating a problem or relationship is a useful tool, and the author believes it bears similarity to Mind Mapping a learning technique pioneered by Tony Buzan[38] shown in Appendix No.6.

5.9.1 A model of 'perceived reality'

In tandem with Flood and Jackson's systemic metaphors discussed earlier, Checkland [39] points out, a system does not actually exist in the real world, it is a perceived model,

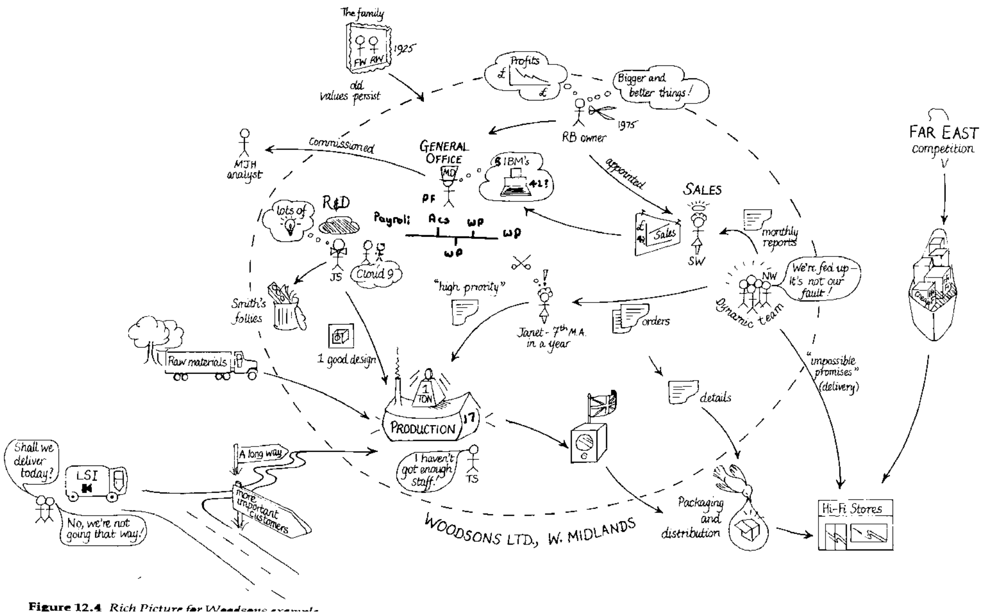


Figure 5.20 An example of a 'Rich Picture' (Hicks)

something used to try and understand the actions and behaviour of a particular environment. In providing this definition of a system Checkland also discusses the misuse of the concept of a system especially in relation to 'human affairs in the social world'. He argues that just because an organization has a group of people with 'things and ideas' does not mean that they are related by a 'common reason or purpose' Therefore do they constitute a 'system' with the requisite 'control and feedback' processes in order to survive? Other consequences are outlined from this hypothesis, including the danger that systems analysts ascribe a subject or entity with the attributes of a system when in fact it is not. What results from this is a 'patch' to fix the 'original system' when in reality the question should be asked as to whether the entity should be in place at all.

Having had doubts about the validity of the systemic nature of the systems in quality management it is tempting to use Checkland's hypothesis as contributory reason for change in organizations like Balfour Kilpatrick. (It is interesting to note that Figure 5.6b the 'shifting the burden' archetype used to interpret the quality issues at Balfour Kilpatrick, Figure 5.6c was constructed prior to reading this hypothesis.) A foreseeable problem of using this argument in the real world, is that systems thinking and its multifarious forms is not recognised widely by management (if it is recognised at all) as a vehicle to facilitate change. There is recognition of this by authors like Checkland (cited by Hicks[40])

Information Technology systems have to a greater extent embraced methodologies like SSM due to the nature of the environment they operate in, and the ease with which it possible to supply systems that don't meet the customers demands. Skidmore[41] illustrates a System Development Life Cycle that describes the stages IT systems analyst should ideally go through to provide a successful system. At the start of the life cycle it is suggested that the strategic issues be modelled by a methodology like SSM. Using a rich picture addresses the following issues:

- It provides an overall view of the problem area.
- It can be understood and contributed to by non-technical parties.
- Gives an overall structure to the system by stripping away the detail.
- Highlights areas of responsibility and conflict.

Unfortunately, the example of a rich picture used by Skidmore[40] (Figure 5.21) is not particularly good, being too formalised and rigid, losing the spontaneity and ability to illustrate the problem to a wider audience, which is essential to the problem solving process.

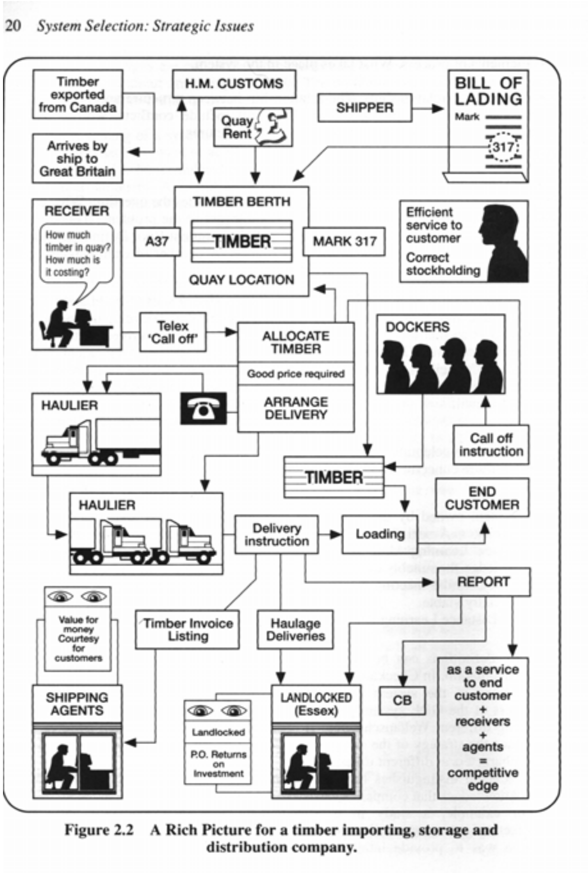


Figure 5.21 Skidmore's version of a rich picture[45]

5.10 Conclusions

As can be seen from this chapter systems thinking is an alternative way of identifying and conceptualising problems in organizations and their environment. It is a wide field applied to many different types of industry, but perhaps because of the disparate number of opinions and techniques its appeal to the main stream can appear diluted. As a tool to examine the issues of quality in project management systems thinking appears well suited to examining high-level issues that can impact the success of projects and their activities. What is more difficult to ascertain is the role in which systems thinking could be applied. Whether it is better as a high level strategic tool identifying patterns of behaviour that affect the feedback between projects or as an operational tool to be used at project level to map out patterns of behaviour. In balance system thinking for the needs of project management is better utilised as a high level strategic tool as it would require a large mainstream adoption by the project management world to make it a useful operational tool. This is not impossible, as can be seen by the relatively recent recognition of techniques like Mind Mapping, which is used to present ideas and concepts in mainstream software applications like Microsoft Visio.

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Chapter 6

System Dynamics

6.1 Chapter Synopsis

System thinking covers a vast indistinct range of methods, tools and principles[1] arguably the most important of these is systems dynamics which is has been described as a language for describing how to achieve fruitful change in organizations. System Dynamics (SD) is a continuation of the 'systems' analysis involving the development of more explicit models to help gain greater insights.

The previous chapter introduced the concept of 'systems thinking' and examined its potential in respect to analyzing fundamental patterns of behavior in relation to quality management in projects. A development of this concept is to model the behavior using a form of simulation that adequately represents the principals of systems thinking and is an accurate representation of the problem encountered. System dynamics attempts model the scenario, recreating:

- The present system (existing homeostasis).
- The qualitative and quantitative relationships in the system.
- The outcome of different actions carried out on the system.

In common with the 'systems' viewpoint the aim is to find the lever, which has the greatest impact on the problem. It may be an anathema to describe System Dynamics as a 'hard' technique but in reality that is what it attempts to do – creating a valid methodology, which

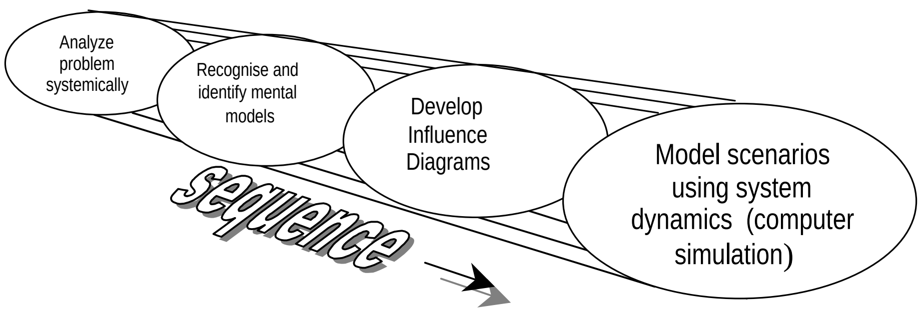


Figure 6.1 The sequence leading to System Dynamics

stands up in its own right as a viable problem solving technique. In this chapter, the basic principles used by system dynamics will be examined including:

- The relationship between system dynamics and systems thinking.
- The visual representations used in system dynamics.
- Computer simulation using the *'Ithink'* system dynamics package.
- Examples of the use of system dynamics in project management and quality management.
- Analyzing the applicability of system dynamics as a suitable feedback tool in project management.

System Dynamics has proved a demanding technique to analyze and understand, and as such the scope with which it has been covered in this chapter is limited to its applicability to this research i.e. examining if the methodology could be a suitable vehicle with which to examine quality issues in project management.

6.2 Defining System Dynamics

The following definition of system dynamics from Abdel-Hamid[2] neatly summaries its generic principles:

> "System Dynamics is the application of feedback control system principles and techniques to modelling, analysing, and understanding the dynamic behaviour of complex systems, that is, the behavioural patterns they generate over time."

System Dynamics is founded on the philosophy that the behaviour of an organisational entity is principally caused by its structure. This structure includes intangibles as well as tangibles, physical properties, politics and procedures that dominate decision making in the organisational entity. The main methodological rules of System Dynamics from J. Forrester[3], the early pioneer of SD are summarised below:

> "There are two - and only two - kind of variables in a system dynamics model: levels (or accumulations) and rates (or actions). Once you believe that there are only two kinds of concepts in a system, everything you look has to be one thing or the other.

> The idea of two and only two kinds of variables should not be new to managers. Accounting reports are cleanly divided between the balance sheet and the profit and loss statement. Balance sheet variables are system levels: profit and loss variables are system rates, which causes the balance sheet levels to change."

In addition the reasons for modelling complex systems and carrying out simulations is outlined by Forrester[3]:

> "The effects of different assumptions and environmental factors can be tested. In the model system, unlike the real systems, the effect of changing one factor can be observed while all other factors are held unchanged. Such experimentation will yield new insights into the characteristics of the system that the model represents. By using a model of a complex system, more can be learned about internal interactions than would ever be possible through manipulation of the real system. Internally, the model provides complete control of the system's organisational structure, its policies, and its sensitivities to various events."

In justifying the use of system dynamics, Abdel-Hamid[4] believes there needs to be an underlying scientific rationale to compound the art of management to understand the fundamental understanding of project processes like the development of software. Although Abdel-Hamid concentrates on and applies the system dynamics approach to the development of software, the problems and solutions are applied in other fields.

6.2.1 The integral role of computing in system dynamics

A very basic definition of system dynamics given by Balle[5] is that it is a 'system simulation assisted by computers'. The part played by computers in system dynamic modelling is very important as illustrated by Piper[6] in the introductory tutorial for the system dynamics software package 'Ithink':

> "People are very good at laying out structure. But as this very simple model illustrates, (this is referring to the tutorial example) they aren't necessarily very good at intuiting the "over time" dynamics that structure will generate. Computers have the opposite strengths. They can't create structure. But they are flawless at tracing out the behaviour associated with a given structure."

Although perhaps not flawless, computer assistance is essential for system dynamics. Flood and Jackson[7] reinforce the point referring to the multiplicity of loops present in even the simplest of situations gives rise to a number of interactions and variables, which are difficult to identify and manipulate without the aid of computer simulation. As can be seen in Chapter 9, Section 9.7.1 even the high level 'organizational learning model' exhibits a number of variables and loops.

6.3 The Relationship between System Dynamics and Systems Thinking

There can be no question that systems thinking and system dynamics are closely related but how is this relationship defined. Richmond[8] illustrates his vision of what the relationship is

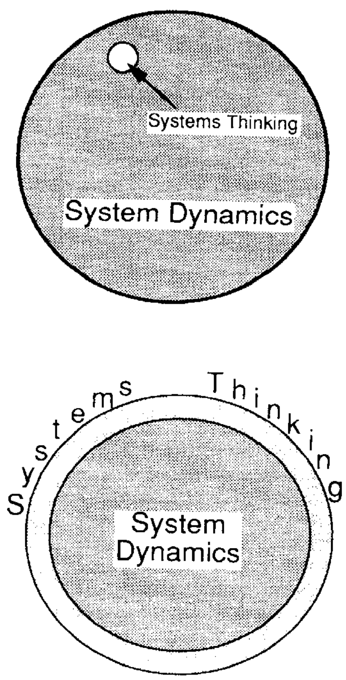


Figure 6.2 Richmond's Venn Diagram[8]

between the two. He contrasts this with what he believes the founder of systems dynamics Forrester sees as the relationship between SD and ST. The Venn diagram is reproduced in Figure 6.2. This shows systems thinking as an 'aura' around system dynamics, which is how

Richmond envisages the relationship. Richmond's supposition is perhaps more important than it first looks. As shall be discussed later in the chapter the system dynamics movement has been criticized[9] for practicing its techniques in a somewhat technocratic manner, which may account for the manner in which Richmond has illustrated Forester's ideal. What Richmond appears to be intimating is that systems thinking needs to be the defining philosophy with system dynamics as a bridge into the 'practical world'.

In conjunction with systems thinking, system dynamics models problems by looking at how structure effects behaviour[10], the common patterns that certain scenarios produce whether in the retail industry, community care or on a North Sea oil installation. System dynamics is primarily a problem solving methodology in which a whole system is examined to visualise the problem, it is then modelled to find an 'explicit' description of the system behaviour, and a 'lever' is ultimately identified with which the problem can be solved. This lever may not be readily identifiable by the symptoms apparent to the organisation, i.e. the lever may appear to be unconnected to their problem. It attempts to model both hard and soft parts of a system i.e. both the qualitative and quantitative parts of a system to produce a holistic view. System dynamics has its roots in control engineering and is based on the concept of feedback over time, allowing the modelling environment to possess 'dynamic' qualities. When analysing a problem, system dynamics forces the modeller to visualise /conceptualise the whole system. The system is then broken down into different and more detailed parts (similar to archetypes). The crucial difference between system dynamics and 'mechanistic' methods defined in Chapter 5 is that there is always a causal link between 'entities'. The classical mechanistic view 'fragment and optimise' phase shown in Chapter 5, Figure 5.1, is not mirrored in system dynamics due to the recognition that the entities being studied are affected by interconnecting relationships.

6.4 Conditions, Actions and Feedback

Combining the main parts of systems thinking with the methodological rules described by Forrester gives the groundwork for a system dynamics model where:

- ‘Conditions’ are seen as ‘Stocks’, which can rise and fall.
- ‘Actions’ are seen as ‘Flows’, which can have different rates and inputs.

To illustrate the interaction between the two variables Figure 6.3 uses two basic influence diagrams from the ‘Ithink’ introduction handbook[11]. In conjunction with these are two basic ‘project’ examples to portray the concept. As shown in the diagrams the construction of the model revolves about feedback and the concept that one action always has ramifications either positive or negative on something else. There is an inbuilt or intrinsic accountability about the models, because each action has to be justified by either an opposite or similar action. This holds parallels with project management culture where every action is

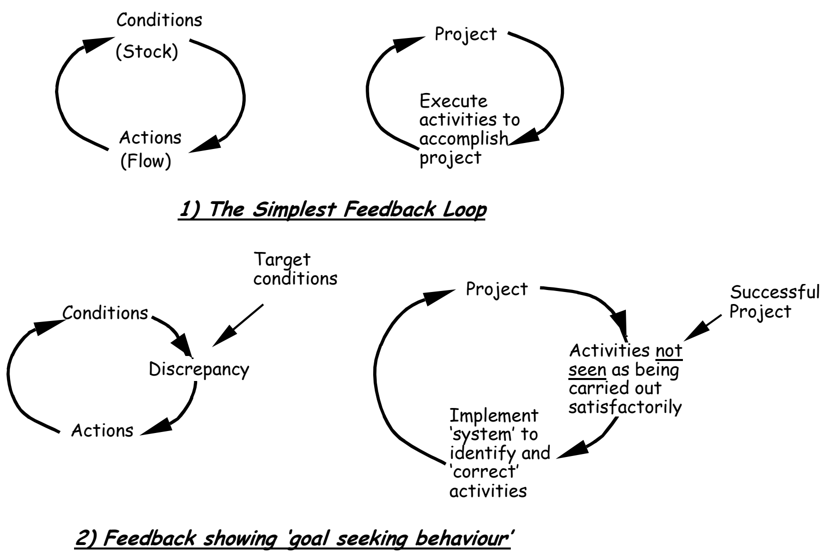


Figure 6.3 Basic Influence diagrams with simple project examples

accountable either in the short term or the long term. Short term accountability is inherent in any project environment even where there is factors outwith the control of the project team. Whether it is a shortage of a particular resource or the failure of a particular component the onus is on the project management to resolve the problem immiediately to meet the projects objectives and deadlines i.e. a short feedback loop. The concept of accountability is discussed further in Chapter 12, section 12.3.3. Long-term accountability is the need to keep having successful projects for the project organization to survive.

6.4.1 Goal seeking and interdependency

'Feedback showing 'goal seeking behaviour',the second relationship shown in Figure 6.3, highlights the trait that all living systems 'goal seek[12]' This is in accord with 'classic' project

Figure 6.4 Components of the System Dynamics software application

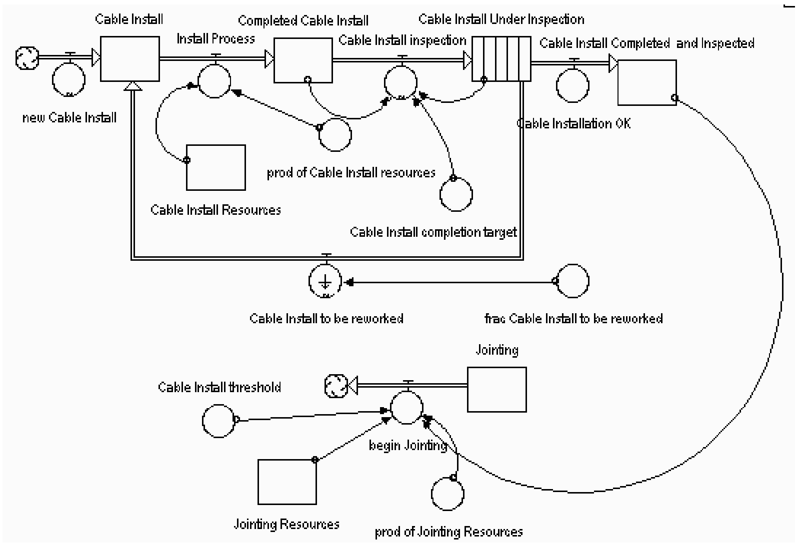


Figure 6.4 a) Illustrating the mapping interface of an SD model

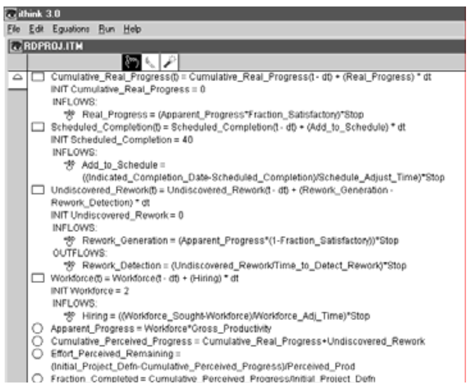


Figure 6.4 b) The equations created by the mapping

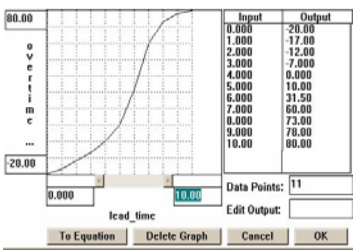


Figure 6.4 c) The Graphical Function

management, where milestones and objectives are integral to the project life cycle. This realization in other organizational areas is perhaps one of the catalysts that is seeing an increase in the interest shown in project management and its techniques.

6.5 From Influence Diagram to Computer Simulation

Transferring the influence diagram to a system dynamics model is the next stage in the modelling process. This can be achieved using specific system dynamics software like 'Ithink'. This application uses a graphical interface that allows a model to be constructed in a

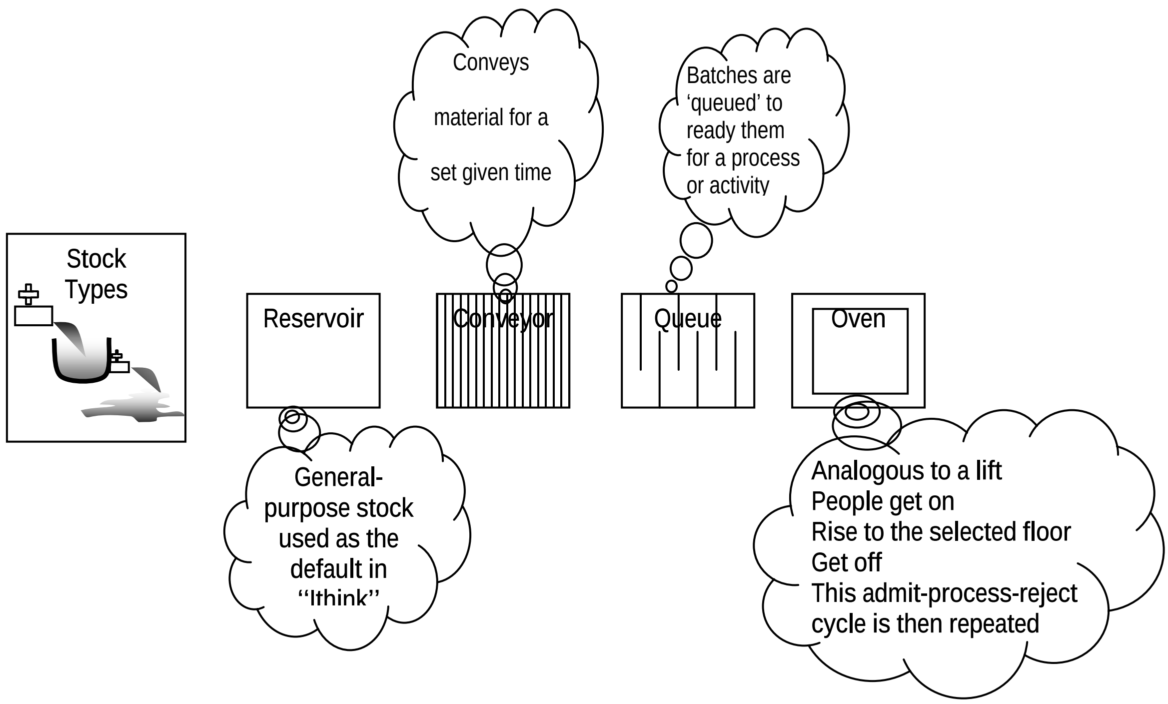


Figure 6.5 Stock types and their attributes (adapted from Balle,1994)

form that is similar to the ideals and disciplines of systems thinking. The underlying equations of the model are accessed 'behind' the main model diagram. This is where key inputs and variables are decided upon and any application specific settings have to be made. Like Forester's[3] key methodological rules stated earlier, the software is based around stocks and flows, which are arranged and connected to construct a model to represent the system being analysed. Figures 6.4 a) and b) are examples of part of a system dynamics model. Figure 6.4c) illustrates the graphical function of ithink.

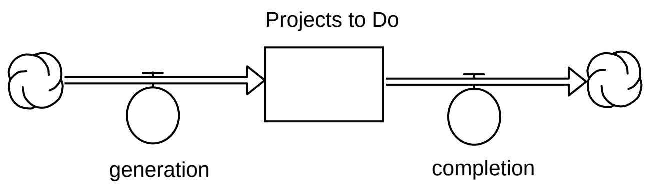


Figure 6.6 The buffer effect of Stock

6.6 The components of the System Dynamics Model

6.6.1 Stocks

In 'ithink' stocks are denoted by a rectangle with an option on the stock attributes. Richmond[13] attributes stocks with three roles in the system dynamics model:

1. As a reflection of the state of the system at any one time. System dynamics models vary over time therefore if the flows in a model are stopped the state of the system can only be determined by the quantity in the stock. A snapshot in time[14], equivalent to a photograph, or an audit.
2. A stock is a buffer as shown in Figure 6.6[15]. From this dynamic behaviour patterns occurs. In ithink the behaviour of the system is illustrated by graphs as will be shown later in the chapter.
3. As resources - *consumable* i.e. raw materials, sub-assemblies or *catalysts* i.e. machinery on a production line, personnel. In the Walpole project for Balfour Kilpatrick the cable, the joints, ballast for the trench are all examples of consumable 'stock'. The equipment used in installing the cable - the winches, rollers and bond wire are seen as catalysts i.e. they create a flow but unlike the consumable stock they are worn out in a gradual manner. This can be applied to personnel as well; the actions carried out do not

'consume' the person's ability to carry out a task again. (In time like machinery, personnel do change – i.e. grow old, but learning through experience should enhance the abilities of being a catalyst).

The stock in ithink can have four attributes, which are summarise in Table 6.1. And illustrated in Figure 6.5.

Table 6.1 Stock Type Attributes

Stock Types	*Attributes*	*Restrictions and Parameters*	*Metaphoric Example*
Reservoir	Default 'general purpose' stock for 'Ithink'. Inflow is generic and 'mixable'	Negative restraint assists initial model making	Bathtub, Project
Conveyor	Inflow is batches of similar materials which are kept separated, and travel to the outflow in a set 'transit' time Used to signify delay in business processes.	The batches of material do not mix throughout their transit time. Control can be exerted on inflows and outflows.	Mechanical walkway or conveyor belt
Queue	A 'line' build up of materials	The batches of material do not mix when in the queue (as in the conveyor)	Shopping going through a supermarket checkout.
Oven	Materials go through an 'admit-process-reject' cycle.	The oven has a specified 'fill time' or until it has reached a designated capacity. The cycle then goes through its allotted 'cooking time' after which it is ejected	Mechanical lift

6.6.2 Flows

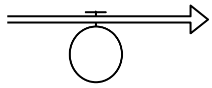


Figure 6.7 The flow symbol

Flows in a system dynamics model are the ingredient that gives the model its dynamic behaviour. Flows are expressed as rates i.e. entities per time period. They are the inputs and outputs that allow the accumulations to occur. The symbol used by Ithink is shown in Figure 6.7. The arrow shows the direction of flow, which can be either one way (shown) or 'bi-directional'. With the ability to model flows, the simulation can mimic relationships that are illustrated with influence diagrams. The flow equation is constructed in the modelling part of the software, which uses any inputs to the flow shown in the model. The flow can also be defined as a graphical function, which allows the characteristics of the system to be seen over time. System dynamics modelling appears to be like an energy balance, energy is never lost it just manifests itself in a different form. Likewise, a flow can be 'conserved' or 'non-conserved'. The conserved flow empties one stock as it fills another. When a flow is not conserved, a 'cloud' denotes it, which signifies the boundaries of the model.

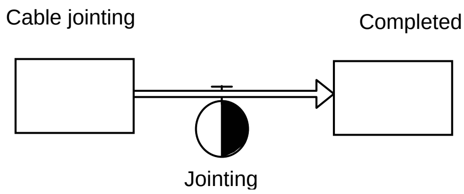


Figure 6.8 A flow being used to convert units

Another facet of flows is that they can represent a conversion process where instead of the flow being expressed as a rate i.e. no. of units/time, it is signified by a conversion process. Figure 6.8 gives an example of this. As can be seen from this diagram the 'unit-converted' flow must be conserved i.e. travel between two stocks to allow the conversion to take place.

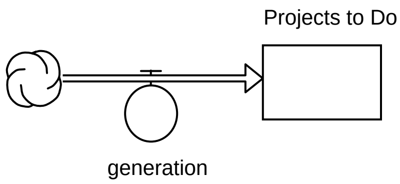
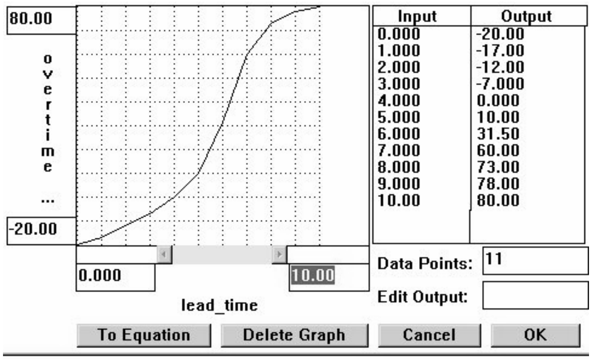


Figure 6.9 'Clouds'

Figure 6.9 illustrates a flow starting from a cloud. It is understandable that the model has to have boundaries, because the aim is to examine, model, and solve a particular problem, which does not have to encapsulate the universe! Figure 6.9 shows the flow 'generation' which signifies the generation of projects, the background to why these projects are being generated does not concern this model it is outwith the models boundaries hence it is depicted by a cloud.



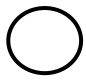


Figure 6.10 The Graphical Function Converter

6.6.3 Converters

A converter is used in ithink to convert inputs into outputs. They have a dual-purpose role in that they can assume both stock and flow related roles. Converters are represented by a circle in ithink and are seen as auxiliary variables. As described in the ithink[16] manual, when in their stock/flow related role converters are used to clarify the logic and the order in which flow regulators operate. As such the converters do not hold stock they signify inputs, which affect the conditions of the flow, or the stock to which they are attached. (When the processes that fill and drain a stock are of no relevance, then the converter can be used for the stock although the quantities must be conserved) Converters are also used to inject time series into the model using ithink's graphical function or using pre-configured inputs like pulse, ramp or step. Figure 6.10 shows an example of ithink's graphical function as represented by a converter.

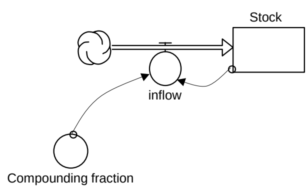
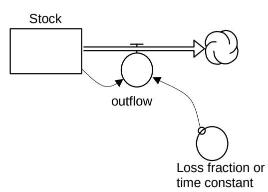
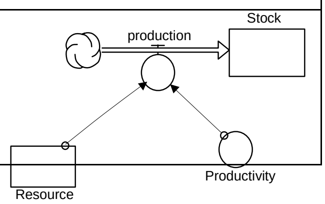
6.6.4 Connectors

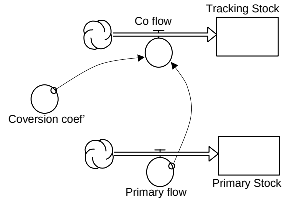
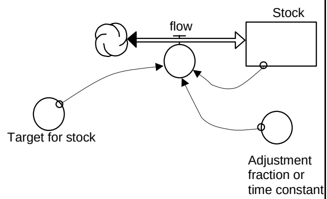
Connectors are the links used between the stocks and the flows and the converters where a non-flow connection is required. They are represented by an arrow in ithink as shown in Fig 6.4a) the main SD diagram. The difference between connectors and flows is that the connectors transmit information they do not become part of the mechanics of the actual background calculations.

6.6.5 Basic Flow Processes

To utilise these components ithink provides some basic building blocks called flow processes to help in the construction of a model. They are seen as templates to focus on the 'nature' of the activities present in the model. Table 6.2 is a summary of the basic flow processes and their generic characteristics that ithink has to formulate an SD model.

Table 6.2 Summary of the basic flow processes

Basic Flow Processes	Use and Structure	Behaviour	Key Equation	Examples	Generic Diagram
Compounding	Represents a self-perpetuating growth process as found in systems thinking archetype 'limits to growth'[17]	Acts in an exponential manner with time as a constant	Inflow(units/t)=Stock(units)*compounding fraction(1/t)	The ISO9000 standard used to define quality in organizations.	
Draining	Represents a self-perpetuating decay process. In relation to systems thinking this is the same as the compounding flow i.e. it is a 'reinforcing loop'	Acts in an exponential manner like compounding except exhibits decay	Outflow(units/t)=Stock(units)*loss fraction(1/t)	Water tank draining. When the tank is full (the stock) the water loss is large, as the water level reduces the flow rate also reduces.	
Production	The production flow is constructed from a stock, which is the 'resource' and a converter which is the	Constant values of both the resource and the productivity lead to constant	Production(units/t)=Resource(units)*productivity(units/unit)/t)	The manpower and equipment used to carry out activities in a project	

	resource ‘productivity’ variable.	production. Varying them produces more varied results.		combined with a notional productivity rate i.e. no. of activities per month. (a better measure would possibly be objectives/project)	
Co-Flow	The coincidental flow can be used to signify a process that runs in parallel with the main and is intrinsic to the main process or it can be used as a tracking part of the model. A variable is used to covert any difference in units between the two	The behaviour of the coincidental flow mirrors that of the primary flow unless the conversion coefficient is a variable	Co flow(units/t) = primary flow(Units/t)*conversion coefficient(units/Unit)	Using a co flow to determine the effect of an increase in staff on a project i.e. to calculate the staff/project productivity average as a tracking figure.	
Stock-Adjustment	This represents a flow of activity, which adjusts a stock to a specific target value. This process has a bi-flow i.e. the flow can travel both ways. Can be used for both physical entities and more intangible entities like beliefs, perceptions or opinions.	The stock-adjustment process is self adjusting as it will graduate towards its specified target either from below or above.	Flow(units/t) = [target for stock-Stock](units)*loss fraction(units/units)/t	Changing people’s perception of the quality of an activity to match the current quality level[18].	

6.6.6 Main Chain Infrastructures

The next level of template provided by ithink is a series of ‘Main Chain Infrastructures’. A Main Chain Infrastructure is defined as a sequence of stocks joined to each other by flows where at least a ‘portion’ of the material passing through is conserved. The Main Chain is

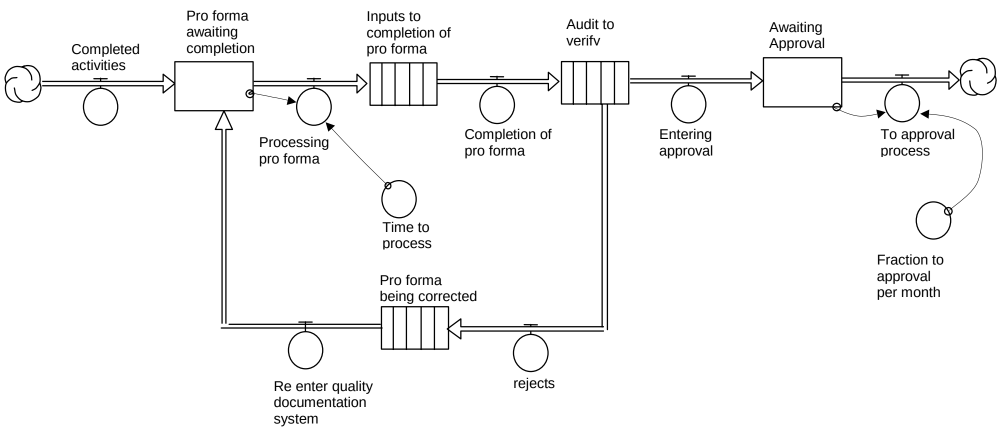


Figure 6.11 The quality system administrative process

seen as the core to a SD model and invokes the need to investigate the reasoning behind flows' volumes and how they impact on the dispersal of material within the model. Figure 6.11 is an adaptation of the Administrative Main Chain[19], which in its generic form is used to depict the sequence of events in an administrative process. The model attempts to emulate the existing industry standard ISO9000 quality system administrative process in use in many companies. Using the template in this fashion does give some insight into the way in which a model has to be constructed. It also emphasises the complexity of the order and way in which tasks are carried out in a project and the interdependencies that exist. There must be assumptions in the model as to the manner in which the administrative process is carried out, i.e. there is a degree of repetition and that the framework illustrated matches that used. The benefit of this type of model is its dynamic ability; the process is triggered by a completed

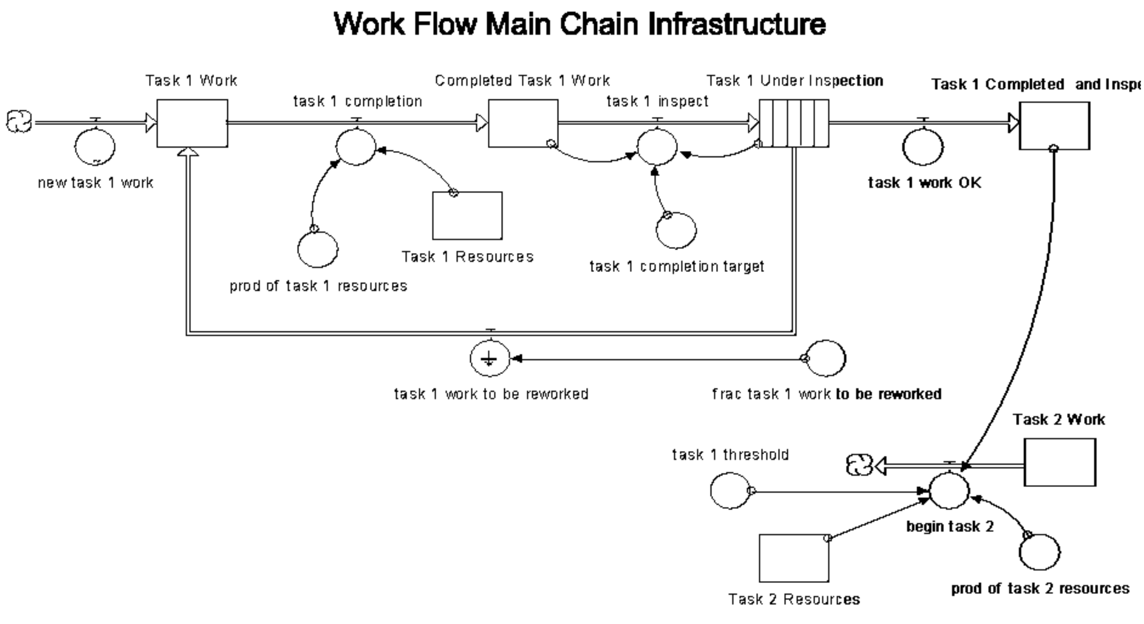


Figure 6.12 The Work Flow Main Chain Infrastructure Template

activity. The working pattern of the project staff involved in this 'administrative process' would also have a bearing on the various areas of the model.

6.6.7 A project management template

The main chain infrastructure of particular interest was the ‘Sequential Work Flow Main Chain’, which represents ‘a generic representation of a sequential work completion process’[20]. This is a type of generic project management template, which can be used to simulate project management issues.

6.6.7.1 Expanding the model

Concentrating on one area of the model as illustrated in Figure 6.13, it can be shown how the model could be expanded to an almost infinite level, which may increase its accuracy or conversely allow the model to become to unwieldy in identifying key variables. This exposes what could be considered a main weakness in SD, namely the nature of the large number of variables that can be entered into a model that in turn can greatly affect the outcome of the simulation. How can the experience of an engineer be quantified into a fraction for use by a converter? Is it dependent on his or hers length of tenure in the job? Or what academic

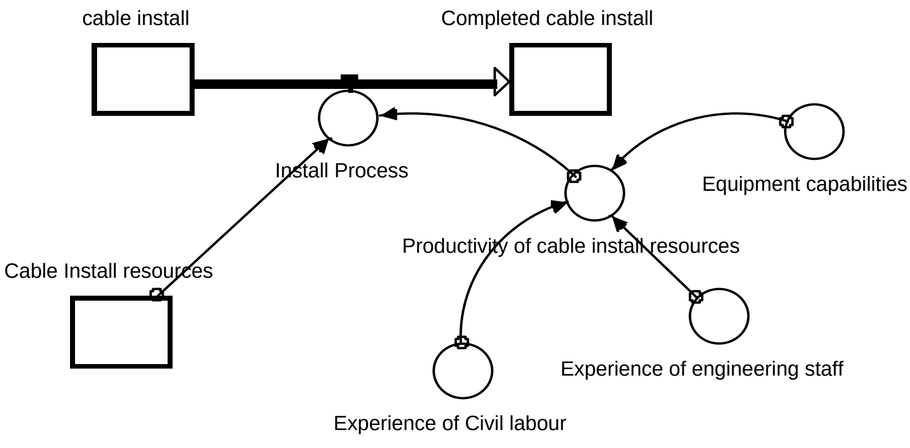


Figure 6.13 Expanding the install process

qualification they possess? In Chapter 3, Section 3.3.3 the concept of the Rework Cycle[21] was discussed which incorporated what was described as a quality quotient. The quotient signified the number of rework cycles that had taken place during the project. The basis for the figures used was from past projects, typically high tech military projects. The criteria for these quotients are not clear therefore it is difficult to assess the way in which the quotients were derived. Similarly how is the capabilities of the equipment used measured? (Equipment may have more objective measurements like Mean Time Between Failure (MTBF) to use than the human element in a model). The insertion of further activities and tasks in a model produces questions as to the accuracy of the value of some of the assumed variables. The SD practitioner would have to be very aware of the subjectivity of the values given to such qualitative entities. The behaviour assigned to the various components is also open to debate due to the number of ways in which it can be represented. Getting a model to fit a given historical scenario (the project example used in the next section) with the number of variables apparently available to the modeller does bring into question the validity of the process.

Using an SD model of this sort in an operational manner in a project management environment would be very difficult. The user would have to be close enough to the project (or project stakeholders) to make value judgements on the qualitative and quantitative variables and have sufficient global knowledge of the project as a whole to identify and model the stocks and flows. The prime aim of system dynamics is to solve problems; an aim, which appears to get lost under the plethora of alternative uses that it is touted for.

In conclusion as an operational method of measuring the quality of activities in a project system dynamics does not offer a viable way of achieving this aim, although it is believed that in conjunction with systems thinking there are aspects which can be integrated into a practical, user friendly form of quality measure.

6.7 A critique of System Dynamics

As a tool to examine the interactions in systems, system dynamics is not flawless. It is certainly not a technique that can be learned and implemented quickly, a solid grounding in the concepts of systems thinking is needed before any attempt can be made to attempt a system dynamics model. Indeed as this researcher found out, educating oneself in the intricacies of system dynamics is not an easy or quick task. In defence of this experts like Richmond[22] in the systems field have recognised that system dynamics has only been available to select groups' in particular academics. In their critique of System Dynamics Flood and Jackson[23] point out that the approach has been attacked as being neither scientifically rigorous enough nor embracing the 'subjectivity' of soft system analysis. This critique is built around a framework of theory, methodology, ideology and utility.[24] Table 6.3 summarises Flood and Jackson's critique at these four levels and includes comment relating it to either particular SD or project issues.

Table 6.3 A Summary of Flood and Jackson's critique on System Dynamics[25]

Theory	**Hard systems critique**	**Soft Systems critique**
	SD attempts to encapsulate the whole system, using feedback loops and stressing that system behaviour is more important than 'exact representation' used in reductionist scientific methodologies. Conclusions on system behaviour are reached before data is collected or verified methods.	The complexity of social interaction and social systems is not accounted for in SD, it does not reproduce the 'innate subjectivity of human beings' due to the external nature in which it is studied. This in turn negates the ability of SD to create objective models. This 'soft systems' viewpoint is the reinforced by the criticism that SD attempts to find the 'optimal' behaviour of a system through the structure of the system. Emulating reality is not seen by the soft system thinkers as a viable or useful objective, instead creating models, which have a different viewpoint to stimulate debate and unravel the reasoning behind other perspectives is deemed to be more profitable. The soft systems perspective believes that SD models must reflect the particular bias of the modellers and it is an isolated outlook that cannot be replicated or compared against any other model, which offers a 'different world view', The parameters for the optimal model are also not apparent and are 'hidden' in the model.

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<td></td>
<td colspan="2">Comment by author
The difficulty faced by SD is that it attempts to model all aspects of the system including what have previously been intangible entities. Its method of expressing parts of a system as an interaction between hard and soft variables does in fact reduce the model into components parts, although the origin of some of the variables are not always well defined and can be open to criticism.

Defining a social interaction or an activity by assigning it a value in a SD model does tend to leave the beginner/inexperienced modeller in a quandary as to its source and its validity. In software applications like Ithink the promotion and inclusion of some variables appear to be promoted as obligatory or compulsory attributes in the construction of the model without discourse to the underlying reasoning. (This criticism must be tempered with the relatively short length of experience that has been had by this researcher with SD)

In the main chain diagram figure 6.12 there is an example that typifies this, the ‘fraction to approval’ converter represents a notional fraction of a process that could typically depend on the diligence or administrative prowess of one or more particular people.</td>
</tr>
<tr>
<td rowspan="2">Methodology</td>
<td>By being touted as a practical tool the SD methodology allows the construction of models without the verification of the validity of the relationships created. The structure of the model is seen as being the most important factor which can lead to existing hypothesis being ignored.</td>
<td>SD is seen as being unsuitable to model qualitative ‘social systems’ due to its application of mathematics to quantify the entities being modelled.
Variables are not readily identifiable.</td>
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Flood and Jackson comment that the ‘richness of social reality defeats SD modellers[26]’ which is perhaps a harsh judgement on the subject considering that SD attempts to model such a wide range of topics. The criticism that there is a one-sided approach taken by the SD practitioner which promotes only one viewpoint can also be levelled at every other methodology which is used as a tool for enquiry. The underpinning role of systems thinking in SD does suggest that the ‘hard’ techniques in SD are not used in isolation.

The difficulty in defining and identifying variables is certainly a valid criticism, and it can be seen to be a key point in this critique. In addition to this, in practise identifying the difference between stocks and flows is not as clear-cut as it appears.</td>
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<tr>
<td>Ideology</td>
<td colspan="2">SD practitioners are depicted in this critique as elitist and partisan, serving the ‘decision makers and managers, as experts providing objective and neutral guidance’. The lack of involvement by other parties (or ‘stakeholders’)in the problem solving is seen as a ‘worrying’ aspect of the ideology of SD. The accusation is that SD analysts provide a solution but do not take part in the implementation of that solution, leaving the stakeholders not knowing why they are carrying out a particular course of action.

The aim of an SD practitioner is to solve an existing problem by analysing, and modelling the existing systems structure then altering it to produce a system which is operating at an optimal level. What is an optimal state? This must depend on the goals, ambitions and objectives of the existing systems stakeholders and the environment in which they reside. The lack of specific future optimal states is put forward as a possible area of conflict in areas like social systems where there are different groups with conflicting objectives.</td>
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	Comment by author Without specific experience of the SD analyst in operation, it is difficult to pass judgement on these criticisms of their role in an organization. Anecdotal evidence[i] would suggest that it is not a known mainstream consulting role, with primarily affluent organizations able to investigate the use of SD as a problem solving methodology. Therefore it is not suprising that the main audience of an SD ‘technician’ would be at a managerial level. To construct a detailed model in the first place requires a certain degree of interaction with the stakeholder, which then has to be translated into operational action. In respect to project management the problem to be solved or modelled is seldom without conflicting groups of stakeholders and it is inevitable that there is casualties. The optimal state in project management is also not difficult to quantify, reaching it is the holy grail sought by all project stakeholders. It is realised that project management with its objectives and goals being an intrinsic part of the process is a simpler area to define, but it also has many of the conflicts seen in other social systems.	
Utility	**Hard systems critique**	**Soft systems critique**
Utility	• SD models are based on poor data • SD models ignore existing theories • Are not rigorously validated • From this it is believed that SD models cannot be used to predict valid future states of systems.	SD is seen as presenting itself as a neutral and objective technique which is an anathema to the soft systems movement. In this light it is recommended as having limited use, being restricted to areas where there is precise definitions and assumptions of the flows and stocks used. These can then be debated as to their validity by other ‘stakeholders’. Areas where there are little or no ‘unforeseen’ elements are put forward as possible SD modelling areas e.g.. readily identifiable organisational structures that want to determine the outcome of policy decisions. Again this critique singles out the SD practitioner for criticism as being remote from the people whose problem is being solved.
	Comment by author The fact that SD ignores existing theories is perhaps due to the lone path it has taken in incorporating aspects of both hard and soft systems thinking. The validation process is also different from the norm in that a model is validated against the systems existing or historical state. In recommending a limited use for SD the authors outline that the problems are caused by the areas of use to which SD was being put. Areas where SD does not have ‘competence’ It should be noted that this critique has been written in 1991 and since then SD has been applied to many other areas	

The learning curve to master system dynamics is steep, and as such could not be embarked

[i] Dr D. Corben of Cognitas

on without some form of expert assistance. It is perhaps this more than anything that prevents SD becoming a mainstream technique. This could explain the reluctance of SD practitioners to involve their clients more in the process. The time and resources needed to teach it in conjunction with systems thinking would be considerable.

6.8 A project example of a system dynamics model used in software development

6.8.1 Overview

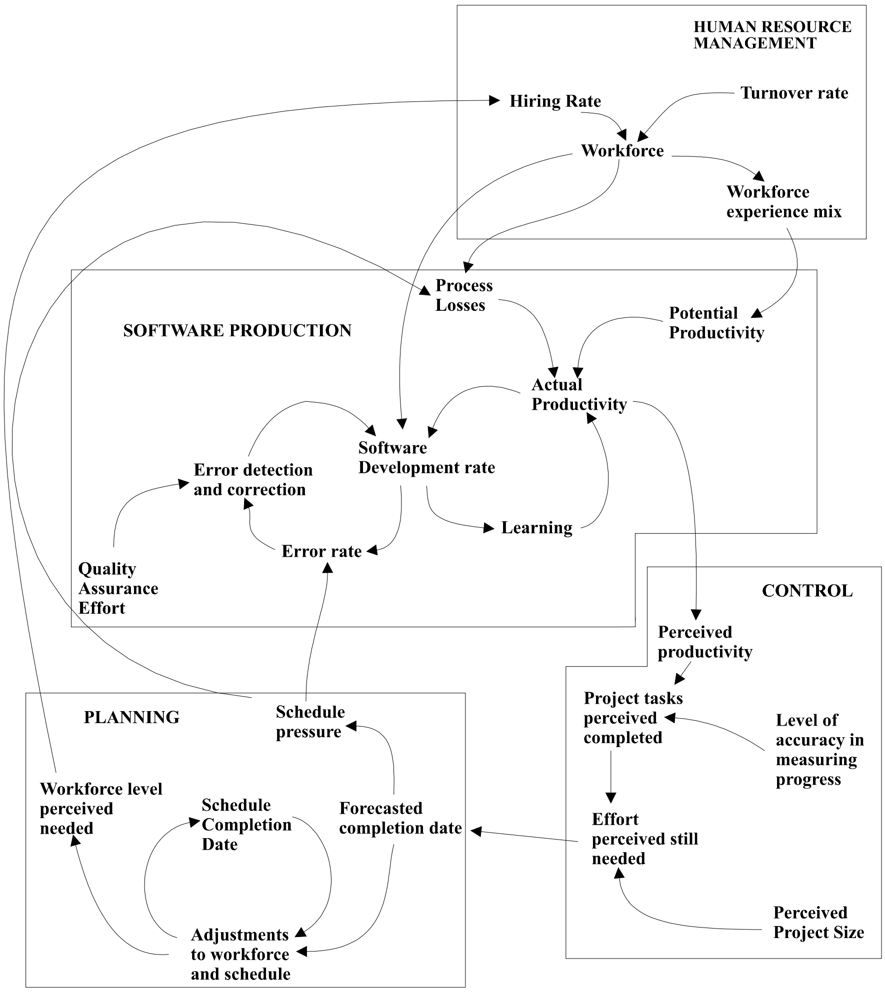

Figure 6.14 Causal Loop Diagram of a Software Development Model (Abdel-Hamid[27])

The causal loop diagram in Figure 6.14 by Abdel-Hamid and Madnick[27] illustrates a model of a software development project, and was used as an example to validate the model's structure. This was part of a wider study of the software development process. The specific project concerned was the development of software system for processing telemetry data and providing attitude determination and control for a NASA satellite. The project was 20% overdue and it was 100% more expensive than estimated. The resulting software was reported to be 'of high quality - reliable, stable, and easy to maintain'. Figure 6.14 reproduces the causal loop diagram, which represents a high level picture of the interacting components of the project. There were three areas that were the focus of attention to the authors:

- Staffing.
- Undersizing.
- Quality Assurance.

They outlined what would be the 'conventional' management thinking behind the three results, and then outlined what their interpretation of the three results was by using the simulation model.

6.8.2 Staffing a project

The conventional thinking on adding more staff to a project to try and either accelerate the completion date or to meet the completion date if project is behind schedule is often associated with Brooks' Law[28]. This postulates that if more personnel are added to an ongoing project then it is going to be delayed further than keeping the existing team numbers static. This is because the new members of the team have to be shown what has to be done by the existing team members, thus delaying them from completing their own tasks i.e. there is an indirect training and communications expense. Brooks Law has not, according to Abdel-Hamid, been formally tested and he believes that it has been applied out of context from its original project environment.

6.8.2.1 Adding manpower to the simulation

By simulating the project using the system dynamics model, Abdel-Hamid and Madnick believed that although the extra staff would contribute to extra cost to the project it did not delay the project end date. As long as the *net cumulative effect* of the extra manpower was positive then there was no difference in the project schedule. In this case study the extra staff were added later in the project life cycle although not late enough to turn the project teams net cumulative contribution negative.

6.8.3 Undersizing (underestimation of project cost, staffing and schedule)

The underestimation of a project in all its key facets as pointed out by Abdel-Hamid and Madnick is not a unique phenomenon, but what concerned them was the use of the final number of man days as a benchmark by which future projects could be estimated. NASA believing that actual project would be the best datum on which to base future similar projects. The argument against using this data was that any project based on it would be overstaffed and wasteful. Projects would be subject to 'gold plating' i.e. unnecessary work would be carried out and the workforce would work to 'fill' the project schedule. The project culture of this environment may lend itself to this type of 'work extension', but is this a valid situation in a more competitive project environment? In projects like the Railtrack and Balfour Kilpatrick case studies resources are inevitably pared down to a bare minimum, even after the project has started. Perhaps the default behaviour of trying to do as much with as little resource is intrinsically flawed especially when weighed against project failure. Countless examples of underestimation continue to hit the headlines, which is as much to do with the political culture of the client/provider relationship than the providers' ability to estimate.

6.8.3.1 Simulating no underestimation

The use of the simulation model based on the estimated optimal data, using no under sizing on the project actually revealed that if the project used this figure it was actually wasteful of human resources. An estimated cost saving of 10.6% is quoted as being achievable in the simulated software project. The study suggests a 'normalisation' process to take place to historical data to achieve the optimal 'benchmark' and calibration figures for future project estimation. This appears to be a useful approach to extracting the best out of historical data, although it begs the question as to why NASA would use estimates from parts of a project that have quite clearly been less than successful? It is recognised that the critical aspect of the project was the quality of the end result, this quality being part of the 'critical path' of the satellite project as a whole.

6.8.4 Simulating the cost effectiveness of the quality assurance policy

Like the under sizing example the study looked at the effectiveness of the QA expenditure which to recap was almost 30% of the total project cost. The system dynamics model was used to simulate different levels of QA expenditure to find an 'optimal level'. Using low values of QA expenditure the total project cost is increased due to the increase in testing. When the QA expenditure reaches the 15 to 20% levels the point of diminishing returns is reached and the costs did not produce any better levels of quality. It is interesting to note the increase in testing if there was a decrease in QA. Obviously there was a mechanism in place that didn't allow the project to continue without some form of check taking place either testing or QA, which when dealing with a high risk project is understandable. In a lower risk environment, it is unlikely that there would be the safety blanket available of having either or QA and testing.

6.8.5 Other examples of Systems Dynamics in Project Management

Rodrigues and Williams[29] cite examples of System Dynamics being applied to project management from the early 1960's, through to the development of large-scale system dynamics tools to aid in the planning and support of large projects in the 1980's. Their article[29] assessing the impact of client behaviour on project performance raises some interesting points regarding the role of SD in modelling project behaviour, and on the dynamics of projects themselves. In particular the positive feedback loops (vicious circles) created when the relationship between the project sponsor and the project supplier deteriorates. One such positive feedback loop was created by the high incidence of progress reporting demanded by the project sponsor and the contractor leading to a downward spiral in the relationship.

In describing the behaviour pattern associated with failing client/contractor relationships Rodrigues and Williams[29] offer another perspective on the role of existing quality systems. They illustrate the consequences of an alteration to the sequence of projects activities, as follows:

- An increase in the number of errors.
- An increase in the number of errors in previously stable activities.
- Project requirements become blurred to the project staff.
- Schedule pressure coupled with the above factors results in Quality Assurance activities being ‘skipped or compressed’.
- Missed errors become compounded and create greater problems later in the project.

The SD model created includes a metric to measure the product quality based on these missed errors. If project staff allocated to QA activities are redirected to other duties to overcome out of sequence project activities the quality review progress does not change:

> “This ‘QA cut’ does not affect the review progress: under high schedule pressure staff spend less time reviewing documents but still report a normal reviewing rate. As a result of this poorer QA activity more defects are likely to escape.”

Whilst this is attributed to pressure from the client, it questions the validity of a quality system that allows the QA function to be compromised both at the initial error checking stage and at review. One important point raised by this article was that the validation of the SD model was based on its accurate replication of past project behaviour and informal interviews of the project staff after project completion. This is a good illustration of the capability of SD to encompass both quantitative and qualitative data allowing a more holistic study of the project environment to take place demonstrating its relationship with systems thinking as shown in Chapter 9, section 9.2.

6.9 Conclusions

The important issues in relation to both quality and project management for the purposes of this research are feedback and the modelling of behaviour over time. The viability of quality management as a ‘systems’ based methodology not withstanding; it is the use of ‘snapshot’ measurement that the author believes to be one of quality management’s integral flaws. In project management, the loss of information between projects due to a breakdown in organisational feedback is critical to improving their rate of success (even the most generic projects). Does System Dynamics[ii] and the models it creates demonstrate the value of good feedback to help improve quality in PM? To answer this it is useful to look at what purposes ‘ithink’ was developed to achieve.

As pointed out by the creators[30] of ‘ithink’ it is seen as being relevant in three areas, Business Process Re-Engineering/TQM, Organisational Learning and Systems Thinking. Business Process Re-engineering and TQM both of which are seen as being part of the process improvement cycle[31], focus primarily on processes. The well being of an organization is fundamentally linked to improving these processes. Ithink as a SD model-building package is seen as a way of identifying and improving these processes. Ithink is designed to allow cross-functional disciplines to communicate in a common language i.e. the graphical interface is seen as being accessible by all. The model of the processes can then be honed by all parties into a realistic or ‘validated’ model. Provided that there can be an input from all relevant parts of the organization the very action of laying out the existing business processes and analysing the relationships between them must be beneficial, in particular the role played by feedback in improving future project performances.

In its role as a tool for organisational learning, ithink is seen as a type of simulator where existing processes can be remodelled either radically (as in Business Process Re-engineering) or as an incremental improvement process (as in TQM). The purpose of this is to encapsulate the knowledge that individuals gain analysing the business processes and integrate this knowledge into the fabric of the organization[31]:

> "The accumulation of this organizational learning should exist *within the business processes themselves* – which is to say that the processes should embody all of the learning that has occurred"

Undoubtedly in this role SD could prove invaluable in identifying the areas of a process where there are problems and most importantly how these areas interact with the rest of the system. SD also has the capability to provide specific operational guidance e.g. how many staff are needed to prevent a project overrun etc. The difficulty is determining the attributes of the different processes, whether they are stocks or flows, where should the system boundaries be drawn what variables to include or discard. Another obstacle is the transferability of the skills and techniques needed to have the cross-functional organisational input needed to construct a useful or valid model. The fundamentals of systems thinking are the base of SD, which increases the leap which managers would have to make to embrace SD. The transition from the systems thinking causal loop diagram to the system dynamics model is not as fluid or as obvious as the creators of the SD applications maintain. It appeared that constructing an SD model could be carried out in isolation of the influence diagram something inadvertently reinforced by packages like Ithink. The mechanics of the

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[ii] For the purposes of this section System Dynamics is synonymous with ithink

software causes the user to lose sight of the influences that are to be modeled.

Unless SD practitioners empower their clients to embrace and make more accessible the thinking and philosophy behind both systems thinking and system dynamics, it will still be seen as a methodology only available to a limited number of academics and organisations. This would be unfortunate because the way of thinking that SD promotes and its attempt to model the qualitative and the quantitative could lead to the much needed change in the way that attributes like quality are measured at present. In its present form system dynamics could be used in a limited manner to identify generic behaviours in existing project quality systems e.g. goldplating, and to promote the original process-based quality philosophy of continuous improvement. Influence diagrams as a more accessible cross-functional medium could allow input into the improvement process. Until the gap between influence diagrams and software packages like ithink is closer (or more apparent) it is unlikely that organisations will move away from their mainstream modelling using more 'static' forms of analysis.

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Chapter 7

Case Study No.1 CRC Gabions Ltd

7.1 Chapter Synopsis

This case study outlines the operational and organisational problems faced by a small civil engineering company in a project environment. The aim of this case study is to highlight the environmental issues faced by such a project company, and in later chapters analysing what relevance existing quality management has for such a company. This is particularly important with 95% of construction companies having eight or less personnel in their organizations. The experience of CRC provided several project case studies and a study of a project organization. The chapter presents the case studies, which will be utilized in the analysis of later chapters.

7.2 The Company Background

CRC Gabions was a small family run civil engineering company that created a profitable business and reputation by using Gabion wire baskets in civil engineering projects. A Gabion basket is a galvanised wire basket or mattress placed in a specified position, then filled with a specified grade of stone as ballast. This provides a building block structure, which is used as an integral part in civil engineering works, for example flood prevention, retaining earth works, roads, coastal defences etc. This simple device has enabled innovative solutions for a number of civil engineering problems. Plates 7.1 and 7.2 illustrate the type of projects that CRC had carried out using gabions.

Plate 7.1 Coastal defence project

The company's founder Mr C.R Clements was one of the first people in the country to realise the benefits of this type of structure and had a franchise on the sale and distribution of the baskets to various contractors. CRC also used them in the civil engineering projects, which become the main part of the business. The company was also proactive in investigating other markets, in the areas of wastewater treatment, flood prevention and canal refurbishment.

Solutions to novel engineering problems appeared to be a great motivator for the management of CRC, combined with a willingness to utilise new technologies to reach their goals.

7.2.1 Project Personnel

The project/engineering part of the company was run by Mr Clements and his son (previously an engineer with a large multi-national civil engineering company). Mrs Clements ran the administrative/accounting side of the firm. The other main staff included, a construction manager a clerk and four foremen based on site. Other staff were employed on a contract basis. At CRC, job classifications were very flexible as everyone was expected to contribute when the need arose. As Mr Clements pointed out, “we all wear many hats”. Evidence of this could be seen continually, from the company director driving a forklift truck and unloading a delivery lorry, to a driver answering the phones in the office. Although this did create problems, with personnel being overloaded from multiple tasks, it did create a very flat organizational structure where there was a high awareness by the management of the status of the projects carried out.

Plate 7.2 A82 Landslide prevention project

The volume of work was high for the return achieved. Cash flow was very important, the company refused to work under a main contractor unless there was first hand knowledge (i.e. personal knowledge) of specifically who the project sponsor was. This stemmed from past experience where larger companies had created difficulties for CRC, by late payment, refusal to pay and generally being adversarial towards them as sub-contractors. CRC attributed much of the financial pressure to the economic climate and, in particular, the problems created by late payment from larger firms: an issue only now being addressed by the government's introduction of the Late Payment of Commercial Debts (Interest) Act.

7.2.1.1 The Labour Force

The labour force working for CRC were hired on a self-employed contract basis commonly referred to as SE60 or 714. The terms referred to the government employment regulations that pertained to that type of employment contract. This type of employment contract transferred the responsibility of tax and National Insurance onto the individual who was termed as being self-employed. While this reduced CRC's overheads it made the workforce transient which in turn reduced the company's ability. A site agent who could recruit further operatives if necessary supervised the actual site work.

This changed over the period of this research, with serious consequences for CRC as a company. The ability of the labour force to be hired as self-employed was altered compelling companies to offer directly employed status. As commented in the Latham report[1] the presence of such regulations would enforce the construction industry to reduce 'alleged self employment' which in turn would provide more incentive to improve training and 'closer supervision of performance on site'. CRC admitted that it had weaknesses in its workforce, due to a lack of skill, because of insufficient training. Although CRC believed they could not afford extensive training of its workforce and relied instead on their existing abilities and what experience they gained on projects.

7.2.1.2 Suppliers

Relationships with suppliers were generally good with the emphasis on using local firms where possible. There was a fatalistic attitude in dealing with larger suppliers, because of poor experiences with the quality of what the larger suppliers offered. CRC felt that they did not possess the necessary influence to alter this state of affairs reinforcing their preference of smaller suppliers.

7.2.2 The form of CRC's projects

The projects preferred by CRC were described as 'Design and Build' projects. These were projects where the client has a problem or a need that had to be solved or satisfied, and as such, they wanted the project organization to take over the task and produce a solution with little or no customer intervention. One example was a company that wanted a flood prevention scheme to protect the new and expensive plant that it has just installed. The customer was not interested in *how* the solution was achieved. Their concern was how quickly a solution could be implemented, cost was important but often a secondary consideration. According to Mr Clements (Senior) this type of project was more likely to be successful for both client and contractor. He did acknowledge however that this type of project was difficult to obtain in the present economic climate where a 'choose the cheapest' attitude was prevalent amongst many organizations. Ironically, it was something that CRC found they had to adopt themselves as work and profit margins became increasingly hard to maintain.

The projects that CRC bid for and were awarded were generally quite well defined e.g. a flood prevention scheme, the construction of a weir etc., but possibly one of their main strengths was in their ability to offer the client a project service which was flexible and to a large extent tailored to the particular problem. They also had the ability to react quickly to problem situations, utilising if necessary new technology or techniques if it produced a solution to a particular problem. This was a major strength in a project management environment with a wide range of often-unpredictable variables. Problems did arise when CRC utilised new techniques and technology. These were due to the rapidity at which they implemented the new technology, often without adequate training for personnel.

7.3 The Lochy Viaduct Project

This was the first in a trilogy of projects observed whilst carrying out the research at CRC. The range and diversity of these projects typified the approach and culture at CRC and illustrated the quality issues facing organizations in a project environment. The first project describes how CRC researched and collated a tender bid in an attempt to secure a difficult construction project from a large ex-public sector organization. The case study outlines the environmental forces, actions, decisions, players and outcomes.

7.3.1 The origins of the project

7.3.1.1 The problem of 'scouring'

Railtrack (formerly part of ScotRail) is the privatised organisation in Scotland with responsibility for looking after and maintaining the railway infrastructure. This consists of the railway track and all its supporting structures throughout Scotland. Over the years, lack of investment in the railway infrastructure has led to some areas needing urgent repair. The erosion of railway viaducts over rivers is one example of this. Over time, the pillars or piers of the bridge along with the immediate river bed area around the piers have become eroded by the passing water, this is called 'scouring'. This weakens the piers and their foundations and can ultimately lead to the collapse of the bridge. Railtrack have a flood warning system that warns when a rivers water levels are rapidly rising, which leads to the closure of the line to rail traffic, once the water subsides, divers have to determine whether there has been any damage to the piers.

7.3.1.2 Resolving the problem

The level of scour can be measured and if it has been found to have reached an unacceptable level then remedial action must be taken in the near future to prevent potentially dangerous

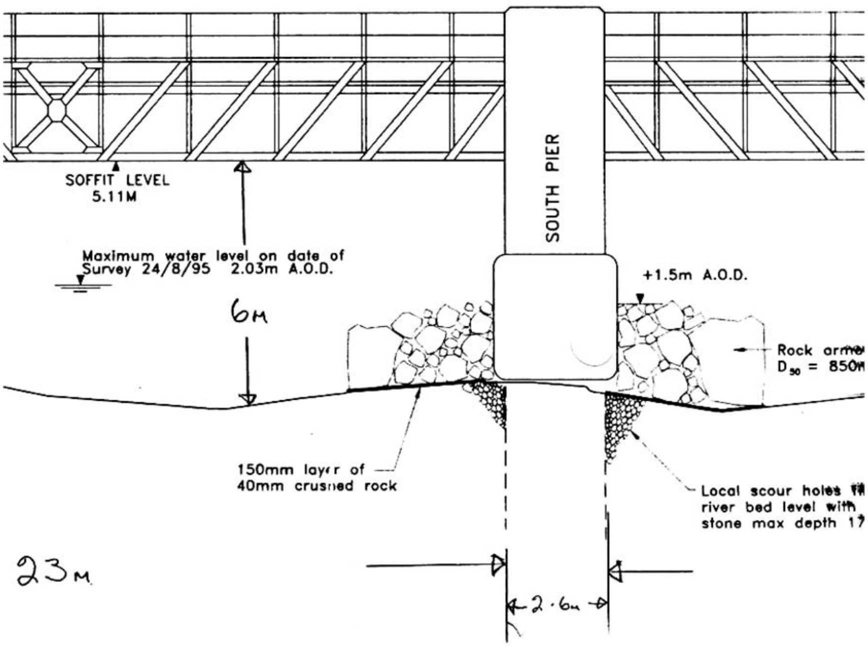

Figure 7.1 **Part of drawing showing how 'scouring' around the Lochy Viaduct bridge piers was to be repaired**

damage to the bridge and railway line. The solution is to excavate around the base of the piers to provide a level surface, then surround the base of the pier with a collar of 'rock armour[1]' as shown in Figure 7.1. This is a straightforward process when the river levels are not high and access can be gained along the riverbed to the viaduct piers. A mechanical excavator then places the rock armour (typically in pieces each approximately one ton in weight) around the pier without causing it damage and in a way that provides the maximum amount of protection to the pier from the scouring process.

The process of installing the rock armour is more hazardous when river levels are higher and the flow rate is greater. In addition, some rivers are prone to flash flooding[2] (the River Allen in Bridge of Allen being one such example). Other factors like surface run-off water, melting snow and local hydroelectric schemes can also have an impact on the river level. Generally, mechanical excavators are limited in the depth of water they can work in, both for practical and safety reasons.

7.3.1.3 The effect of seasonality

The main criteria in reducing the risk of technical failure in such a project is to make sure the project is carried out at the correct time of year i.e. when the river level is at its lowest and there is as little as possible chance of the river rising rapidly. Historically, in the UK the best time to do this is in summer time (July to Sept.) when river levels are low, with winter conversely having the highest river levels.

Railtrack had identified two viaducts that were in urgent need of scour protection. These were the Lochy viaduct on the outskirts of Fort William, and the Cornton viaduct across the River Allen in Bridge of Allen. Of the two projects, the Lochy viaduct was the larger and more challenging, due to the width and depth of the river, the access to the site of the viaduct, and the amount of work to be carried out. The level of scour at the Lochy viaduct had, in the words of a consultant engineer “gone off the end of the measurable scale” posing

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[1] Rock Armour- a term used to describe a form of rock cladding which is placed around a structure to protect it. Can be in the form of lumps of solid stone or made up of gabion baskets or mattresses

[2] Another contract bid by CRC was for remedial works on a bridge over the River Allen, which is very prone to flash flooding.

considerable threat to the safety of the rail bridge and its traffic.

7.3.1.4 The project stakeholders

This information was available approximately in August 1995. The 'sponsor' of the project was a Railtrack 'cost centre', which was responsible for the finances available to carry out the projects. The Major Projects Division (M.P.D) of Railtrack was the separate business unit that was going to carry out the project (or manage it) on behalf of the Railtrack 'cost centre'.

7.3.2 Railtrack's approach to CRC and preliminary investigations

Railtrack M.P.D had heard that CRC specialised in river works and the use of gabions for flood prevention. They contacted CRC, outlined the severity of the problem, and asked if CRC would make a site visit to both Cornton and Lochy viaducts, construct a proposal on

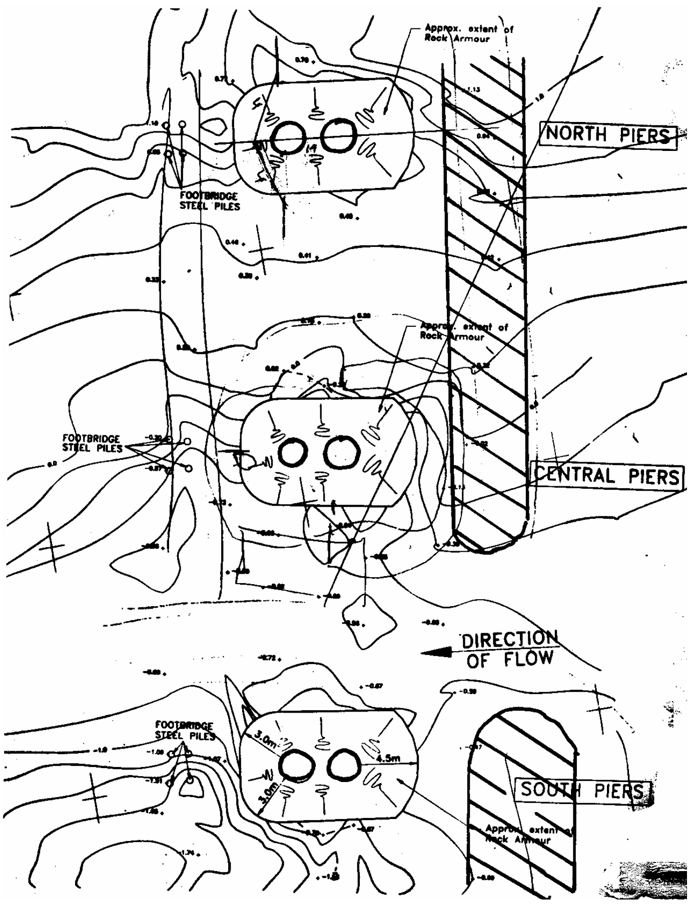

Figure 7.2 **Plan view of Viaduct with temporary causeways shown (shaded area)**

how they would implement both projects, and if approved by M.P.D, work would commence as soon as possible.

After a visit to the sites, CRC's director Mr Clements had formulated how CRC were going to carry out both jobs. The method for the Lochy viaduct would involve 'temporary works' i.e. the construction of a temporary causeway out into the river, parallel to the bridge, from which a tracked vehicle could work, allowing the placing the 'rock armour' around the piers. Two causeways were to be built one which would reach two of the bridge piers and another from the opposite bank that would reach the remaining pier. Both causeways could not be built at the same time, as this would cause too much pressure to build up on the pier nearest to the remaining access for the water. A preliminary sketch of this arrangement is shown in Figure 7.2.

The initial proposal was submitted to Railtrack M.P.D with this method. The importance of the project being carried out within the available 'weather window' was also stressed. M.P.D had employed a group of consultants from the Babtie Group who had designed and drawn up the specification of the works required (as shown in Figure 7.1). The method that CRC had proposed had to meet with the approval of M.P.D, and also the consultant engineer, as well as satisfying the financial demands of the Railtrack Cost Centre. MPD had intimated to CRC that due to the urgent nature of the repairs as long as approval was given then the project could go ahead. This was approximately 4 weeks after the site visit. There was one anomaly to this. MPD had also asked another contractor to price for two similar types of viaduct repairs at different locations. This contractor was not in exactly the same business as CRC i.e. it worked in different areas and markets. CRC speculated that MPD were trying to dissipate any perceived risk by using two different contractors, with different work methods for similar work, or that they were collecting information on alternative ways in which to tackle this problem. This was not an unreasonable idea, considering they had not used at least one of the contractors before. There was also speculation that it was an attempt to force a lower price for the contracts by playing one company against the other.

7.3.2.1 Logistics research

Already at this stage CRC were carrying out some preliminary logistics work into various aspects of the project. Access to the viaduct would need to be through land not owned by Railtrack, therefore permission would have to be sought from the owners. There would be restrictions on any plant and machinery that came in from the Fort William side of the river due to a narrow bridge with a 7 tonne weight limit. What materials were available locally? For example, was the stone at the local quarry suitable for use as rock armour? Were there any plant firms that could supply CRC? Information on the River Lochy was also sought, from local people, the local water authority and the Hydro Electric board who controlled the flow of the river when generating electricity further upstream. It was discovered that the river was affected by tides as well.

7.3.3 Meeting the client on project implementation

MPD requested a meeting with a representative of CRC to review the causeway method that had been initially proposed. The date of the meeting was 29th September. Mr Clements (Jnr) represented CRC at the meeting that was attended by Railtrack's project personnel. Railtrack's project team consisted of the MPD project controller, who was in overall charge for MPD, the MPD project manager who would supervise the actual work on site and a consultant project engineer, who was directly answerable to MPD. The consultant engineer was to supply independent technical expertise on the civil engineering works and their design, as well as approving any sub-contractors temporary and permanent works on site. Finally, a consultant quantity surveyor represented the 'sponsor' the Railtrack cost centre. The author of this case study was fortunate enough to be able to sit in on this meeting having received permission from those present.

7.3.3.1 Contingency project proposal

Before this meeting, an alternative way of carrying out the temporary works had been discussed at CRC. This involved creating a temporary enclosed 'bund' around the first two piers, lining the inside with a bentomat liner[3], pumping out the water inside to create a 'dry' working environment for the placing of the rock armour, then removing the temporary bund. CRC believed this had some advantages over the initial causeway method; the rock armour could be more accurately placed because the area around the pier would be dry (negating the need to have divers check the positioning) and it would reduce the risk in damaging the bridge. CRC decided to use this as an alternative at the meeting with Railtrack, if the first proposal was not positively received.

The initial proposal to build a temporary causeway at the Lochy viaduct was put under heavy scrutiny by the consultant project engineer, he did not believe that it could be made stable enough to support a mechanical excavator for the proposed works, in addition there would be height restrictions due to the proximity of the bridge. MPD at this point mentioned that they would use the consultant engineer present to approve or reject any temporary works that were to be carried out by the sub-contractor which won the contract.

The dynamics of the meeting were very interesting, on one side, there was a representative of a small civil engineering firm, on the other side there were four representatives of a very large organisation with distinct job and role descriptions. The suprising aspect was the lack of participation by certain members of the Railtrack team. The role taken by the project controller was one of facilitation, trying to find a solution to the problem. This was in direct contrast to the role taken by the consultant engineer, which seemed purely adversarial and negative towards any proposed solution. The other two members of the team hardly took part in the meeting at all. Their role appeared to be that of observers, not as active participants which was unusual as some of the topics of the meeting would have had a direct effect on one of them. This may have just been an illustration of the organisational culture at Railtrack where job definition appeared to be quite well demarked, in contrast to CRC were personnel were expected to carry out a variety of roles.

If CRC wanted to win the contract they had to offer some form of alternative to the causeway, and this is what Mr Clements (Jnr) proposed. He outlined the idea behind using an enclosed bund with a liner. The consultant project engineer after briefly looking at the drawings supplied was still not satisfied. His objection centred around what would the risk be on the viaduct pier not enclosed by the bund with the increased pressure of water on it. In addition, how would the bund be breached quickly in the event of a flash flood? (This point was also brought up with causeway proposal) The enclosed bund would also have to be classed under different regulations because in effect it was a type of dam. This put different parameters on the specifications that had to be used for the bund, which would negate its viability straight away. Having had no experience of using the bentomat liner that CRC were proposing to use, the consultant was not prepared to accept its suitability for either the enclosed bund or the causeway.

The project co-ordinator made it very clear that if the project went ahead and a programme of works was decided, MPD would hold CRC to it regardless of what adverse conditions were encountered. Mr Clements pointed out that the delay that had already taken place since the

[3] Bentomat liner - a liquid clay filled membrane which on contact with water sets to form a waterproof liner.

first site visit had reduced the available weather window considerably. MPD recognised this although they said that this was very fast for them in relation to their normal project procedures, where the considering of a tender process alone, usually took a minimum of six weeks (thirteen weeks being the average).

7.3.4 The Health and Safety Plan

A project's Health and Safety Plan is now a key document in getting a project proposal accepted, when bidding for contracts from large organisations. It includes risk assessments and often forms the basis for complying with Construct (Design and Management) Regulations, which will be discussed in greater detail in Chapter 11, Section 11.5.3. Although there was no decision about the Lochy viaduct project, things began to move (albeit slowly) towards an eventual start date for the work at the Cornton viaduct. The next hurdle that faced CRC was constructing a Health and Safety Plan that met with MPD's approval. The Health and Safety Plan is used as a key framework to describe every aspect of the project from method statements, risk assessments to programmes and planning. This proved to be a very onerous task for CRC because there was a lack of up to date company policy statements that fitted Railtrack's need for documentation. This did not mean that CRC as a company was unaware of safety or quality; it just was not written down in a consistent or integrated manner. Railtrack with their vast administrative backup and catalogue of documented procedures for every eventuality, were constantly contacted to gather information on how to modify and tune the Cornton Health and Safety Plan which after approximately three attempts was finally accepted (with conditions) by MPD.

The final document as shown in Appendix No.1.- Health and Safety Plan took approximately two days and nights to construct, and provided a good template for the Lochy viaduct contract. The lack of integrated documentation illustrated a weakness that would have proved costly to CRC if more prospective client organisations required similar amounts of information when accepting tenders from contractors. The introduction by the Government of The Construction (Design and Management) Regulations 1994 in an attempt to tackle the root causes of the construction industries poor health and safety record means more organisations are looking at implementing the type of Health and Safety Plan that Railtrack use. These regulations (commonly referred to as CDM regulations) are discussed in more detail in Chapter 11.

7.3.5 An Alternative Method for Lochy Viaduct

Following the meeting with Railtrack's Major Project Division, CRC realised that alternatives would have to be explored and a different approach taken if they were to be considered for the Lochy viaduct contract. The same day as the meeting took place an idea was proposed to use a water borne craft, equipped with some form of lifting arm. That

Plate 7.3 Comparison of river levels in August and November at the Lochy Viaduct

evening at CRC an impromptu brainstorming session took place and some basic requirements were discussed. The flow of ideas (good and bad) was unhindered and with a lot of sketches and discussion carried out. Compared to the meeting that had taken place that morning it was a very positive exercise and fuelled more information gathering over the weekend. On

Monday morning (2nd Oct.) a decision had been taken to start making serious enquiries about the feasibility of using a barge/lifting platform. It was decided that an alternative proposal would be formulated and presented to Railtrack MPD as soon as possible. Even at this stage CRC were demonstrating great flexibility and an ability to respond quickly a point that is analysed in greater detail when discussing existing quality systems in Chapter 11, section 11.7.

That week a marine consultant, Captain Shakesby MBE, flew up from Dorset and met Mr Clements at the Lochy viaduct site. Already the level of the river had risen substantially from the first site visit made in August as shown in Plate 7.3.

The problems faced were discussed back at the CRC office and again an impromptu brain

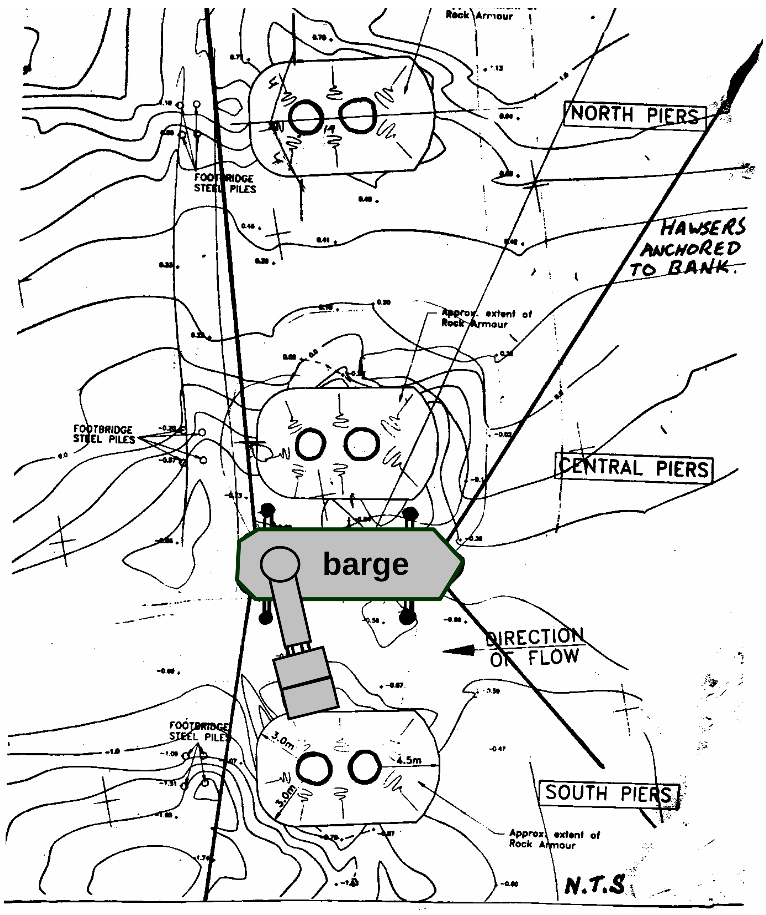

Figure 7.3 Plan view of Viaduct with sketch of barge in place

storming session took place, with the expert on marine matters and the expert on civil engineering filling in the gaps that were raised when amalgamating the two areas. Cost was also discussed and the availability of suitable vessels that could be modified. The need for specialist personnel was also covered and the safety regulations that would cover the craft whilst it was on the river. Measurements taken from the available drawings were used to determine the maximum draft available to any craft and the width and height restrictions of the viaduct were taken into account. The turning radius, lifting capacity, reach of the mechanical arm was measured and combined with the scale sketches of the barge/pontoon. Railtrack had specified a 'fail-safe' restriction to any plant in close proximity to the viaduct. The 'fail-safe' distance being the minimum distance that a piece of mechanical plant can get to any part of the railway line or adjacent structure. Mechanical excavators can have special valves fitted to them to restrict the movement of their boom or jib to lessen the risk of collision with a structure whilst they are working in close proximity to them.

The basic principal behind the barge based proposal was to have the barge attached to hawsers which in turn were anchored at a number of positions on the river bank, and upstream as shown in Figure 7.3

The barge would be positioned and manoeuvred by its own air winches, which would act on the hawsers. A safety boat would be positioned beside the barge as well in case of any emergency. The barge would not go within a 3.0m radius of the piers and it would be able to reach the downstream side of the piers. This was important, as there was a footbridge on one side of the bridge, which prevented access to both sides of the viaduct. The barge would be loaded with 10 tonnes of rock armour at a time, from the North bank (the same site that would have been used regardless of how the project was done). The rock armour would be lowered into position by the hydraulic arm piece by piece.

Advantages of this proposal included; no need to have any temporary earthworks therefore no additional pressure on the piers, less environmental impact on the river and if the river levels rose rapidly, the barge could be easily removed from under the bridge and moored until such time as the river levels fell again. The cost of hiring the barge and modifying it would have been equivalent to, or less than, the proposed temporary earthworks. Moreover, this method could be used on other viaducts with scour problems, CRC also had other plans to utilise the barge in canal repair work. Disadvantages centred on the fact that this was an unknown, untried method with a high degree of risk and investment for CRC. Also convincing MPD of the validity of the method was always going to be difficult. Unlike projects that CRC had carried out for other established clients, CRC had no recognisable project champion in MPD therefore it was not going to be easy to convince the MPD project team.

The new proposal for Lochy viaduct was constructed and sent to Railtrack MPD within the next five days (and nights!). The price CRC had originally quoted for the job had gone up substantially but that was primarily to reflect the increased financial risk that they were going to take, considering that the weather window shown on the original plan had past.

7.3.6 The Outcome

CRC did not get the contract at the Lochy viaduct. It is known that MPD did consider the alternative project seriously, but it is believed that the project sponsors were not willing to increase the cash available to MPD to use CRC's method. The reluctance of Railtrack to spend a comparatively small amount of money (small in relation to the consequences of having a railway viaduct collapse) on a repair that was deemed extremely urgent just before winter seemed shortsighted. MPD were going to compensate CRC for the outlay in time and money that it had spent in formulating the proposal, in fact, this never happened. The official reason given by Railtrack was that CRC were charging too much for the contract.

Plate 7.4 **Excavator sunk in silt on the riverbed under the viaduct**

Plate 7.5 **Divers prepare to investigate how deep the excavator has sunk**

Plate 7.6 **Later in the week the excavator is pulled half way out.**
(Note the 'turret' extending from the body of the machine, emphasising its size)

Plate 7.7 **Three of the four mobile cranes used to pull the excavator out**

Plate 7.8 Excavator out awaiting repair
(Note pieces of 'rock armour' visible in the background on the far bank)

Plate 7.9 Excavator finally underway

7.3.7 Update

The project to place the ‘rock armour’ at Lochy viaduct was awarded to another contractor. The price the contractor was charging was approximately half that of CRC’s bid. The method used was to hire a specialist, large (approximately 50 tonne) excavator that was going to drive onto the riverbed and place the pieces of rock armour around the piers. No causeway was needed and the river was at a record low for the month of December. Unfortunately, the excavator sunk in the silt on the riverbed under the bridge and was stuck for seven days as chronicled in Plates 7.6 – 7.9. It took four heavy recovery vehicles seven days (at an approximate cost of £100/hour) to remove the excavator, in which time no work was done, the contractors other plant was lying idle and the project had lost probably ten days out of its programme. It is unlikely that Railtrack will have lost anything financially although they came close to losing their bridge. The contractor, which carried out the work, was not the other preferred contractor but one whose price was substantially lower than CRC’s. It is not known whether they were still in business after the end of the Lochy viaduct project.

7.4 The Admiralty Pipeline Project

The second of the projects studied at CRC illustrates a medium to long-term project, which demonstrated their ability to be flexible to the changes that occur during a project and their ability to capitalise on opportunities that were presented during the course of the project lifecycle.

7.4.1 The Project and Project Stakeholders

During a small project for British Waterways constructing a slipway on the Forth and Clyde canal, CRC were approached by a small local contractor who informed them of a possible business opportunity involving the reclamation of an old underground pipeline. At some stage during the First World War, a pipeline was installed between Grangemouth and Dumbarton to facilitate the moving of fuel oil between the East and West coast (both areas have historically been used as petrochemical storage areas) in a safe and secure way. This pipeline was approximately 0.4m in diameter, 9m long and laid underground in the towpath alongside the Forth and Clyde Canal at a depth of approximately 1.5m. A second pipeline laid along the same route just before the Second World War followed this. The pipe itself was a seamless mild steel pipe covered in bitumen and non-ferrous mechanical couplings joined the pipe sections. The pipe was no longer in use and where the pipe was in British Waterways ground, it became their property.

The local contractor had a market for this pipe. Apparently, it has considerable value in third world countries like India where it can be refurbished and re-used. The contractor proposed to enter into a venture whereby his company extracted the pipe and sold it, CRC would provide supervisory staff, manage contact with British Waterways and reinstate the towpath along the canal. The local contractor primarily wanted to utilise CRC’s long-standing relationship with British Waterways.

British Waterways had, over a period been upgrading the Forth and Clyde and the Union Canal. The canal system had fallen into disrepair over the years and needed considerable work on it to allow it to be utilised as a beneficial civic amenity. In addition, certain parts of the canal were heavily contaminated with industrial pollution, for example mercury, cadmium and other heavy metals.

An added incentive to upgrade the canals was the Millennium Bid. In the year 2000, the Government was going to contribute large sums of capital to projects that were considered worthwhile and in the public interest (the money having been provided by the Lottery Fund). British Waterways along with other organizations, had put in a bid for Millennium funding. They wanted to upgrade both the Forth and Clyde and Union Canal to provide a continuous 'sea link' between the east and west coasts of Scotland. The amount they were trying to secure from the Millennium Commission was £135M; combined with £30M of their own capital and £30M of EC funding was needed to make the scheme viable. As part of the process of putting together a bid, British Waterways had to be seen to be actively improving the canal infrastructure, which is why the proposed project was seen as worthwhile.

The idea behind the project was quite simple. The pipe belonging to British Waterways would be extracted, removed from site and sold by the local contractor. Using the proceeds from the pipe sale CRC would reinstate the towpath to a higher standard than it was. British Waterways in theory would get the towpath upgraded for nothing. Plate 7.10 shows the towpath prior to upgrading.

7.4.2 The Trial

Initial trials and research started in June 1994. An initial test section of 2km was going to be excavated to see if the project was viable. If this was successful then a possible 73km of pipe was going to be extracted. Once the pipe was located and identified, there was some initial doubt as to its value due to the outer condition of the pipe but after a trial piece was extracted and analysed, the trial began in earnest. Technical and staffing problems started to arise early on in the project. The personnel supplied by the local contractor were inexperienced and the method used to extract the lengths of pipe that could be up to 11m in length and weighing almost 1.5 tonnes was very haphazard and dangerous. Added to this was the discovery of other utility services buried near the pipe. These consisted of two 11,000-volt power cables and a 4” duct, which housed six fibre optic cables. The fibre optic duct was laid in a very erratic manner. It had been laid alongside, underneath and above the pipeline, making it very difficult to extract the pipe without disturbing the duct. This was a major risk, although it was not realised how large a risk by either CRC or the other contractor.

7.4.3 The Cost of Damaging the Fibre Optic Cable

The duct with the fibre optic cable inside it was in real danger of being damaged and after the author expressed his concerns, it was decided to investigate the consequences of such an event. The cable belonged to a company in England called Fibreway whose main business was ‘peak fibre leasing’. This is where companies such as British Telecom, Mercury Communications and others lease a fibre optic link for the transfer of telecomm data. The fibre optic link went from Glasgow to Edinburgh and had been laid on a speculative basis in an attempt to capture the growing market for data transfer. If the cable was damaged it could only be replaced in 2km lengths. This was due to the loss in light transfer through fibre optic cable joints therefore joints were kept to a minimum. The cost to replace the cable was approximately £70,000 for 2km, but this was not the expensive part, the loss of lease revenue if the cable has been rented was also charged which could have be in the region of £50,000 every 4 hours. The shortest time it would take to replace one section of cable would have been two weeks, i.e. a possible overall cost of £4 million. This was a worst case scenario but one which was liable to happen if the local contractor was not made to change the way in which they extracted the pipe. CRC confirmed that their insurance covered them for such a liability, but it was obvious that the local contractor was going to be too much of a risk when extracting the pipe. The site supervisor provided by CRC was also expressing concern at the working practices of the local contractor. CRC was beginning to get concerned that the abilities of the contractor reflect on them, damaging a lucrative relationship with British Waterways.

Surprisingly, documentation, maps etc, of the location of the fibre optic duct did not seem to exist (most utilities have a record of where their equipment or 'plant' is buried). On contacting Fibreways regarding this, they did not seem unduly concerned, and an interesting fact became known. They had apparently used a large part of the existing admiralty pipeline to feed the fibre optic duct through. This was quite suprising as the pipe itself still had residual amounts of heavy fuel oil in it, which would have to have been cleaned out prior to putting in the fibre optic duct. In fact Fibreway were believed to have spent up to an estimated £250,000 cleaning the pipe for a large part of the route, this cost was considerably higher than the equivalent cost of laying a new duct. Evidence from local machinery operators indicates that

Plate 7.10 Canal towpath before pipe extraction and upgrading

the standard and execution of the original fibre optic project was very poor, which was reflected in the way in which the duct was laid in the ground. Despite this news, the management at CRC remained optimistic that enough pipe would be available for viable extraction. The way in which CRC perceived risk/opportunity regarding the fibre optic cable and the pipeline was very interesting. As is discussed in subsequent chapters the culture at CRC was one where the 'degree of adventure' was high, i.e. they were not risk averse.

7.4.4 Operational changes

CRC decided to stop using the local contractor to extract the pipe, the risk was too great, and their progress was not economically viable. At least 10-12 pipes had to be extracted in a day and this was not being achieved. The local contractor was still going to remove the pipe to storage and sell the pipe, but they would not be involved in any extraction works along the towpath.

7.4.5 The Towpath Reinstatement

As the pipe was being extracted, CRC's own personnel reinstated the towpath. The 'bank' of extracted pipes in theory paid for this upgrading, with approximately one metre of towpath being upgraded for every metre of pipe being extracted. This was as long as British Waterways did not change the specification for the upgrading of the towpath.

As the work progressed it became clear to CRC that British Waterways 'pipe bank' was not going to cover the cost of the towpath upgrade. British Waterways were very pleased with the reinstatement of the towpath and as such started to ask for the reinstatement to increase. The width of the towpath reinstatement was to increase from 1.0m wide to 2.0m, plus an increase in the specification. There was also mounting uncertainty over the total length of the pipe available, which CRC felt left them vulnerable to being left facing late payment from British Waterways, something that CRC as a small company with limited cash flow, could not afford.

British Waterways could see the potential to the upgrading of the canal and as such wanted to keep the momentum going once it has started despite the fact that the pipes would probably not cover the cost. Initially, British Waterways wanted CRC to provide the higher specification towpath for the same price and this did lead to some disagreement, but after lengthy negotiation, it was agreed that other funding would have to be supplied to meet the extra costs. 2 km of towpath was laid before this was decided, by which time CRC had used up considerable resources. British Waterways began to use the higher standard of towpath to convince local authorities where the canal ran through, that this was a worthwhile project to support as joint project sponsors. Re-organisation of the local authorities effectively stopped the possibility of any further contribution which effectively brought the whole project to a halt. This was a prime example of the external environmental variables that can affect both the project sponsor and supplier.

7.4.6 Internal Problems

Following a change in Government legislation regarding the way in which self employed people were employed at the company, CRC had to change the conditions of employment that all of the personnel were under. The employees previously worked under a self-employment certificate, which meant they were responsible for their own tax and National Insurance payments. CRC supplied transport to ensure a reliable means of getting the personnel to the site and to ensure that the company projected a good image to its customers. This arrangement appeared to work well for both parties, the employee negotiated an average rate over the working year - a flat rate for all types of work.

After the changes, all the employees at CRC had to be employed under a Pay As You Earn

Scheme which entitled them to holiday pay, sickness benefit, pension scheme, and bonuses. CRC management believed that this would be more beneficial to the employees, but the employees did not agree, six of them left, at that time a third of the workforce. The management felt betrayed. Some of the employees had been with CRC for 3 - 5 years (a relatively long time in the construction industry). The employees believed that they were not going to get as good a deal and tried to force CRC’s hand. It is difficult as an outside observer to gauge the validity of either party’s grievances, but it was apparent that in one instance at least, there was a different perception of the way in which a project was viewed by the manager and the ‘front line’ employee. At the pipeline project, the supervisor in charge was given more responsibility, as it was realised that the local sub-contractor was not going to be suitable. This resulted in more work for the supervisor, although some resources were provided to assist him; a mobile phone, backup from the manager in the main office and on the site. The manager saw this as ‘training’ for the supervisor and believed that this would be a stepping stone for him. When it was suggested by the author that perhaps the supervisor viewed this as just in increasing workload with no apparent gain, this was strenuously denied. The directors at CRC viewed this as an opportunity for the supervisor.

Certainly, the two directors did expect employees to do a lot for their money, and were not reticent in telling an employee if he did not meet their expectations. This work ethos was reflected in the hours that both directors worked, it not being unusual for Mr Clements (Snr) to work through the night if necessary to meet a deadline, and both directors worked at least one day at the weekend. The commitment to the company was absolute, and I suspect in common with many project managers the job is not just work but a way of life that precludes everything else. The fact that the two managers were also the owners of the company is in the author’s opinion irrelevant, as he witnessed the same commitment by project managers who were employees of large multi-nationals. Shtub, Bard and Globerson [2] describe the project manager as a 'lightning rod, frequently under a storm of pressure and stress' and the work at CRC certainly met that criteria. The archetypal project manager is geared (or has been conditioned) towards dealing with the unexpected, the long hours, and the stress, the need to make unpopular decisions, indeed it could be speculated that this variety is what makes the job attractive. The departure of the six employees and the new payment regime resulted in a change to the structure of the workforce and a limit to what projects could be attempted and resourced. The fact that the towpath was the only project at this time was fortuitous for CRC, as they had no immediate projects available.

7.4.7 Portable Dam Project

Whilst CRC was working on the canal for British Waterways, they put together a bid to de-water and repair another part of the canal. The canal liner had to be repaired and to do this, a temporary dam using special scaffolding structures had to be constructed, the water was then pumped out of the canal, the clay liner repaired, then the water would be re-introduced. The construction of the temporary dam is the most expensive and time consuming part of the project. CRC had decided to try a different technique, a portable dam imported from the United States. Mr Clements had read about the idea in a civil engineering journal, and thought it was ideal for this particular application. He had contacted the American company, found out who had the distribution rights to the dam in the UK and had made contact with them to buy one, again illustrating the rapidity in being able to respond quickly.

Meanwhile the contract for repair of the canal had been awarded to another company. Undeterred CRC contacted the company that won the contract and offered to do the damming section of the project for them, using the portable dams.

Plate 7.11 The sequence in the utilisation of the portable dam

CRC managed to persuade both the contractor and its customer British Waterways that this was worth doing, indeed they saw a possibility of using this technique in other parts of the canal. The portable dam was a remarkably simple idea, it consisted of a geotextile tube which was floated across the stretch of water that was to be dammed and then it was pumped full of water and silt. The dam sinks to the bottom of the canal, another dam is located at the other side of the damaged part of the canal, then the water was pumped out from in between the two dams. The four pictures in Plate 7.11 shows the sequence of this happening on the canal.

This appeared to work but there was an unforeseen problem the dam was not heavy enough or of sufficient diameter to withstand the water pressure which increased as the canal drained. A slip plane was created at the base of the tube causing it to move and eventually rupture. This occurred three times, once at 1.00am on a Sunday morning, creating a lot of problems for CRC mobilising personnel, pumps etc. Initially vandalism was believed to have been the problem, or the dam sliding along the floor of the canal. The dam's importer discounted this. After the third breach, it was realised that it was the unequal water pressure on the dam, combined with sliding on the silt on the canal bottom that was causing the problem. To relieve this pressure smaller dams were placed alongside the first one to break down the pressure, similar to a sequence of locks. The importer supplied the other dams to facilitate this, and although CRC had additional expenditure due to the bursts and could have lost credibility with an important customer (British Waterways) they managed to recoup the situation. The test had proved to be a 'successful' failure.

CRC again had demonstrated how they were not afraid to experiment with new technology to try and overcome a technical problem. This trait was one that had benefited them in the past (e.g. the use of gabion baskets etc.) although the implementation of the technology was not always well controlled.

7.4.7.1 A Project Champion

One aspect of CRC's work for British Waterways was the presence of a project champion. The chief engineer from British Waterway's was impressed by CRC and their keenness to try new technology. His backing was important in overcoming resistance to adopting the temporary dam. This patronage extended to other canal work and produced a useful client supplier relationship. The role of project champions will be examined in Chapter 7, Section 7.2.11.

7.4.8 Towpath

The proposed towpath total was 48km of which CRC had laid 26km. The expected completion date was August with an estimated overall value of £0.5 million. During that time CRC were looking for spin-offs to this project, involving the construction of cycle paths along disused railways. British Waterways eventually encountered financial difficulties in funding the towpath project due to a shortfall in European Community funding, despite the fact that the project was almost at the completion stage. This had a direct effect on CRC who had no projects lined up for their workforce and a budgetary shortfall on their expected future income.

7.5 Lidl Surface Run-off Scheme

7.5.1 Background to the project

Water Authorities in Scotland went through a series of changes in the last few years. Originally there was five River Boards in Scotland. These were incorporated into the Scottish Environmental Protection Agency (SEPA) that was split into three geographical regions, North, East and West. SEPA became responsible for monitoring and policing air pollution, liquid/water pollution and landfill pollution. One of their responsibilities was the monitoring of the pollution of any streams or rivers from any industrial site from surface run-off water. Surface run-off water is defined as rain that falls onto the ground, buildings and sites of commercial premises, and is then transported by a drainage system into the nearest watercourse. The materials the water collects on the way contaminates it. Typical contaminants are hydrocarbons from spilt fuel, zinc from the tyres of vehicles, and other harmful substances. Areas of heavy traffic are particularly prone to contaminating the surface run-off water. Although legislation has been in place for over 10 years to prevent such pollution, it had not been enforced to any significant degree. This was expected to change due to greater public environmental awareness and further government legislation to stop pollution at its source, therefore enforcing commercial premises to treat their own pollution

The Scottish Environmental Protection Agency (SEPA) have the power to shut down premises that do not treat their surface run-off water before it leaves their premises, therefore it is in an organisations interests to avoid this happening by installing some form of ‘treatment plant’ to deal with the problem.

7.5.2 The Project Sponsors

The German Supermarket chain Lidl were having a distribution centre constructed at a site near Livingston. This gigantic warehouse would have hundreds of heavy vehicles driving in and out, parking, loading, unloading etc. bringing with it the risk of pollution of the surface run-off water. The value of the distribution centre project was estimated at approximately £10M with the duration of the project being 28 weeks. The main contractors Balfour Beatty Construction had estimated that it would cost £15,000 for the surface run-off scheme. They did not appreciate the need or cost of this ‘treatment plant’. The initial quote that they had received from one company was £120,000 plus a design fee. This was obviously far in excess of the money set aside for the scheme. In addition, the timescale for the construction of this plant was 8 weeks, which was over the complete project deadline, which was of the most concern to Balfour Beatty. CRC became involvement began when it was asked to construct the scheme for the design company. CRC turned the offer down, they believed that there was ‘anomalies in the design’ due to its complexity and it would be difficult to construct. Two other construction companies also turned down the project.

7.5.3 A Commercial Opportunity

Having seen what was required, CRC decided to bid for the project. CRC had over a period of two years been investigating new types of projects in the environmental market, which would complement their own expertise and experience. This had yielded numerous contacts with professionals in the environmental industry, and a limited number of small-scale pilot projects. Through collaborating with an ecological engineering consultant, CRC believed that they could design and construct a better more cost effective drainage solution for Balfour Beatty and their project sponsors Lidl.

7.5.4 The Project Proposal

CRC submitted a proposal to Balfour Beatty and Lidl. The total value of the contract was £80,000 the project duration would be 4 weeks, half the original company's proposal, allowing Balfour Beatty to meet their overall project deadline. CRC had built in a contingency of approximately 10% in the contract value to allow for unforeseen problems.

The treatment method proposed involved the construction of series of interconnected filtration ponds, which would 'naturally' treat the contaminated surface run-off water before it passed into the local river network. The first stage was a large collection pond, which was lined with various types of vegetation; this allowed the settlement of larger contaminants (like rubber), which cannot degrade any further. The second stage, involved the water passing down and through a grass/reed filter bed to trap further contaminants and the final stage involved the water travelling over a boulder/stone cascade to aerate the water before it passed into the local river network. The vegetation that was planted in the pond for the reed bed was vital for the successful operation of the 'treatment plant'. The pond also had to be periodically drained and cleaned out every 4-5 years.

7.5.5 The Risks

The design had not gone before the Local River Board for approval due to the speed at which the proposal had been submitted. Therefore, there was no guarantee that they would grant it approval (natural treatment plants are still a relatively new way of dealing with contaminated water). In addition, the treatment plant would not become fully functional until the vegetation was almost completely grown. CRC had 10% of the total value of the contract, as a contingency built into its price although this would not insured against the treatment plant not working. There was also a risk to Balfour Beatty and Lidl, if the plant did not work in six months time they still had to solve the problem, to prevent possible action by S.E.P.A. which in a worst case scenario would mean closing down the distribution centre.

7.5.6 Approval from the Project Sponsor

The final decision to approve the project was taken by Lidl's General Manager in Scotland, who instructed the architect (Lidl's representative on the project) that CRC could go ahead with the scheme under a 'nominated sub-contract'. The nominated sub-contract meant that although Balfour Beatty were the main contractor in overall charge, the value of the CRC contract was 'ring fenced' with Lidl and not subject to the contractual obligations of other types of sub-contractors. Balfour Beatty would get 2.5% of the contract value as a type of 'commission'. This was important, as CRC had information from another contractor, alleging that the main contractor achieved cost cutting by using very few staff and penalising sub-contractors. This obviously did not engender trust between the two parties, as the same sub-contractor said that they would just overcharge for works carried out because Balfour Beatty did not have the staff resources to supervise or control them.

Plate 7.12 The collection pond of the 'treatment plant'

Although CRC had carried out work for Balfour Beatty in the past, they were particularly pleased at the fact that Lidl ratified them as approved subcontractors and had decided to commence with the project. In a £10M project the 'treatment plant' was very small part of the distribution centre, and the delay of completing the overall project combined with the lower cost may have been the deciding factors for Lidl.

7.5.7 Project Implementation

The construction of the treatment plant went very well, with only minor alterations needed to the original plan. Plate 7.12 shows the completed collection pond prior to planting with vegetation. CRC attributed the success of this project to several factors,

- The project was 'design and build' project, the preferred form of project for CRC
- The financial margins on the project meant that there was no restriction on resources i.e. staff and equipment,
- The client and the client's main contractor didn't get involved in the actual project execution.

This third case study again illustrated CRC's ability to capitalise on both business opportunities and new technologies. The question over whether CRC could have built a market on these type of projects is open to speculation. CRC offered other options to Lidl to complement their surface run-off plant. These were in the form of further landscaping to make the catchment area an integral feature of the distribution centre that would enhance the surroundings. Lidl were not interested which is perhaps no surprise considering the purpose of the premises. Mr Clements (jnr.) described this project as near to a perfect project for CRC as they could get.

> "We gave the client a better designed, innovative, more cost effective solution to their problem. We executed the project efficiently and on time to the satisfaction of all parties, and made a worthwhile profit for CRC. A perfect project"

This was a good example of a 'quality' project that in theory should have led to future business, although as much as CRC could grasp opportunities they often appeared not to be able to capitalize on these opportunities.

7.6 Conclusions

This case study was created as an 'instrumental' case study to provide insight into the role of quality in the project environment where no industry standard quality system was in place (as discussed in Chapter 2, Section 2.2). It also contributed a significant amount to the formulation of an alternative model for the management of quality in projects (the research's second objective). CRC demonstrated that they had the capability to increase their operational scope and knowledge through their adoption and use of new technology. Whilst CRC exhibited a high degree of risk-taking, it appeared to be balanced by the gains made in knowledge and capability as discussed further in Chapter 11. As a project organization, CRC had strengths and weaknesses. It was innovative, flexible and fast to react when dealing with unusual projects and problem situations. Conversely CRC's weaknesses were exposed when the organization was stretched due to an influx of work or work related problems. Bottlenecks were unavoidable because of the lack of personnel, although the hard work and flexibility that were displayed by those in the company made it difficult to level criticism at their commitment. Issues of control, delegation and defined working parameters were blurred and occasionally lead to conflict. Yet, this same blurring of job specification also allowed ideas to be aired. CRC did not possess a formal quality system; quality was commensurate with keeping the customer satisfied, which led to increased work if projects produced positive results. Another key facet of CRC's culture was that they were not risk-averse which appeared to be a positive attribute especially when it was combined with a drive to make things work. When risks were taken and they did not succeed, CRC had the ability to extract what they could from the situation and move on looking for the next opportunity. The organization had the ability to adopt and learn quickly, but there was not enough consolidation to capitalise on what had been learnt i.e. there was no learning infrastructure to capture the knowledge.

Table 7.1 provides a cross reference guide to the areas from this case study that are relevant to the objectives of the research and to the general debate of the role of quality in projects. Summarizing these areas from this case study are as follows,

- The contrast in the relationship between CRC, Railtrack, CRC, and British Waterways.
- The role of a project champion (as shown by the British Waterways chief engineer) in creating a positive relationship between client and contractor.
- CRC's ability to recognize and use new technologies to achieve project objectives as demonstrated by their use of gabion baskets, the portable dams, their innovative proposal for the Lochy viaduct project and their early adoption of mobile phones.
- CRC demonstrated great flexibility and the ability to respond quickly even during the planning and implementation stages of a project. Would this have been restricted by a formal quality system? This shall be analysed in later chapters.
- The CDM regulations briefly described in this case study were conceived as a way of enforcing companies in construction and civil engineering to take responsibility for all aspects of safety throughout their projects. By enforcing regulations to ensure companies, carry out adequate risk assessments should ensure that an activity is carried out with less risk. Therefore, by default, more planning will take place and hence a greater chance that the activity will be carried out successfully thus improving its quality. Whilst the CDM regulations are not enforced to ensure quality but to ensure safety, is it the case that enforcing some form of quality system on project organizations would produce improvements in quality? This did not appear to happen at the Lochy viaduct project. The next case study in Chapter 8 also has an example where CDM regulations were a part of the project process.
- CRC exhibited a high degree of project risk taking, using relatively unknown techniques and methods to carry out their projects. This increased their knowledge

base and hence increased the type of projects that they could attempt. This was balanced by the increased risk faced by using new and untried techniques. These factors have contributed to the development of the 'Learning Project' model developed in Chapter 11. The behaviour displayed by CRC was recognizable as a PM systems archetype.

- In this case study cost was shown as a key driver in the project decision-making process, typically at the expense of quality.
- With no formal quality system CRC may have excluded themselves from bidding for more lucrative projects. Conversely, existing formal quality systems may have created too rigid a structure for CRC to operate with, reducing their ability to react quickly to commercial opportunities like the Admiralty pipeline project.
- With no method of capturing the information and knowledge that their project experiences created, CRC was not able to capitalize on its knowledge.

Table 7. 1 Cross Reference table

CRC experience	Subsection	Relevance to research objectives and the general debate of the role of quality in the management of projects	Chapter(s) and subsection(s)
Absence of recognised quality systems	7.6	The relevance of existing 'formal' quality systems e.g. ISO9000 Investigating the pertinence of the industry standard quality system in a real project environment and its contribution to project success [1st Objective]	Chapter 9, Section 9.6 and 9.7 Chapter 11, Section 11.3.1.1
Risk taking ('Degree of adventure')	7.3.5 7.5.5	Contribution to the formulation of the 'alternative' model for the management of quality in projects [2nd Objective]	Chapter 11, Sections 11.4,11.8

CRC experience	**Subsection**	**Relevance to research objectives and the general debate of the role of quality in the management of projects**	**Chapter(s) and subsection(s)**
Relationship with Railtrack	7.3.3	Relationship between client and customer	Chapter 11, Section 11.5
The role of Project champions (British Waterways)	7.4.7.1	Advantages of positive relationship between client and contractor	Chapter 9, Section 9.7.2.1
Use of technology	7.3.5 7.4.7 7.5.4	Data capture methods Innovation	Chapter 11 11.8.1
Project planning	7.3.2.1	Alternative quality systems	Chapter 13, Section 13.3.1
Risk assessment	7.3.2 7.3.4	CDM legislation and its impact on project quality	Chapter 11, Section 11.8
Cost as a driver in project decision-making	7.3.6	The consequences of using cost as a key project driver as opposed to quality	Chapter 10, Section 10.2.12
Design issues	7.4.7 7.5.4	The impact of design on project quality.	Chapter 8, Section 8.6.9 Chapter 10, Section 10.3.2
Example of Systems Thinking Archetype behaviour	7.3.5	Example of Project Systems Thinking ‘archetype behaviour	Chapter 5, Section 5.3.3
Learning infrastructure	7.6	The use of the quality system as a method of capturing project relevant information	Chapter 5, Section 5.7.1. Chapter 12, Section 12.2.1

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[1] Latham, M., (1994), ‘Constructing the Team’, *Final Report of the Government /Industry review of procurement and Contractual Arrangements in the UK Construction Industry*, HMSO, p.68.

[2] Shtub, A., Bard, J., and Globerson, S., (1994), *Project Management Engineering -*

Technology, and Implementation, Prentice Hall, p.224.

Chapter 8

Case Study No.2 Balfour Kilpatrick Ltd

8.1 Chapter Synopsis

In the course of data gathering the author was offered a short-term contract to participate in a 12-week construction project in the South of England, as part of a project team installing a high voltage cable. This presented an ideal opportunity to carry out the primary objective of the research, which was 'to investigate the pertinence of the models implied by existing quality initiatives in a real project environment and their possible contribution to future project success.' As project engineer there was the opportunity to take part and observe the complete project, allowing the collection of original and up to date facts on the difficulties faced in implementing quality management techniques in a project environment. The scope of the quality management practices encountered, their effectiveness, and their possible contribution to future project success (with a holistic viewpoint of the complete process, it would be possible to pinpoint areas where quality was effecting the project). This case study provides the basis for the first objective of the research, 'to investigate By being involved with the project it was also a chance to see if the organizations implemented quality system, targeted the activities that effected quality and ultimately project success.

Discovering how quality was measured in these types of project and what importance was assigned to it, throughout the project life cycle would be of particular relevance. The experience would also refresh the author's current knowledge on what the important issues were in a recent project and business environment, the culture that existed, and the effects of any external environmental forces, for example government legislation. In respect to the other case studies carried out, this organization was much larger with an industry standard quality assurance system in place, the British Standard BS EN ISO 9002 (1994) Quality Systems Specification for Production and Installation. Therefore, Balfour Kilpatrick provided the main example of an implementation of an industry standard quality management system in a project environment.

8.2 Relevance to the Research Methodology

As discussed in Chapter 2, Research Methodology, the main information gathering techniques were participant observation with some action research. In this case study the scale of participation as defined by Junkers Continuum and Easterby-Smith[1] et al (illustrated in Figure 2.2, Chapter 2) was close to complete participation i.e. action research. Gummesson[2] believes that this is a valid strategy to use when researching change processes in business organizations, in this case the application of QM to project management. To recap, the attributes of action researcher outlined by Gummesson[3] were:

- The researcher having had experience of ‘decision making’ and ‘responsibility’.
- Personnel experience being an essential part of the gathering and interpretation of information.
- Have the ability to change their preconceived view of the situation, if reality dictates it.
- The researcher/consultant must be mature, open and honest.

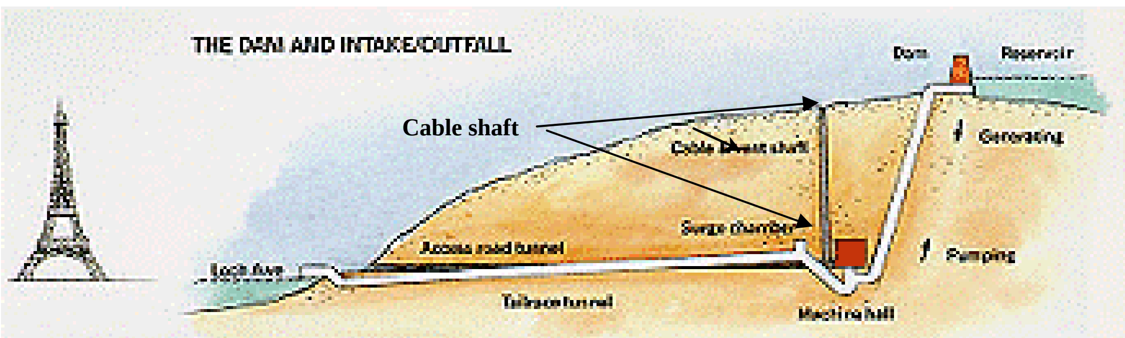
Having worked with the organization previously, it was an easier proposition to create relationships with the personnel, as there was an awareness of the difficulties and issues that were faced by the project team in their day-to-day work. This relationship is also reinforced when it takes place over a period of time and involves the researcher taking part in an operational capacity. The advantage of being a part of the working environment is the larger number of opportunities the researcher has to interview, question and observe the process that is of interest. Location, time and resource constraints become less of an issue. Interviews can be carried out in situ, and on an ad hoc basis. Despite this, it does not jeopardise the integrity of the information received, indeed the author believed it enhanced its accuracy and validity. Frequently in this case study the circumstances and the setting of a conversation provided an honest and open opinion on topics that could have been construed as sensitive if requested in a traditional interview scenario. The breadth of information obtained to create this case study, the author believes justifies the validity of using this approach.

8.3 How unique was the Walpole Project?

In discussions regarding this case study, the question was raised as to whether this contract constituted a 'project'. Did it have the necessary degree of uniqueness to be classed as a project? Or should it have been termed as an operation? The term 'project' is defined by Dilworth[4] as:

> "… an organized endeavour to accomplish a specified nonroutine or low-volume task. Although projects are not repetitive, they take significant amounts of time to complete and are large scale or complex enough to be recognised and managed as separate undertakings."

Dilworth continues to list the attributes of a project, the finite time of a project, and the dynamics of the project team, the organizational structure, and the importance of scheduling and the other mainstays of project management literature. The Project Management Institute (PMI)[5] defines the difference between a project and an operation by classing an operation as



(The cable/ventilation shaft rises 305 metres up through the mountain, almost equivalent to the height of the Eiffel Tower in Paris)

Figure 8.1 Cross-section of Cruachan Power Station (Scottish Power, 1998)

'ongoing and repetitive' and a project as '...a temporary endeavour undertaken to create a unique product or service'. 'Temporary' in this case means that the project has a start and a finish date i.e. a define timescale and scope. The PMI also outline that the presence of repetitive elements does not change the fundamental uniqueness of the overall effort.[6]

8.3.1 Two levels of uniqueness

Using these criteria the installation of a high voltage cable can certainly be legitimately classed as a project, with the observation that many of its activities are indeed operations, but what about uniqueness? On a routine[i] project like Walpole the activities that were carried out were tried and tested, for example the site personnel determined the method of installing the cable to suit the conditions encountered, therefore should the contract be defined as a project at all? The author believes that uniqueness does occur at two levels. The first level is when an unusual project takes place and it is technologically unique. The second type of uniqueness is when a routine project is affect by 'environmental' factors e.g. climatic, political, legal, commercial etc.

A perfect example of the first level of uniqueness is the pump storage power station at Cruachan in Argyll. The power station, built in the early 60's, is an impressive engineering achievement. A man-made loch was created in the mountains to feed water down through two shafts to power turbines situated inside the mountain. The power generated is then fed through two 275kV transmission

Plate 8.1 The Turbine Hall

[i] Routine in regards the technical aspects of the job, the Walpole contract, technically was a 'routine' project.

circuits, which travel vertically up a ventilation shaft to connect with the overhead transmission line as shown in Figure 8.1[7].

The installation of these cables in the ventilation shaft was unique, it was the first time it had been done in the UK and it required specially designed oil filled cables to withstand the pressures at the base of the shaft. The installation took meticulous planning and execution, with the result that the project was in engineering terms a complete success. Interestingly as a footnote to the Cruachan cables, when the Hydro Electric Board the previous owners of the power station required maintenance carried out on the cable support equipment, Balfour Kilpatrick found it very difficult to get the same quality of components fabricated as the original equipment. Plate 8.1 shows the interior of the turbine hall at the power station. This illustrates quite clearly that Cruachan was a unique project, due to the technical difficulties imposed by the location of the cable.

The second level of uniqueness takes place during the execution of the project, commonly known as the ‘production’ phase of the project life cycle. This uniqueness is caused by the circumstances surrounding the execution of the project. These can range from the climatic conditions, resources, and interactions between contractor and client, legislation to the relationships between personnel. Every project has these ‘unique circumstances’, the combination of a number of different events, which have to be dealt with in a unique way. This is one of the main thrusts behind this research, is to find a practical way of capturing this information to provide feedback to enhance future projects.

Although not technically unique, the Walpole project did have its unique circumstances, which could have provided useful lessons and feedback for the future. Whilst they could be not be classed as revolutionary, it was believed that they were important enough to warrant recognition and further action.

8.3.2 The Company Background

Balfour Kilpatrick was part of a multinational organization, which primarily carried out electrical and construction projects for large corporate customers. Typical projects include high voltage and low voltage cabling, undersea cabling projects, overhead line cabling, and electrical wiring of large buildings. Balfour Kilpatrick is part of the BICC Group a global conglomerate. As the following in house chronology illustrates[8], cables have always been a mainstay of BICC's business:

> "The BICC Group is an international engineering business which serves the world's markets for infrastructure development in power, communications, transport and building. It has two principal businesses: Balfour Beatty, a leading UK-based construction and engineering company with a significant and growing proportion of its business conducted in North America and the Asia-Pacific Region; and one of the world's largest cable making businesses with substantial positions in all the world's major regional cable markets. The cables business is managed through regional operations based in Europe, North America, Australia and Asia-Pacific. The Group's primary objective is to provide long-term value for its shareholders through the exploitation of its core competencies. It is dedicated to total quality, technical excellence and the satisfaction of customer need. BICC was formed in 1945 through the merger of two of the UK's leading electrical cable companies. For the next 25 years the company developed its international interests, largely in the Commonwealth and in 1969 acquired Balfour Beatty, at that time, predominantly a power construction and power engineering company.
>
> In the 1980's and 1990's, the Group has developed its cables interests through acquisition in North America, continental Europe, Asia and Australia. Since 1969 it has broadened the base of Balfour Beatty's activities to encompass a major capability

in civil engineering and in other contracting businesses."

The relationship between the different companies in the group was not always apparent, even to those in the companies. Balfour Kilpatrick's quality manager based in Derby suggested having the organizational chart on a sheet of Velcro due to the frequent in-house reorganizations of the group structure and subsequent name changes. A recent example was the amalgamation of the overhead line part of Balfour Kilpatrick and its underground cabling business. This led to a reorganization of both companies with common overheads and costs being merged (e.g. wages and accounting). The appointed of regional managers introduced an extra management layer in a relatively flat management structure. It was too early to determine whether or not this created any significant changes in the operational abilities in either business, but it caused a degree of uncertainty with existing administrative staff in respect to security of employment.

8.4 Technical Background to High Voltage Underground Cables

8.4.1 Oil Filled Cables

The market for high voltage[ii] cabling has undergone some changes in recent years. For many years in the UK there was only two manufacturers of supertension cables, BICC Supertension Cables Ltd and Pirelli General who used their own respective in-house recognised cable installers (Balfour Kilpatrick and Pirelli) The type of cable that was used has undergone technical changes as well. Originally the only type of cable that was capable of being used at supertension voltages, 33,000V to 400,000V was oil filled cable. This type

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[ii] High voltage cable in this case study refers to cable of 66kV 132kV 275kV and 400kV also referred to as supertension cabling

of design uses a very fine mineral oil to cool and insulate the cable allowing it to be used at higher ratings than a ‘dry’ design of cable. The design of each cable circuit had to take account of the hydraulic needs of the cable as the cable had to be kept under pressure. Oil pressure tanks were placed at various parts of the route to feed the cable; these tanks had sealed bellows inside to account for the fluctuations of pressure caused by temperature changes and how close to its operational limit it was being used.

When planning a route for oil filled cable the profile of the ground had be taken into account because there is a limit to the length of a hydraulic section that can be incorporated in a circuit. In addition, if the profile of the route varied dramatically the pressure differentials had to be taken into account in the design. To limit the hydraulic sections ‘stop’ joints were used. These were joints that had a hydraulic barrier and their position on a route is determined after the profile has been surveyed and given to the design department. The process of jointing oil filled cable was very involved and the design tolerances that had to be met were critical.

8.4.2 Technical Problems

In the past BICC had problems with the design of their stop joints, which led to a number of stop joints blowing up. This had serious consequences (not withstanding commercial considerations) when it is realised that cables like this are integral parts of the national grid. For example one 275kV cable circuit in Glasgow supplies half the electrical needs of the city. This led to BICC changing the design of their stop joints and more importantly changing the procedures used in its jointing. The joint bays had to be surgically clean, dehumidified, and a particle counter used to check the flushing oil used in the jointing process. These joints (known as accessories) could cost in the region of forty thousand pound each.

8.4.2.1 Inherent disadvantages of oil filled cable design

There were disadvantages with this design. The installation, like the jointing is very involved and the cable is vulnerable to damage particularly when being pulled into position (the lead-time to produce a supertension cable is approximately a year). Any cable that is installed in the ground is vulnerable to third party damage especially now as routes become increasingly congested (Inner London areas have now resorted to building tunnels to house certain utilities). When oil filled cable is damaged by a third party there is a loss of oil, which can allow ingress of air. This air must be evacuated from the cable by vacuum to restore it to a repairable state, which is a time consuming process. Another disadvantage is the need for maintenance on oil filled cable circuits. The cables oil tanks are connected to gauges that warn if the cable is losing pressure, sometimes these are connected to automatically switch out the circuit to prevent damage to the cable. These gauges have to be checked annually, in a maintenance contract specified by BICC. In older circuits, which have small oil leaks, it is sometimes uneconomic to repair the cable; in this case a mobile oil van restores the pressure to the tanks on a regular basis. Restoring the pressure on older oil-filled circuits is usually carried out under an annual maintenance contract, which also carries out calibration checks on the cables pressure gauges.

8.4.2.2 An Alternative Design - Cross Linked Polythene

An alternative supertension cable design is starting to replace the oil filled cable. This is Cross Linked Polythene cable (XLPe). This design is primarily a solid cable as shown in Plate 8.2, with the insulation being made up solely from a resin type material. This has many of the advantages of oil filled cable without the need for the hydraulics. Jointing XLPe cable is as technically difficult as its oil filled equivalent but without the considerable extra hydraulic work. The development period for this cable has been relatively long, as the proof of the success of a new cable design is in its longevity in service. Electricity companies needed to see that the product would last before committing to it. In this country, using XLPe cables up to 132kV has become well established and there are also some 275kV circuits. The first 400kV XLPe cable in the country had just been installed at the time of the Walpole project by Balfour Kilpatrick at a site near Liverpool (400kV is the largest voltage of cable used in the UK). This prestige project had technical difficulties, created by poor interaction between the customer and BICC, which led to an inadequate design for the structure, which supports the sealing ends.

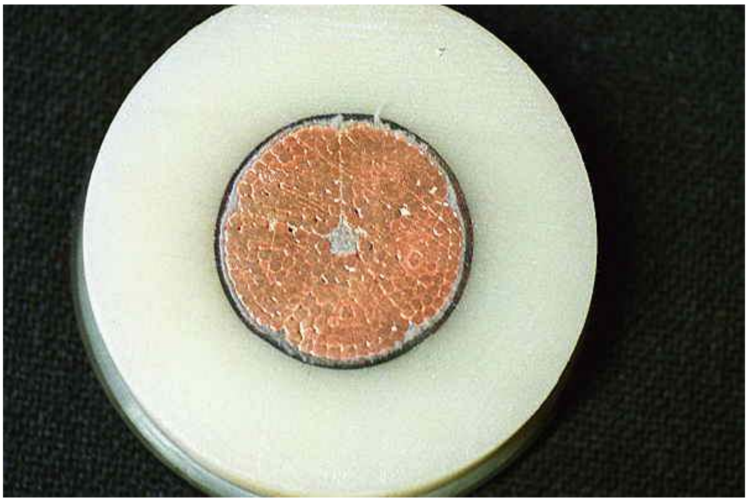

Plate 8.3 Cross section of 132kV XLPe cable

8.4.3 Increasing Competition

Competition in the market had now increased with companies from mainland Europe tendering for contracts in the UK. This had led to pressure from BICC (the cable manufacturer) on Balfour Kilpatrick to cut their cost of installation, allowing a more competitive bid to be tendered to the customer. Balfour Kilpatrick endeavoured to achieve this although they had reached the stage where it was increasingly difficult to reduce cost further. In an interview with one BICC manager, he did acknowledge that many of the tenders were tight and the factory had created pressure on Balfour Kilpatrick. New jointing equipment and new methods of reducing time to implement a project were being continually developed and tested by both BICC and Balfour Kilpatrick but conflicts of interest did arise and this lead to some acrimony between the two parties.

8.5 The Project Stakeholders

Project stakeholders[9] are the collective term that describes the organizations and individuals who are an integral part of the project, or those that are affected by the success or failure of

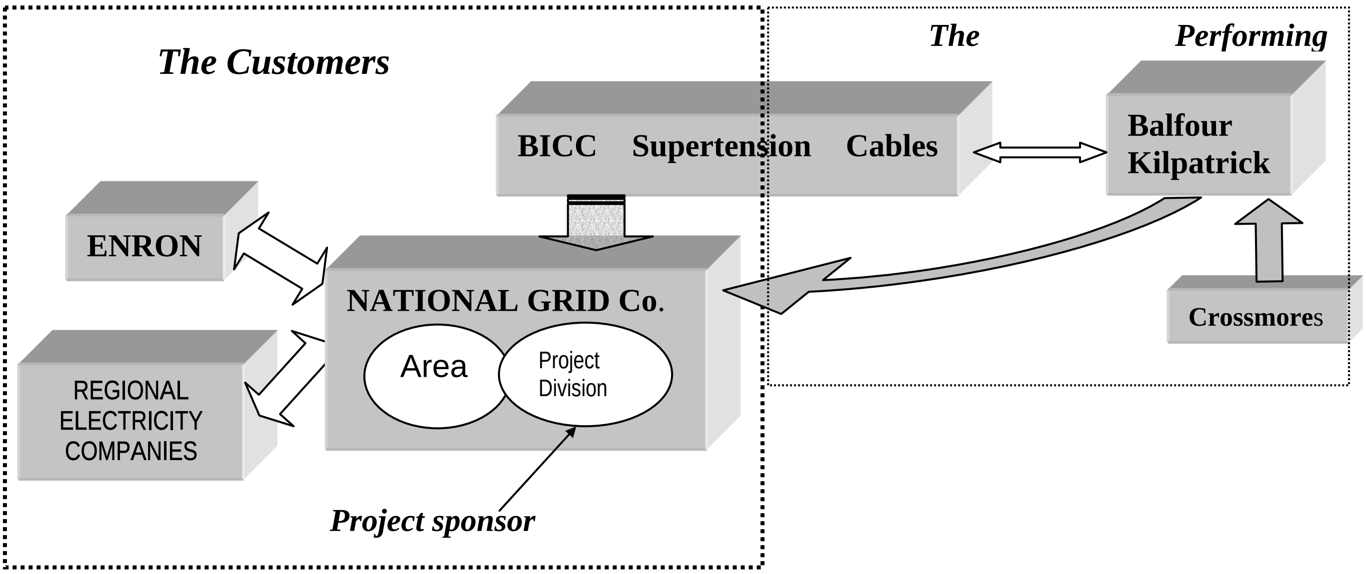

Figure 8.2 The Project Stakeholders in the Walpole Project

the project. The Project Management Institute (PMI) provides definitions of key project stakeholders, which have been translated into a schematic diagram shown in Figure 8.2.

The primary customer was National Grid Co. Projects Division who were also the project sponsor. It was this department in National Grid that was in overall charge of the extension to the Walpole substation. The Projects Division was the co-ordinators of the whole project that had been instigated by one of their future customers, Enron. Enron were constructing a power station in the locality that needed access to feed the power generated into the National Grid at this location. National Grid are also a conduit for the Regional Electricity Companies (REC’s) like East Midlands Electricity. As shown by Figure 8.2 Balfour Kilpatrick had two direct customers the National Grid Company and BICC Supertension Cables Ltd. BICC manufacturing and supplied the cable to NGC with Balfour Kilpatrick as their recognised installers.

8.5.1 The Customer - National Grid Company

The project was carried out for the National Grid Company (NGC), which is responsible for the distribution of power throughout England. NGC is responsible for the development, construction, operation and maintenance of the National Grid transmission system, which encompasses the provision of any connections to the system by power generating companies. A network of 7000km of overhead lines, 600km of underground cables, including substations distribute power between power generators like PowerGen and Enron to regional electricity companies (REC’s).

8.5.2 The Purpose of the Walpole Substation Extension

Construction had commenced on a combined gas cycle power station at Long Sutton, which when completed would supply electricity into the electricity network through National Grids 400kV substation at Walpole. In order to accommodate this extra input National Grid were obliged to build a new generator bay and uprate the plant and equipment at the substation.

This obligation stemmed from the privatisation of the electricity industry. In England and Wales the electricity industry was divided into three;

1. The generating companies, PowerGen and National Power,
2. The National Grid, responsible for the distribution network,
3. The Regional Electricity Companies (REC's) e.g. Midlands Electricity.

The work involved extending the substation, undergrounding existing overhead pylons, building new pylons, and adding new switchgear. This is a considerable amount of civil, mechanical and electrical work, the costs for which were being met by both NGC and Enron (the power generator). Other contractors involved in the project were May Gurney, GEC Alchom, NGC, and Reyrolles including the sub-contractors employed by these companies.

8.5.2.1 The Roles of National Grid Personnel

National Grid Projects the project management division of National Grid were responsible for the project and co-ordinated the different contractors involved in the works. At the Walpole substation the National Grid Area Engineer responsible for the day to day running of the substation had the authority to sanction any works he deemed unsuitable. The project engineer for National Grid was not on site permanently, the Walpole site being one of a number of sites that were his responsibility. Weekly site meetings kept him apprised of the progress of the project and he could be contacted at any time by mobile phone. The contractor also had to liase with the Area Engineer on site to arrange permits to work in proximity to the live equipment in the substation. The Area Engineer (termed the 'Senior Authorised Person' or SAP) had ultimate responsibility for all safety on the site therefore it was imperative to have a good working relationship with him and his staff.

8.5.2.2 Regional Electricity Companies

Although National Grid ran the substation, other electricity companies had responsibility for other items of electrical plant. Electrical Plant refers to the items like underground cables, overhead lines, and transformers - i.e. any piece of equipment that is part of the electrical system. Cables that distributed power to the regional areas were under the jurisdiction of other power utilities like Eastern Electricity and East Midlands Electricity. One cable which ran underneath the proposed route of the new 132kV cable was owned and operated by East Midlands Electricity, which meant that Balfour Kilpatrick had to meet any technical requirements that they required to safeguard their cable during the installation of the new cable.

8.5.3 National Grid's Project Staff

In National Grid the format of using a project manager who had a type of 'roving commission' to cover projects throughout the organization was going to be changed. The projects department used their own staff to co-ordinate and oversee projects throughout National Grid. In the future the local Area Engineer would have the responsibility of all the projects that were carried out on their site. There was some disquiet about this at the Walpole site from both the project staff and their counterparts on the area side. The advantage of having staff that deal solely with projects is that there is a relationship created between the subcontractors and National Grid, reinforced by the knowledge and experience of what is going to be needed by both parties when a project is undertaken. As the Area engineers already had a considerable workload the inclusion of project duties as well might have a detrimental effect on all the project stakeholders. The role the National Grid project staff played in liasing between their area personnel and the contractors, i.e. creating a working relationship to begin with and resolving any disputes during the contract was in the author's opinion vital. The difference between the day-to-day running of a substation and a construction project is significant enough to warrant bespoke staff for both. According to the National Grid staff at the site there had been significant downsizing in the last few years, which had increased workloads, and considerably reduced moral.

8.5.3.1 Independent Business Units

Like Railtrack another organization studied in the course of this research, National Grid Projects had their own departments in competition with contractors for parts of work on a National Grid project. On this project National Grid's overhead line department had to bid to win the job of dismantling the existing overhead line, and erect steel platforms at a tower and connect the droppers (the connection between the overhead line and the cable as shown in Plate 8.3) The fact that National Grid projects used their own department to do this work did not mean that they preferred an in house solution, initially another contractor had won the contract but on further analysis, it was realised that their bid did not cover all the works. A re-evaluation was carried out and National Grid's own overhead line department was given the job. The process of awarding this contract appeared to be haphazard with some distrust between the National Grid departments. This was also reflected to some degree in the contract awarded to Balfour Kilpatrick/BICC Supertension Cables Ltd with the second of the two circuits being an option that increased logistical and quality problems when the project was brought forward by nine months.

Plate 8.3 Cable Sealing Ends at Tower connected to overhead line

8.5.4 The Contract Awarded to Balfour Kilpatrick

The contract awarded by NGC was a penalty clause contract, if either the cable factory (BICC) or Balfour Kilpatrick failed to deliver or install the cable on time, National Grid would charge for the lost revenue caused by the delay. This can be extremely punitive, with figures of £12,000/hour being possible. The amount would have depended on the circuit involved (£12,000 being the lower end of the scale). When important connections were involved like the cross Channel link to France the figure would be far higher. The fact that this contract had been brought forward by nine months made no difference to the actual scheduling or programming of the works, although it initially caused resource difficulties for Balfour Kilpatrick because they did not have available personnel to supervise the contract.

8.5.5 Balfour Kilpatrick Southern Cabling Unit

Of the six cabling units in Balfour Kilpatrick the Southern Cabling Unit based in Erith, Kent was the largest, corresponding with the size of the population and the subsequent larger number of supertension cables in the area. The unit covered a geographical area from Cambridgeshire in the North to the Isle of Wight in the South and encompassed the Greater London Area. The breadth of expertise available at this unit sometimes meant that they would take part in projects in other areas, like for example at Rock Savage Liverpool, which was the first time in the UK that a 400Kv cross linked polythene had been installed. Indeed there had been rumours that the Southern Cabling unit would take over all responsibility for supertension cabling in the UK. The arguments for this being that areas were there is very little of this type of work (for example Scotland) it would have been more cost effective to send up project teams to deal with supertension contracts than deal with them at a local level.

The cabling unit was primarily split into three. ‘Faults and Maintenance’ dealt with existing cable circuits (predominately fluid filled and gas filled circuits) repairing them and maintaining them. At the time this section had the majority of the work in the unit. Another part dealt with the new contracts, which could consist of installing new cable circuits, rerouting existing circuits, working on the underground railway network or on the national grid. The focus of business was on supertension work but other types of cabling were catered for. A very large contract for London Underground was expected to start later that year for an approximate value of £15 to £20 million pounds over a three-year period. The final part of the unit was the Submarine Cabling section, which dealt exclusively with undersea cables, their installation and repair. This was a very specialised operation, which could be very high-risk. The profits that could be made could be substantial, but if a contract went wrong the losses could be catastrophic. This part of the business was set to expand. BICC were investing £25 million pounds on developing part of their factory to allow very long sections of cable to be manufactured (submarine cable has to manufactured without any joints) and transported straight onto barges on the River Thames adjacent to the factory.

8.5.6 The Personnel involved in a Supertension Cabling Contract

The personnel can be approximately grouped according to their function (overlap does inevitably occur) and consist of two main groups, office based staff and site based project personnel.

8.5.6.1 Administrative and Support

Personnel based at the main office in Erith consisted of administrative and support staff. This ranged from the Contracts Manager who would oversee all the projects at the unit to the stores personnel who ensured an available supply of materials for all the contracts. There was approximately 40 office staff based at Erith. The type of jobs carried out were as follows:

- Contracts Manager.

- Quantity Surveyors.
- Jointing Supervisors.
- Transport manager.
- Draughtsman.
- Accountancy and Personnel.
- Quality engineers/staff.
- Stores personnel.

8.5.6.2 Project Personnel

Engineering personnel were usually based on site when participating on a project and based themselves at Erith out with projects. Typically most of the engineers were capable of taking on any of a number of engineering functions as listed below, (assuming they had the necessary qualifications and experience):

Project engineer – is responsible to the Supertension Contracts Manager for the efficient running of the site in accordance with all the pertinent procedures and specifications. Areas of special responsibility include, site organisation and planning, engineering, quality assurance, site safety, site liaison, commercial aspects, and sub-contractors.

Hydraulic engineer – responsible to the project engineer for the efficient implementation of the hydraulic procedures and requisite standards as laid down by Balfour Kilpatrick/BICC. Assumes the responsibilities of acting project engineer in his absence.

Installation Engineer – responsible to the project engineer for the efficient implementation of the civil engineering works and prerequisite procedures and standards as laid down by Balfour Kilpatrick and the client.

Jointing Engineer – responsible to the project engineer for the efficient implementation of the jointing procedures and requisite standards as laid down by Balfour Kilpatrick and the client.

8.5.6.3 Staffing Levels

If the project were a large one, (defined by Balfour Kilpatrick as above £½M in value) then an individual engineer would be used for each function. Experience was the main form of training used in Balfour Kilpatrick cabling units, the more projects that the engineer had been involved with, the higher the level of responsibility entrusted to that engineer (provided the contract has been a success) The one exception was the function of oil engineer on a contract. To carry out this function the engineer had to attend a special in-house course at BICC and pass a set exam as well as being judged competent to work on fluid filled cables. Recruitment for engineering staff had in the past taken many forms, either directly from out with the company (e.g. from Pirelli, the rival cable company), by promoting a member of the hourly paid personnel (a jointer or oil mechanic), or as was increasingly the case recruiting graduates directly from university.

8.5.6.4 Responsibilities and Pressure

How an engineer progressed in the organization depended on their own drive and how much the management believed the engineers could cope with. The workload for an engineer was considerable with responsibility that far outweighed the remuneration he[iii] receives. The engineer was personally responsible for every activity and action on site (as shown by the site organizational chart); therefore the success of the project was very much determined on his managerial and technical ability. Balfour Kilpatrick had traditionally been geared around how well the engineer could do their job. Qualifications were not seen as a prerequisite to progressing in the company. Great emphasis was placed on the need for projects to make a profit. This was achieved through tight financial restrictions on costs, including personnel, salaries, materials and equipment. Engineers would be held personally responsible for their projects, which placed considerable strain on their physical and mental well-being. It was not just the engineering staff that was put under this stress, office staff too, were expected to work long hours and be accountable. The presence of a 'blame culture' also increased the pressure on personnel. If contracts were losing money the engineer or manager responsible would be replaced quickly (dismissed or moved), the expression that described the situation was encapsulated by the phrase 'you were only as good as your last job'. Many of the circumstances that led to this, were out with the engineers control. Frequently in an effort to win tenders the estimating department were exhorted by senior managers to put in a low bid.

This led to low or non-existent profit margins, which in turn led to projects that were ill equipped with both personnel and equipment. The effect on quality was disastrous. Routine tasks would go wrong due to equipment failure (the cheapest equipment was purchased all the time). The squads that carried out the excavation and actual cable installation would continually leave due to the poor wages, which again had a considerable impact on quality. To try and make profits engineers would be continually looking for 'extras' to charge the client i.e. work carried out with the original contract specification. The organizational culture of Balfour Kilpatrick had always been influenced by the top management, and although the management had changed over the years the culture had not, personnel were still expected to

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[iii] As yet no female engineers work for the Southern Cabling Unit.

work under a great deal of pressure frequently to the detriment of their health and family.

In respect to stress, it was interesting to witness the effects of the implementation of the quality management system at Balfour Kilpatrick. Although this shall be examined in more detail in later chapters the overall opinion was that the quality standard significantly increased the stress on the project team. This was primarily due to the addition of another level of administration and responsibilities, which did not significantly enhance or improve the role of project manager. An aspect pointed out by Nicholas[10]:

> “ Role conflict and stress are also felt when a person has two roles with incompatible requirements. A project manager, for instance, may find that he has to do things to be a good administrator that conflicts with his values as a professional engineer”

The role conflict and stress is amplified if the project manager believes that the extra work he has to do is superfluous, as was the case with the Balfour Kilpatrick contracts manager, who believed that the existing quality system was not improving organizational performance. Regardless of the effects on the project team of stress and the organizational culture at Balfour Kilpatrick over the years, it is apparent that it did not prevent the completion of successful projects. There was a pride and professionalism in the projects that were done despite the lack of reward, which appeared to contribute to the quality of the overall service provided, which allowed Balfour Kilpatrick to remain in business.

8.6 Subcontractors

8.6.1 Civil Engineering – Crossmores

In recent years, Balfour Kilpatrick subcontracted out the civil engineering side of their cable contracts. This meant that the subcontractor supplies the necessary personnel to carry out all the excavation, cable installation and reinstatement under the supervision of Balfour

Kilpatrick personnel. The primary reason for this was cost; the subcontractors provided cheaper labour than Balfour Kilpatrick employing its own direct labour. The subcontractors managed this by paying low wages, which in turn led to a high turnover of personnel. The civil work was carried out by semi-skilled labour usually under the direct supervision of a Balfour Kilpatrick Foreman. The subcontractor that Balfour Kilpatrick had been using was a company called Crossmores, with whom they have had a relatively long-term relationship (approximately 9 years). As an organization, Balfour Kilpatrick (and others in the BICC group) did not have a good reputation for treating their subcontractors well. Like many large organizations, Balfour Kilpatrick did not always look after the welfare of their suppliers, and subcontractors were no exception. Disputes over payment, late payment, and forcing subcontractors to take unnecessary financial risks were common practice that contributed to Balfour Kilpatrick's poor reputation. The Walpole project was no different as shall be outlined later.

8.6.2 Lump Sum Contracts and Time and Materials

There were a number of subcontractors who carry out cabling work in the South East; some had actually expanded into Balfour Kilpatrick's area of expertise by jointing cable as well as installing it. The contract at Walpole to carry out the civil works had been awarded to Crossmores and like the contract that Balfour Kilpatrick had from National Grid it was a Lump Sum contract with a provision allowed for any time and material work carried out. Time and Material working (also referred to as Day works) is any work carried out outwith the specification or remit of the original contract. This work is then charged on a cost plus basis, by time, type of personnel, equipment and consumable materials used (typically in the region of 230%).

The use of lump sum contracts was becoming more predominant. There were a number of reasons for this. Clients believed it to be more controllable, subcontractors having agreed to carry out a project, found it more difficult to charge for ‘extras’. The contract documentation that is associated with payment is simplified for the customer, as for the Walpole contract there was no need to measure any excavations. In the past each cable track was measured as well as the amount of material excavated, the type of material excavated, the way it was excavated (machine or hand dig) and every type of layer of excavated material. This information was then transcribed onto a sheet and then agreed with the customer and then charged. The lump sum contract tends to put the onus on the contractor to have correctly evaluated the work at the design and estimation stage. If the project turns out to be more complex or difficult than estimated there is very little redress with the customer.

On the first stage of the Walpole contract, Crossmore’s estimate was half of what it was for the second stage, and it was almost certain that they lost money on the contract. The lump sum contract is constructed in exactly the same way as any other contract, the only difference being that the documentation presented for payment is drastically reduced. The necessity to correctly estimate this type of contract is amplified when there is no chance to reclaim any extra payments. The rationalisation of contract schedules from companies like National Grid had increased as the reduction of their personnel had increased. As organisations have fewer personnel, the advent of the lump sum contract has reduced some of the workload involved in agreeing payment to subcontractors. In larger contracts a payment scheme is usually determined prior to the project start date. This is commonly based on the completion of key milestone activities in the project life.

8.6.3 The Civil Works Personnel

The personnel that Crossmores provided carried out the civil work of the project. These personnel consisted of a site agent, ganger, labourers, and machine operators. The number of personnel supplied varied with the activity being carried out; the usual squad consisted of 5 or 6 men, increasing to 25 for installation of the cable. The roles of each person and the project hierarchy are mapped out in Figure 8.3. The site agent was responsible for organising the squad and liasing with the Balfour Kilpatrick foreman to ascertain the labour requirements for each activity. This was occasionally a source of conflict. Crossmores wanted to supply as few personnel as possible, to the site. As the Walpole site was a considerable distance away from the London area, it meant that any personnel working at the site would have to be paid subsistence allowance, increasing Crossmores main overhead cost. The personnel especially the labourers were very poorly paid (approximately £30 for a

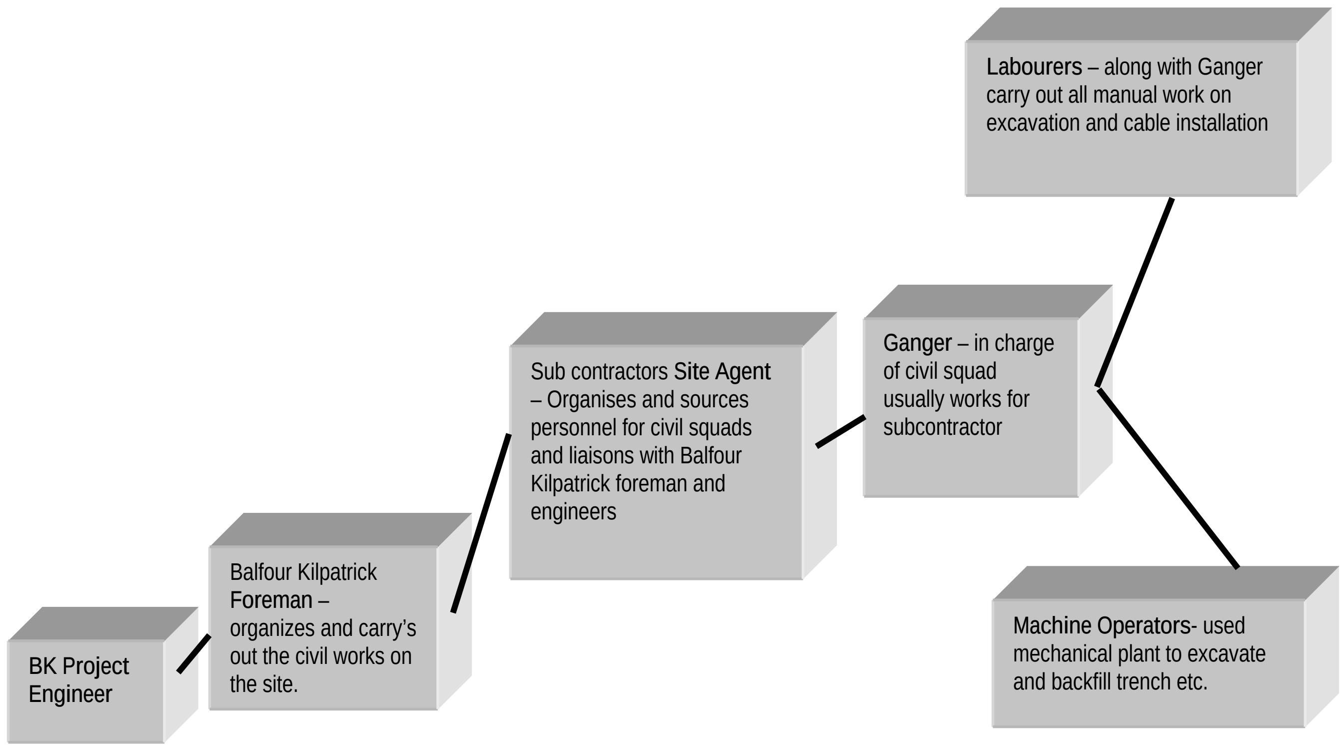

Figure 8.3 Site hierarchy for the civil works on the Walpole contract

minimum 9 hour day) and working away from home on top of this was not popular.

The poor rates of pay means that there is a high turnover of personnel, which in turn meant that there is a lack of experienced personnel, which lead to an increased workload for the Balfour Kilpatrick personnel supervising. This had implications on both the quality of the work carried out and on health and safety. Indeed the implications of the incident described in the following section were an indication that Balfour Kilpatrick needed to re-evaluate using a sub-contractor for the civil works in its projects.

8.6.4 Slippage Created by a Security Incident

8.6.4.1 Safety Training

At the Walpole site National Grid insisted that everyone had to go through a safety course to become a recognised 'person' i.e. the bare minimum of knowledge needed to work safely in a high voltage substation or power station. On entrance to the substation and before any work is carried out, the 'Senior Authorised Person' (SAP) scrutinises and verifies that the personnel have the relevant qualifications to work in the substation. Other qualifications and certificates for operating machinery like excavators, cranes, and dumpers also have to be current and valid.

8.6.4.2 False Documentation

The National Grid SAP discovered an excavator operator who had been working on the cable excavation outside the substation had spurious documentation; his 'persons' certificate had a different name from his machine operator's certificate, despite having his picture on both. The man was banned from the site and the subsequent investigation delayed the progress of the project by at least two weeks. This came at a particularly sensitive time for National Grid, due to the security issues involved with protecting the electrical distribution system from terrorist attacks. At that time a trial was taking place of suspects who were plotting to plant explosive devices in substations, like Walpole. Balfour Kilpatrick was also open to criticism due to this incident and a procedure was quickly created and implemented to try to prevent a reoccurrence. It took a considerable amount of personal diplomacy by the Balfour Kilpatrick foreman and project engineer to avoid an escalation of this incident into a major project stoppage. As it was, a hurriedly organised ‘persons’ course, and a new onsite security procedure prevented it going any further.

8.6.4.3 Resolving the Problem

The manner in which the National Grids Project Manager (and his superior) dealt with this episode ensured that the delay was no longer than the two weeks. After hearing an explanation into the operators conduct and approving the action Balfour Kilpatrick were taking, they were reassured that it was unnecessary to take further action.

The resolution of scenarios like this is very dependent on the relationship between the client’s representative and the contractor. Personalities inevitably play a large role in this, and therefore the uniqueness of a project is just not confined to the project characteristics, it is also shaped by the interaction of the personnel involved. This also applies to the project team carrying out the work. At the beginning of each project (in the case of Balfour Kilpatrick) there was a strong possibility that at least 50% of the project team members are unknown to each other, unknown to the client and unknown to the subcontractors. Therefore having the ability to form a cohesive unit, using communication, diplomacy and a certain amount of compromise was essential for the project to succeed.

Another problem using the subcontractor Crossmores was that not all of their personnel had been through the ‘Persons Safety Course’. During the first stage of the Walpole contract, the safety rules enforced by National Grid stated that ‘non persons’ could work in the substation under direct supervision by a ‘competent person’ (in this case the Balfour Kilpatrick foreman). Despite this, the Walpole Senior Authorised Person insisted that all personnel should be certified to a minimum of the ‘Persons Safety Course’ standard. Quite reasonably, considering the high personnel turnover of the subcontractor, which in itself could have compromised safety.

The reasons behind having a safety course were to prevent accidents, and to make personnel aware of the dangers that surrounded them in a high voltage environment. In the past subcontractors would not be allowed into a substation without a representative of the client, a standby man who had knowledge of the surrounding electrical equipment and could watch the activities taking place to ensure that no one was in any danger of being injured. This is now rare; the system employed now, involves demarcating the work area, signing a permit-to-work over to the subcontractor’s representative (the ‘Competent Person’) after making them aware of the dangers in the vicinity. The subcontractor’s ‘competent person’ is now responsible for the safety in the designated area. This system did not require standby men to the same degree as before, meaning they could be utilised elsewhere. When Balfour Kilpatrick wanted to work into the evening at the substation, a standby man had to be present to ensure that everyone had left the substation and it was secure. Ironically, there was a plan to use personnel from a large security firm to carry out this task, which appeared to contradict National Grid’s concern for safety and security.

8.6.4.4 Ambiguities with the Safety Training

There was inconsistency in the way in which National Grid's senior personnel interpreted the safety regulations and this in itself led to difficulties for the contractors on site. The number of men needed for the two days of cable installation would increase to about 30, therefore all these personnel had to be certified. This initially was not a problem as it had been decided by Balfour Kilpatrick to supplement Crossmores personnel with their own staff. These men were to be drafted in from a contract taking place at West Ham in London, an expensive process because it meant that production at that project would suffer, also they were a higher overhead cost to the contract than Crossmores personnel. It was believed that this was a justifiable expense as the Balfour Kilpatrick squad although small, consisted of experienced men, which was vital for cable pulling.

Problems arose when the Senior Authorised Person at the Walpole substation would not accept the certificates of the men that had been put through the 'persons' course at the West Ham substation (which was also under the jurisdiction of National Grid). He insisted that the men should have gone through a course run by National Grid's training centre at Eakring (the same course just delivered at this training centre). There was a certain amount of internal wrangling and the test papers of the Balfour Kilpatrick personnel involved were faxed to Walpole and scrutinised. Eventually a 'persons' course had to be hurriedly organised to take place at the Walpole site conducted by a National Grid safety consultant and charged to Balfour Kilpatrick. Only this would allow the access of the extra personnel onto the Walpole site. Interestingly in discussions with other contractors on site (GEC and May Gurney) it was discovered that this inconsistency was not just affecting Balfour Kilpatrick. Experienced subcontractor personnel had to sit 'persons' or 'competent persons' courses in each regional electricity area they worked in. Although this was a relatively small-scale problem, the costs and implications involved can soon escalate.

8.6.5 The Project Programme

The cable installation was a major milestone in the project schedule and everything was based around the date of this activity. The added complication of the Walpole project was its distance from the London area (approximately 100 miles from the companies site in Erith, Kent), where many of Balfour Kilpatrick's suppliers and subcontractors are based. Any delay to the cable pull would have a knock on effect on the rest of the programme, i.e. the cable pull was a critical task. Also resources like cable pulling equipment are shared between projects and its utilisation and movement needs to be scheduled and planned in advance.

The milestones of a supertension cable project are as follows:

- Excavation
- Cable Installation
- Backfilling
- Jointing and Bonding Works
- Testing

8.6.6 The Cable Contract as part of the National Grid Project

The manufacturing lead-time on a supertension cable is determined by how busy the BICC factory is and what type of cable is being requested. The customer then has to programme when the cable has to be installed. The cabling works are typically part of a far larger overall electricity supply project, with various other ancillary pieces of equipment also being installed, therefore extensive co-ordination is needed to ensure the constituent parts combine for overall project success. National Grid was spending up to £50 million on their high voltage electricity system for London improving the systems security and reliability. Balfour Kilpatrick are involved in most of the key sites in this project. The West Ham site mentioned earlier was one of these. Two devices, known as quadrature boosters are being fitted in the substation with an approximate cost of £20 million.

8.6.7 Scheduling and Deadlines

In the case of the 132kV cables at Walpole the contract was actually scheduled for 1998, but it was brought forward when a maintenance window was made available which permitted the necessary switching out to take place, allowing the installation of the cable. The length of this time window was approximately nine weeks, therefore there was a penalty clause inserted in the contract to the effect that the cable had to be manufactured and installed by the deadline, which was the 20th June 1997.

8.6.7.1 Route planning and Preparation

The cable route through the substation and to the pylon had been prepared when the previous circuit had been installed, which allowed prior planning to take place for known problems, like for example the crossing of an existing high voltage cable in the substation. The initial route entailed routing the cable outside the substation, travelling along the perimeter fence to the pylon. This would have aided both excavation and cable installation, as there would not have been any high voltage equipment in the vicinity. Unfortunately this was going to prove too expensive due to the increased length of cable. Therefore a route through the substation was decided and marked out ready for excavation.

8.6.7.2 Decision Making

Although this was the second cable circuit to be installed, National Grid had not committed itself to using BICC/Balfour Kilpatrick, therefore the tender and subsequent contract documentation always referred to the second circuit as an option. This led to a rather inefficient and pressured approach to many aspects of the second contract's execution, as the relatively sudden project start up created more rigorous deadlines for materials, resources and preliminary work to be completed. Why there was an inability to commit a commercial decision on both cable circuits as opposed to just the one is not known, especially as it was a relatively small project value – a total of £220,000. This made a difference to the execution of the project because materials and one off steel fabrications that could have been made for both circuits were only made for one. This necessitated the re-ordering of materials (with its associated costs) and the chance that certain items could not be fabricated in time. Certain items had to be sourced from different suppliers as a result of this, although fortunately nothing prevented the programme from being achieved.

8.6.7.3 Excavation

The excavation of the cable trench was carried out either by machine or manually. A trench 1.1m deep by 0.9m wide has to be excavated then 'timbered' i.e. shored with timber and adjustable struts, to prevent it collapsing. Typically an excavator with a banksman will excavate the trench in areas where it is safe to do so, with three or four men following on, shoring the trench. The rates of machine excavation depended on the ground conditions and the prevailing weather. At Walpole on the part of the route, which was outside the substation, in a field, 25m of trench would be excavated in one day. The weather was also good, allowing the trench to stand up better whilst shoring, If the weather is wet, the trench is in more danger of collapsing before it is timbered, also the excavator cannot access the site so easily (not forgetting the unpleasantness of working in this environment) The previous circuit at Walpole was installed in November which created a lot of problems, with excavators, cranes and other equipment getting stuck in the field. The few days of torrential rain at the end of the second circuit contract briefly highlighted the difficulties faced when the weather was bad.

8.6.7.4 Working in a High Voltage Environment

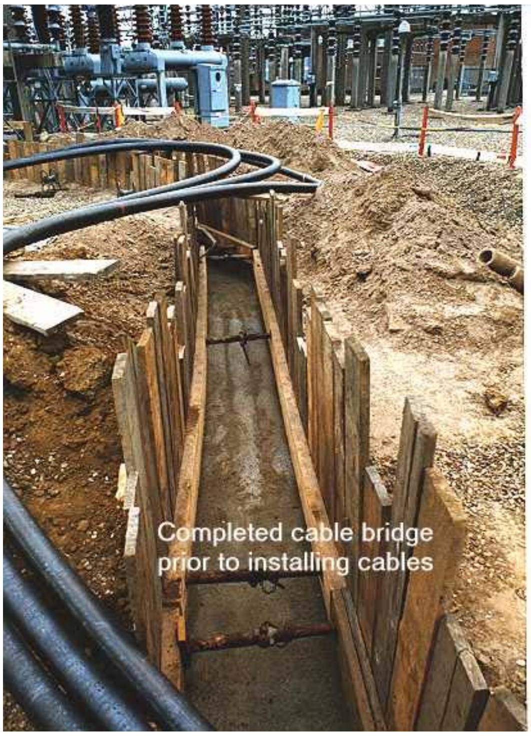

Plate 8.4 The Cable 'Bridge'

Excavation in the substation involved greater risk, due to the proximity of live electrical equipment and existing underground cables. Parts of the switchgear were isolated and a special small excavator was used inside the substation. This had to be under direct supervision of the Balfour Kilpatrick foreman the designated 'competent person'. Electricity has the capacity to jump across air gaps (1.2m for 132kV up to for 400kV) therefore it was essential that a safe working distance was kept from live equipment. Certain sections of the route where existing cables lay had to be 'hand dug' by the civil squad. This involved locating the cable on the route records, digging carefully down to the protective concrete cable slabs, and then after the cable was switched off a protective concrete 'bridge' was installed over it (as shown in Plate 8.4). Hand digging also had to be carried out where the route was in close proximity to the live equipment.

The excavation work initially went well, the trench outside the substation was excavated and shored with timber in approximately one week as per the programme. Then the security incident regarding the excavator operator reduced one week from the allocated programme time to the excavation. This left just over one week to excavate the route in the substation, which was governed by a proximity outtage[iv]. This was going to be a difficult task to achieve as a large part of the trench was to have been excavated by hand and the excavated material had to be transported out from the substation compound.

Following a meeting with National Grid's Senior Authorised Person (SAP) an alternative proposal utilising mechanical machinery was put forward and accepted. Communication and co-operation between the client and contractor solved what appeared to be an intractable problem. In this case Balfour Kilpatrick outlined the proposal to the National Grids SAP, who approved it and outlined what permits would be required. This interaction involved virtually no documentation (apart from safety certificates) which was interesting considering the involving method statements that had to be written for other changes in project activities. The need for documentation for certain activities appeared to bear no correlation to the importance or difficulty of the task.

8.6.8 Quantification of Risk

Whilst observing this project (and others in the past), it became apparent that quantification of risk appears to be an intrinsically personal judgement. Regardless of the scenario an action that one person would be comfortable to carry out, may not be acceptable to someone else. In a project environment, the pressure to nullify the risk associated to certain actions because of deadlines appears to have an effect on decisions taken. Deadlines alone may not be the sole variable; status, role, accountability and personality also contribute to the type of decision taken. Having hired a skilled and certified excavator operator (charged to the subcontractor Crossmores following the security debacle) a small excavator was utilised to dig a large part

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[iv] An outtage is where an electricity circuit is switched off and isolated to allow work to be carried out on it or

of the trench that was to be hand dug. This saved a lot of time and allowed the excavation to be completed in the substation before the end of the proximity outtage.

8.6.8.1 Cable Installation

Cable installation was the 'main event' for most project engineers at Balfour Kilpatrick. It was the culmination of a lot of planning, co-ordinating, and technical work. The value and vulnerability of the cable that had to be installed created a lot of pressure on the project team. The cable system constitutes a large part of the contract price, and is specifically manufactured for each contract; therefore it had to be installed right first time. The cable pull put great pressure on those supervising the project, inevitably that pressure was transferred to those carrying out the work.

8.6.8.2 Preparing for the cable pull

Like other project activities, the more planning and preparation that can be done beforehand the greater the chances of success. With cable pulls, the setting up of the trench and pulling in close proximity to it.

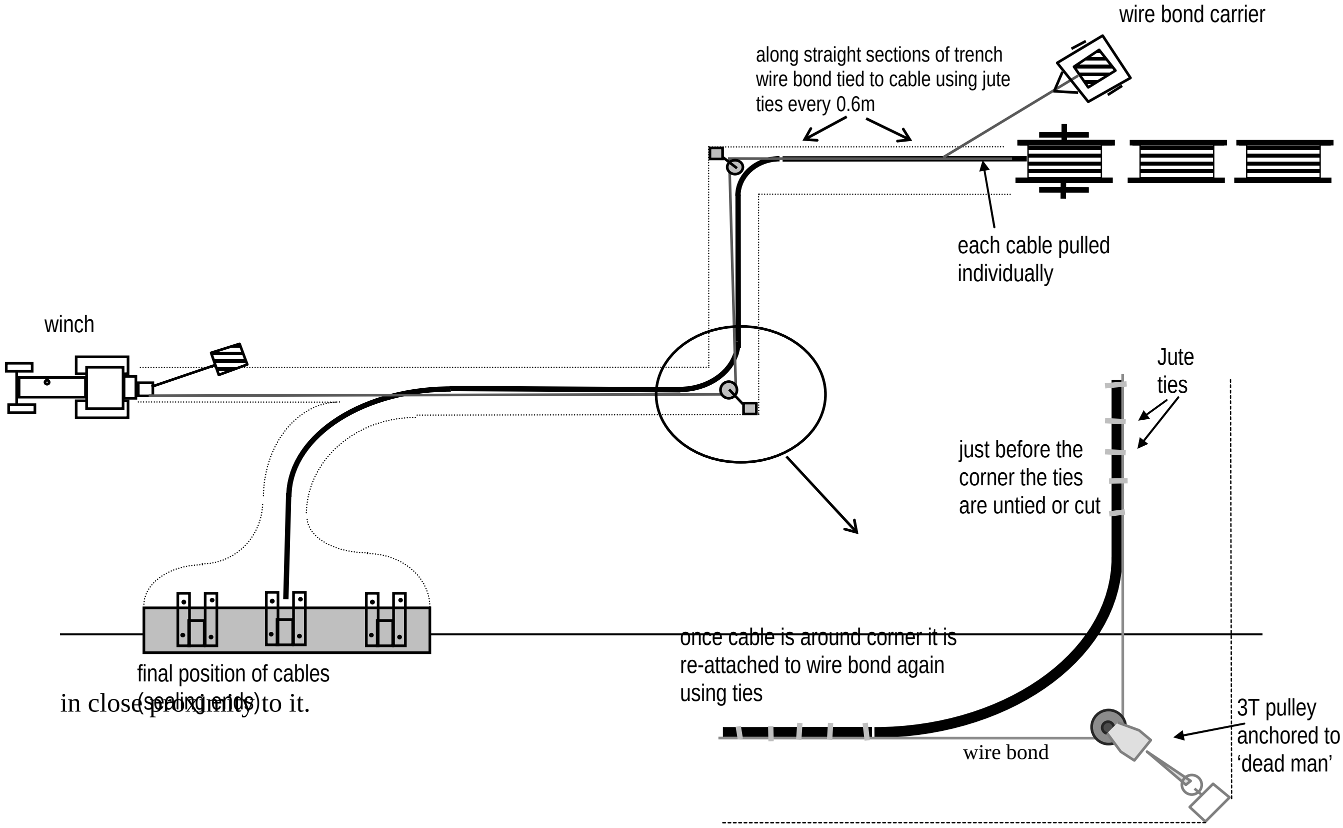

Figure 8.4 **Sketch illustrating the principles of 'bond-pulling' a cable**

equipment beforehand was vital. The 132kV cable at Walpole was designed to be able to be pulled by the nose from its drum position, along the trench and up the pylon. This method was immediately rejected due to the number of bends on the route, which would have imposed too great a force on the cable resulting in damage. It has to be appreciated that the cable was measured very precisely, with 1.0m 'jointing tolerance' allowed at either end, therefore any damage to the ends could have had disastrous consequences. It was decided to use the 'bond pulling' method to install the cable, which although being more complex to set up and implement, it was a far safer and prudent way of installing the cable.

As shown in Figure 8.4 the principal behind bond pulling the cable was relatively simple. A wire bond is pulled along the length of the trench and attached to a capstan winch. The cable is then fed off the drum, and attached to the wire bond by ties made of jute yarn. The jute yarn is soft enough not to damage the cable as well as being strong enough to grip the cable tightly. At the cable drum end, two or three men attach the ties, and one man watch's the drum to ensure it does not come off the stands (the drum can travel along the spindle if it is not level). These drums can weigh anything up to 20 tonnes therefore it is important they are monitored. Someone with a two-way radio is also stationed at the drum to stop the winch if necessary.

The cable complete with bond travels on rollers along the bed of cement bound sand that has been laid on the bottom of the trench. Two people guide the nose

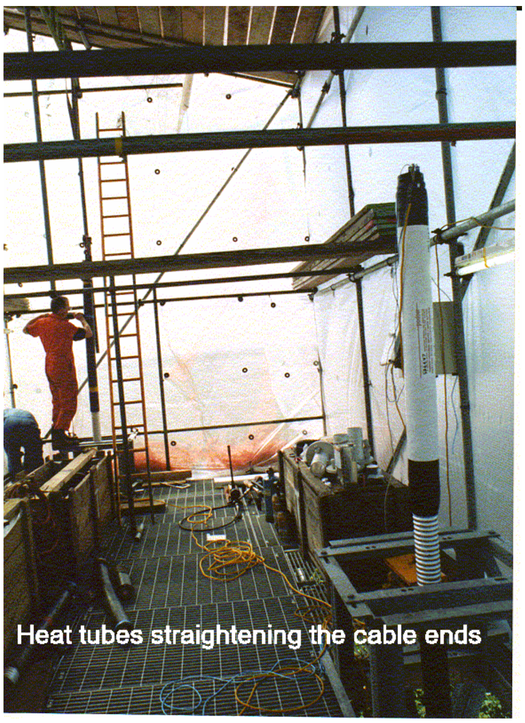

Plate 8.5

of the cable along the trench onto the rollers and a third person (usually the engineer or foreman) has a two-way radio to control the winch. Strict radio discipline has to be kept at all times and whilst anyone can stop the pull if they suspect a problem, the engineer or foreman on the nose of the cable are the only ones who can start the winch again. Prior to the cable pull the trench has been swept, and inspected for stones and debris that could damage the outer sheath of the cable. As the cable approaches a corner in the trench, one person unties or cuts the ties and the nose of the cable is guide around the corner free of the bond. Once it has reached the straight part of the trench again, two people re-tie the bond to the cable. Every corner has one person with a two-way radio monitoring the progress and ready to stop the winch if needed. This sequence of events continues until the cable reaches the end of the track and is fed into position. This can be either a joint bay or as at Walpole a pylon platform where the sealing end terminations were situated. Once in position, the cable is laid off the rollers and the trench is prepared for the next cable.

A cable of this size and type is extremely unwieldy and difficult to manoeuvre and cable pulls are a slow process. At Walpole it took two long days to install the three 132kV cables and one auxiliary bond cable. The aluminium sheath and resin insulation gives the cable a ‘memory’ of the position it was in when on the cable drum, which meant that before it could be jointed, it had to be heated and mechanically straightened (as shown Plate 8.5). At the cable pull there is usually a representative of the client (NGC) and a representative of the cable factory (BICC). The involvement of the client’s representative is usually minimal; they are principally just witnessing the process. At Walpole the BICC representative was also a witnessing the process. Some BICC personnel would also assist on the cable pull or advise if necessary, although this was dependent on the individual. Some personnel on site cynically suggested that the cable pull was just a day out of the office for the BICC staff; certainly it sometime applied additional pressure on the Balfour Kilpatrick staff supervising the work. The relationship between Balfour Kilpatrick and BICC was not always as co-operative as it could have been. BICC would assign a co-ordinator for each contract, which was the factories representative and point of contact for both Balfour Kilpatrick and National Grid. In addition to this, BICC had their own engineers who would take part in contracts either full time or when necessary depending on the size of the project. The BICC project engineers could be posted worldwide and had a rather more glamorous image than their Balfour Kilpatrick counterparts. When involved in UK contracts their position is usually in tandem with a Balfour Kilpatrick engineer and their responsibilities were limited.

At the Walpole contract there was four BICC personnel out to witness the cable pull, a project engineer, student engineer, a mechanical engineer and a designer. It was with some surprise to the team on site that this was the first cable pull that the designer had witnessed, despite having been with the company a considerable time. The BICC design department had been looking into new methods of pulling cables into tunnels and a taste of the practicalities involved was the reason for the engineers visit.

Plate 8.6

The cable pull took two days to complete and was a slow process, because of the route and the inflexibility of the cross-linked polyethylene cable. The more corners on a route the greater the strain on the bond. As the cable reaches its final position the load is at greatest and this can necessitate the alteration of corner pulleys and even the trench itself. Once there are two cables in the trench it becomes cramped for space and again there has to be frequent alterations to the pulling equipment, which leads to delays. The weather on the day of the cable pull was perfect, (if a bit hot!) which helps both physically and psychologically. In the event of bad weather cable pulls usually went ahead regardless, because it was a key activity in the project programme. Only in very cold conditions is there a danger to the cable. At Walpole the cable route was mostly in the substation and in the adjacent field, so there was none of the difficulties associated with excavating a road where roads departments, utilities, and the police have to get involved. Plate 8.6 shows the cable route and winch in position prior to the cable pull.

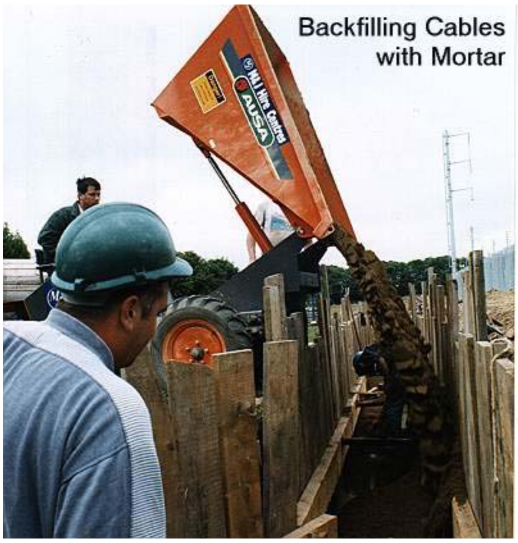

Plate 8.7

8.6.8.3 Taking Responsibility

The main concern apart from pulling the cable in undamaged was that the correct cable goes to the correct sealing end position. The circuit consisted of three individual phases, one for each cable, each having to go to their respective terminations. This involved crossing the cables at the base of the pylon at one end. Having a crossed phase i.e. a cable that has been accidentally transposed, was not uncommon and could be an expensive mistake, as it meant piecing in a new section of cable plus its ancillary joints. The difficulty at Walpole was that the National Grid project manager would not commit himself to confirming the phasing in writing, something Balfour Kilpatrick's engineer had to obtain. Having experienced the repercussions of not confirming the cable phasing in the past, the Balfour Kilpatrick project engineer was not going to be caught out again.

The unwillingness on the part of the National Grid project manager appeared to stem from a reluctance to communicate with another department of National Grid where confirmation could be obtained. This poor interaction between departments was to be more apparent towards the end of the contract. Finally, Balfour Kilpatrick's engineer drafted a memo asking the phasing to be confirmed which the National Grid project manager eventually signed. This was one of a number of scenarios in which there was reluctance by the client's personnel to make a decision, something that was beginning to become apparent as the project progressed. Once the cable was laid the civil workers would space the cable in the trench to its correct specification, then start backfilling with cement bound sand as shown in Plate 8.7. At this point, a security firm was employed to guard the exposed cable overnight to prevent any theft or vandalism to the cable.

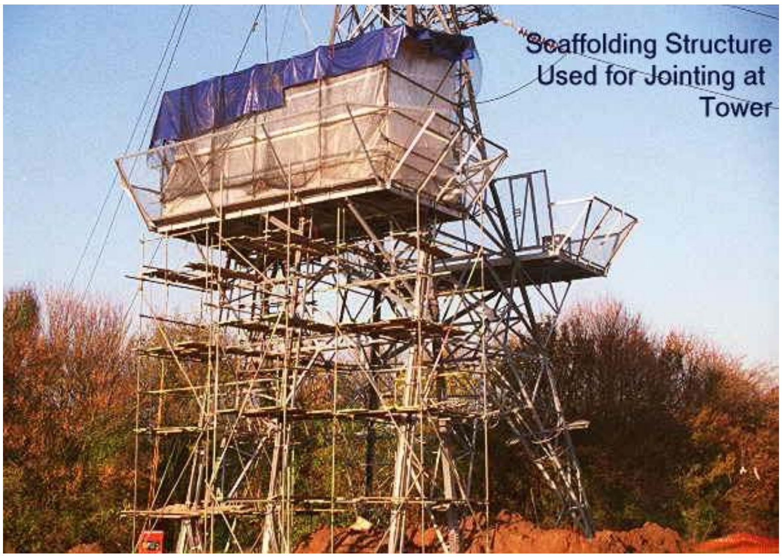

Plate 8.8

8.6.8.4 Jointing Works

The installation of the cable was the key milestone event, which triggered the jointing works to commence. This commenced with the erection of scaffolding, which took about two days per structure. The scaffolding was in place to lift the porcelain sealing ends up over the cable and onto the sealing end support structure. The jointing had to take place under dry conditions therefore the scaffolding had to be sheeted with tarpaulins as shown in Plate 8.8.

8.6.9 Poor Design, Poor Fabrication and Poor Installation

At the tower (pylon) end the sealing ends had been lifted by crane up to the platform, which was approximately 9.0 m off the ground. National Grid had designed, manufactured, and erected the platform, which supported the cable and sealing ends. Balfour Kilpatrick had to fit the part of the cable support steelwork that went from ground level to the platform (the cable ladder). There had been problems with this steelwork on the previous circuit, which had caused considerable delay and cost, and similar problems arose on this occasion. The structure was ill fitting and poorly designed and consequently it took a considerable amount of effort on the part of the project team to alter it in situ.

The implications of this poor quality were highlighted in a serious incident later in the project as shown in Section 8.22.2. Every facet of the steelwork was unsatisfactory; it had been poorly designed, poorly manufactured and badly erected. It was interesting to note that apart from some concerns voiced by National Grid's project manager, there had been no attempt to respond to an identified quality problem.

8.6.10 The Cable Jointers

The jointing team consisted of two jointers and a 'mate'. The jointers were highly skilled artisans, and an indispensable part of the project. Plate 8.9 illustrates the start of the jointing process. This meant as a workforce they were in a powerful position, and over the years the pay structure that they had negotiated had resulted in them being the highest paid personnel in the company. For each joint they did an agreed number of hours were paid. At every contract there was a certain amount of negotiation between the jointers and the engineers as to what they could do and in what timescale. It was a scenario that took place at all of the cable contracts and was unlikely to change, unless there was a radical change in the way in which joints were created that reduced the skill needed. The main reason that this bartering took place was that there was always an activity or task that needed to be done either on a shorter timescale than usual or a different task from usual. The preliminary programme for Walpole only allocated half the necessary time needed to do the sealing end terminations, therefore a deal had to be struck with the jointers to do the work in half the time. This coincided with a trial period at the company, where the jointers were working in pairs and without a 'mate' i.e. someone who prepares the materials, carries equipment onto the scaffold etc. This was in an attempt to cut the costs of the jointing, and had been agreed, by both the jointers and the company. Labour cost is the largest overhead cost on any contract, and there was continual

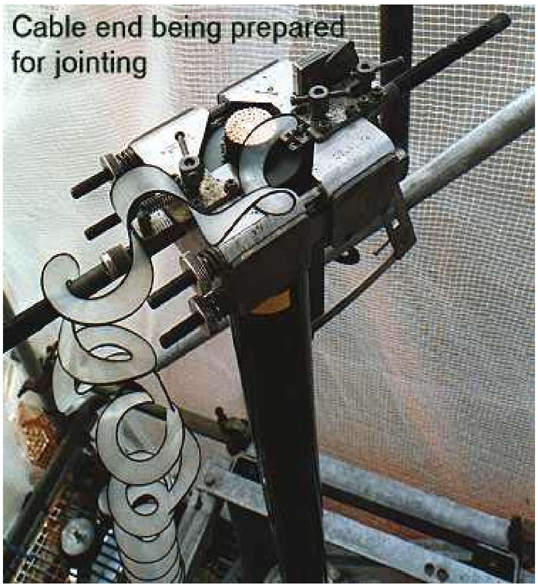

Plate 8.9

effort by the company to try and reduce this cost. This was the reason for using subcontractors to carry out the civil works; their personnel were the lowest paid on the site. Yet, paradoxically these men were also responsible for working on the most valuable item on site the cable.

After outlining what had to be done and the timescale, the jointers agreed to make every effort to achieve it. A jointers 'mate' was provided to assist them, and extra hours were agreed on to provide the monetary incentive. Once the jointers started, they were relatively self contained and just occasionally needed extra assistance. Again the steelwork on the platform proofed a problem and needed to be altered to allow the sealing ends to fit.

8.6.11 A Quality Query

On checking the parts of the sealing ends, it was noticed that a flange and the copper stalk was discoloured and looked as if it had been used before. Photographs were taken, as shown in Plate 8.10 and the BICC co-ordinator for the Walpole contract was contacted. A verbal assurance was given that it was nothing serious and would have no effect on the performance of the parts. Coincidentally the Balfour Kilpatrick quality assurance engineer paid a visit to site before the jointing. When shown the parts, he announced that it was not within his remit to deal with the technical aspects of the contract, and informed the project engineer of the pro forma which could be filled in should the decision be taken to pursue the matter.

Plate 8.10

8.6.12 Project Termination Pressure

The jointing was carried out satisfactorily, leaving one week to dismantle the scaffolding, finish the ancillary earth bonding works, and complete the backfilling around the scaffolding areas. Already at this stage pressure was being brought to bear by the jointing supervisor at Balfour Kilpatrick Erith, both jointers were needed as soon as they finished at Walpole. At this point it was vital to ensure that everything that needed to be done by the respective site personnel was done, as it was not cost effective to have them returning to site to finish off or rework activities that had not been completed properly. Plate 8.11 illustrates the porcelain sealing end being lowered onto the cable.

Plate 8.11

8.7 The Termination Phase of the Project

The last three weeks of the project as shown in the official programme were going to be difficult to achieve, but on site the team was confident of achieving the deadline. Two events occurred that could have reversed the outcome of the project. The first concerned the relationship between Balfour Kilpatrick and its civil engineering subcontractor Crossmore's.

8.7.1 Crossmore's vs. Balfour Kilpatrick

During the project the author had been informed about a long running dispute between Crossmore's and Balfour Kilpatrick. Approximately six years before, Crossmore's carried out work for Balfour Kilpatrick in the region of £250-300K. After this had taken place, Crossmore's two directors decided to split up and the company was divided into two, another director joined the company and they started trading under the name Crossmore Engineering.

When they tried to recoup the outstanding invoices, Balfour Kilpatrick refused to pay, stating that the Crossmore Company they had dealt with no longer existed, absolving them of any need to remunerate them. The dispute had continued in the courts for six years, during that time Balfour Kilpatrick had continued use Crossmore's as subcontractors. According to Crossmore director Mr Dave Mahar, he believed that the company would eventually be reimbursed and that by keeping connected to Balfour Kilpatrick was the best way to achieve this. Balfour Kilpatrick apparently had the outstanding amount in a separate account knowing that they might have to settle the dispute eventually.

During a number of discussions with Mr Mahar regarding Balfour Kilpatrick's relationship with their subcontractors, it became very apparent that creating a symbiotic relationship between the two companies was not a Balfour Kilpatrick strategy. The author questioned Mr Mahar regarding the training of his workforce, the issues regarding the 'persons' course, and his opinion on how Crossmores as a company could contribute to the quality of the project activities carried out. He was typically forthright in his answers. If he had some contractual guarantee of continuity of work from Balfour Kilpatrick, he would happily invest in training, equipment and other mutually beneficial operations. As it stood, the only reason that he continued the relationship was to recoup what he viewed as his outstanding money. The operatives would only be put through courses if absolutely necessary because in his experience there was more chance that they would leave and take up employment with rival subcontractors. It was realised that only one side of the story was being heard, but confirmation from other sources gave credence to a lot of what Crossmore's director discussed.

Towards the latter part of the project the situation regarding this dispute started to come to a head. The author was informed that from the end of that month Balfour Kilpatrick were no longer going to use Crossmores as subcontractors. This decision had been taken by a senior executive of Balfour Kilpatrick, irrespective of the operational effect this would have on the projects where Crossmore's personnel were being used. The author had been told of this decision by a senior manager immediately after it happened, with the instruction not to inform anyone on site. This was in the hope that the contract could be finished without incident. The fear being, that the news of the termination of Crossmores association with Balfour Kilpatrick and the inevitable loss of jobs, could provoke someone to maliciously damage the cable. The fear was groundless, when the news eventually filtered out, nothing happened and the civil work reinstating the last of the cable track was completed. The trigger that had prompted this situation was Crossmore's director carrying out a court injunction on Balfour Kilpatrick to hasten his claim.

This illustrated the vicious reality of what happens in a situation where there is no mutual respect or co-operation between the senior management of a large organization and one of its contractors. The outcome is a low paid, overworked, disposable workforce bearing the brunt of what is in reality is a knee jerk reaction to a relatively insignificant financial claim. Initial estimates were that up to 100 personnel would be directly affected by the decision. Crossmore's director was not in the least surprised and actually expressed some relief that the relationship between the two companies was coming to an end.

8.7.2 The Near Miss

The overlap between the finish of the cable jointing and the connection of the overhead transmission line took place in the final week. By this time the National Grid department that had won the contract to carry out the works around the tower including the final connections between the transmission tower and the cable sealing ends had arrived on site to begin their work. As previously mentioned there was some resentment that National Grid's projects department had not initially chosen their own in-house linesmen to carry out the work, and called into question their planning capabilities. The part of the line that was replaced by the cable had been dismantled and the down droppers were being fitted. It was only at this stage that it was discovered that the clearance between the various connecting conductors was not adequate. The angle of the tower in relation to the conductor created an insufficient clearance between it and the down dropper. Already there had been alterations to the tower sealing end platform that had been designed to be at 8.0m high and was now at 9.0m. Two days before the project deadline one of the National Grid engineers almost fell to the ground from the platform. He had stood on a rectangular piece of sheet steel, which was part of the platform, and without any warning it had given way. Fortunately whilst falling through the gap created, he managed to grab part of the structure and held on until a linesman pulled him up to safety. The piece of steelwork that had given way fell onto one of the scaffolding towers upon which two Balfour Kilpatrick personnel were working. Again, luckily it landed on the scaffolding platform just above their heads.

On being told of the accident (or near miss) a formal assessment of the damage was made by the foreman and the author. On close inspection it was realised how lucky all three men had been not to receive serious injuries. The plate had clipped the cable causing light damage to the sheath, which would have to be repaired. Following discussions with National Grid's project manager who was not available on site, the decision was taken to go ahead and repair the cable. This had to be done quickly as to not effect the overall project programme, as the damage would also mean another electrical test would have to be carried out on the circuit to prove the integrity of the repair.

8.7.2.1 Repairing the Damage

At the time of being told about the incident, the author had mentioned to the National Grid project manager that Balfour Kilpatrick could carry out the work to the platform to make it secure, as Balfour Kilpatrick had the personnel and the equipment on site to carry out the work. This offer was gratefully accepted, as there was a distinct distrust in the workmanship of the National Grid squad, which had erected the platform originally. Despite this, Balfour Kilpatrick’s project engineer was requested to keep the repair ‘as cheap as possible’ something that he found incredible, considering the circumstances surrounding the incident.

The Balfour Kilpatrick foreman’s initial reaction to the extra work in repairing the platform was not very positive; he did not want to get involved. His argument was that once Balfour Kilpatrick had worked on the platform, they would then be responsible for it and he did not want his reputation sullied by other’s poor workmanship. This reaction seemed extreme, but his concern was also matched by a feeling of anger at the way in which the accident was being down played. There was justification for this. If Balfour Kilpatrick had caused the accident then the subsequent investigation would have been far-reaching and severe, and outside agencies like the Health and Safety Executive would have been involved. This was acknowledged in private by National Grid’s project manager and by other personnel on the site.

The work to carry out the repair was already underway within 12 hours of the accident; a programme of works had been faxed to National Grid and approved. Brackets and other materials were sourced to repair the platform and discussions between the engineer, foreman and jointers had worked out what was to be done and how. As this was the termination phase of the contract, two of the jointers had to be relieved for other work, but this did not prove any problem. The cost of the work and the subsequent oncost had been estimated on site and then discussed with Balfour Kilpatrick's contract manager. A final figure was arrived at and presented as a lump sum price to National Grid. The BICC factory representative was also informed of the situation and approval was given to the repair of the cable. Photographs taken on site were copied and supplied to all parties and any information needed for the as-laid route records was supplied to Balfour Kilpatrick's draughtsman. The speed at which decisions were taken and actions carried out one of the strengths of organizations like Balfour Kilpatrick. The problem was quickly and efficiently resolved to the benefit of all parties. In total the repair and testing of the cable and platform took approximately four days. National Grid paid for this 'extra' without dispute.

8.8 The Quality Management System at Balfour Kilpatrick

Balfour Kilpatrick used an industry based quality system, British Standard BS EN ISO 9002 (1994) Quality Systems Specification for Production and Installation. The ISO9000 series of standards are primarily geared at improving the economic performance of an organization by implementing a quality system. This system concerns itself with the monitoring, measuring and auditing of all aspects of the organization which effects directly or indirectly the quality of the product or service supplied. Most large private sector and government organizations require that suppliers have in place one of the ISO9000 standards as a prerequisite to being allowed to bid for contracts. Approval to ISO standards is achieved by certification by independent, approved bodies and is paid for by the organization seeking approval. The certification process involves intensive audits by either the client or by a third party assessor. The organizations own quality personnel also carry out internal audits periodically. The audits are concerned with whether or not the organization personnel are complying with the organizations own quality system.

To summarise the process of achieving ISO 9000 certification:

- The organization constructs a documented Quality Management System (QMS).
- Submits the QMS to the customer (second party assessment) or independent assessor (third party assessment).
- The assessor will then notify the company of any deficiencies in the document and seek agreement to rectify them.
- A thorough audit takes place of the organization in respect to their documented procedures and from this they are awarded or refused accreditation.
- Once certified, regular compliance audits must take place to keep accreditation.

The rational behind this process (paid for by the organization seeking certification) is to provide assurance to the customer that the company is committed to quality and able to supply products and services in accordance with their requirements. It is very important to realise that the quality management system is a determined by the company itself and as such can be as complex or simple, as they believe necessary. Quality management literature is quick to point out that a Quality Management System must be tailored to the organization, well thought out, and is implemented by a committed management. According to Munro-Faure[11] the key components of a quality management system are:

> "…a controlled, documented system of procedures, designed to ensure that only conforming products or services are released to customers."

Balfour Kilpatrick's certification to ISO9002 was in theory meant to indicate to its customers that its quality management system has been independently assessed as effective. To achieve this an extensive documentation system had to be put in place, consisting of three main sections. The Quality Manual, which describes how the company are going to achieve conformance to ISO9002. The Control Procedures that described in detail the methods that the organization had employed to assure quality and Work Instructions were the specific instructions for tasks or processes.

The main document relating to Quality Assurance on the Walpole site was the Quality Plan. This document outlined the salient parts of the contract, what was going to be done, by whom, the organizational structure, responsibilities, documentation and quality inspection forms. On initial inspection this appeared to be a useful document. It outlined the scope of the contract, any special requirements and the organisational responsibilities of the contract staff on site. Even for a relatively small contract like Walpole this was a useful exercise, it allowed new members of staff to become acquainted with the organizational structure. Having never worked for this particular cabling unit before there were certain operational differences that the author in his role of project engineer was not aware of, which were illustrated by this document for example the support staff available to assist on site. The author's involvement in this project happened quickly (approximately two weeks before the project commenced) therefore he had to 'hit the ground running' as far as knowledge of the organizations support infrastructure was concerned. Included in the Quality Plan was the Inspection Plan, which listed all the 'pro formas' i.e. the inspections that had to be carried out on site and the corresponding forms that had to be completed. There are approximately 60 pro formas that are applicable to various types of project. The Walpole quality plan consisted of thirty of these, which represented all of the major activities in the project. Each pro forma consisted of a pre-set instruction sheet detailing the information needed, and space for the information to be entered.

The relevance of the pro formas was questioned by many of the project engineers. Whilst acknowledging their uses in documenting important activities in the project life cycle, all too often the information required was irrelevant and repetitive. The impression was that Balfour Kilpatrick's engineers became slaves to the company's own quality system. Internal quality audits carried out by Balfour Kilpatrick's own quality personnel, slavishly scrutinised the contract documentation for any missing or incorrect completion of the pro forma's. This led to bitterness and resentment both towards the quality system and towards the quality personnel. Instances of personal aggression towards the quality personnel were not unknown. There were two main reasons for gathering any data in the quality management system. The first was to document that the work was carried out in accordance with Balfour Kilpatrick's own quality procedures. The second was to provide feedback on what can be improved. The existing design of the pro forma although capturing the detail of an activity did not have any useful function other than that of a historical record, and whilst this could have been useful, the majority of the data collected served no useful function. The relevance of the pro forma as a feedback method was lost because nothing was done with the information gathered. The result was that pro formas were filled out retrospectively. Engineering staff already pressured by their existing duties, tended to leave the forms until the project had finished or an audit necessitated it upon them.

8.8.1 Interpretation

Another feature of the quality procedures at Balfour Kilpatrick was their interpretation by different members of the quality department. When interviewing the quality engineer, he contended that the problem was that the 'older' engineers would not participate in the system, whereas the younger members of staff would happily comply. This particular quality engineer described the difficulties of fitting a quality system to Balfour Kilpatrick projects was like ‘nailing water to a wall’ From this interview it was interesting to note that the project had to fit the system not vice versa. The site engineer was also seen as the root of most of the problems. The author described the problems he had with Crossmores and asked if Balfour Kilpatrick’s subcontractors were vetted in any way. The author was told that this was not a quality issue and the responsibility for this lay with the contract manager and the project engineers on site, and ‘rough labour’ (his derogatory term for the civil works personnel) would always be supervised by Balfour Kilpatrick, therefore that was adequate to be in compliance with the Quality Plan.

8.8.2 Method Statements

Following the advent of Construct (Design and Management) Regulations (discussed in greater detail in Chapter 11, Section 11.4) it had become part of the principal contractors obligations to formulate a ‘method statement’ for any activities that the client believed may increase the risk to anyone on the site. The method statement included a description of the activity to take place, the risks to personnel associated with that activity, and how the contractor was going to minimise those risks. The quality department wanted a record of the method statements that were held on site. During the course of the contract the author had to alter a method statement concerned with lifting the cable drums from the cable transporter over the substation fence into the position from which they were going to be pulled. The Senior Authorised Person had requested this method statement on the site, due to the proximity of live electrical plant, where the crane was going to be situated. The method statement was collated and submitted for approval by National Grid (as shown in Appendix No. 2). Alterations had to be made to the proposed location of the lifting crane. This was done and the Method statement resubmitted. Again it was rejected. This happened five times before approval was given, ironically to the second scheme submitted. This sequence of events was recounted to the quality engineer, who was horrified that the method statement had not been approved and signed by Balfour Kilpatrick's contract manager. It was pointed out that the contracts manager was not on site, did not know the location or the circumstances and would have been most upset if the programme had delayed until he gave his permission for this task. In addition why pay an engineer to make decisions on site if he constantly needed to get approval from head office? From his prior experience as a project engineer, the author would not have attached any particular importance to this event, yet according to the company's quality system the author should have contacted his superior to have the altered method statement approved. It was becoming more and more obvious that the contract had to fit a quality system, regardless of the absurdity of the situation. Balfour Kilpatrick's Contract Manager conveyed the sense of frustration at the pedantic and unrealistic demands made by the quality system. As a result, he requested that the author observe an internal quality audit conducted at a major Balfour Kilpatrick site, to give an unbiased opinion on what was carried out.

8.8.3 The Quality Audit

The size and location of the Walpole site meant it was unlikely that an internal audit would be carried out. Therefore, the internal audit that the author witnessed was at a major Balfour Kilpatrick site for London Electricity in West Ham, London. The quality assurance engineer carrying out the audit came from the Balfour Kilpatrick Birmingham district office and was accompanied by the local Balfour Kilpatrick quality assurance engineer. Before the audit, the site engineers and the contracts manager had been meticulously filling out the pro forma needed for the audit, asking oil mechanics and jointers to update the calibration tickets on their equipment and generally ensuring that there were no non-conformances with the quality manual. This 'preparation' work started at least five days before the audit, and the tension caused by it was tangible on the whole site.

8.8.3.1 The Assessor

The senior quality engineer carrying out the audit would not conclude his findings until the end of the day, which caused some consternation with the local quality assurance engineer, who appeared to take every question as a personal attack on the quality system. The questions were directed at the site engineer, as he was responsible for quality assurance on the site. The quality system is described in the Balfour Kilpatrick Quality Manual and the Quality Management System consisted of procedures as described in the previous section. The quality documentation was checked first, whether or not the organogram was correct and in place along with the organizational quality policy and contract review. The purpose of the contract review was for commercial purposes; it was a snapshot of the handover of the contract documents, the enquiry the tender the bill of quantities etc. Also it allowed document tracability, and issue status to be confirmed. Whilst checking on the drawing register the auditor found that there was no distribution list on the drawing schedule and this was mentioned as something that could be modified to improve the system.

The site engineer agreed that some alterations to the drawing schedule would be needed. These included identification of what were site drawings, anomalies in sketch classification and clarification as to whether the drawing office had issued all drawings to the site including any generic drawings. Two trench cross-section sketches appeared to have the same sketch number but a different measurement. At this point the local QA engineer became very reactive to any change in the system, despite the internal auditor's recommendation. Once the internal auditor had left the office, the QA engineer berated the site engineer for agreeing with the auditor, it seemed he had completely lost sight of the purpose of the quality system.

His primary concern was not to receive a Non-Conformance Report (NCR). The NCR was not seen as a form of feedback to improve the system, but as a form of failure. The purchase order system was then examined, and document tracability checked. With the purchase orders, the item that affects quality the most is usually targeted for examination, in this case it was the mortar (cement bound sand) requisition note that was queried. (The sand in the mortar has to be approved by BICC for suitability; therefore a sample had to be sent to be approved. If it passed then all subsequent batches of sand used had to come from that specific quarry site). The location of the quarry site was not specific enough on the requisition, which in theory could have led to mistakes when the purchasing officer placed the order.

The ongoing cost of the Quality System

The estimated percentage of time spent keeping the quality system up to date at the West Ham site would be no different than the Walpole site i.e. approximately one fifth of the two project engineers and managers time (this was a larger and more complex project than Walpole)

Approximately £600/week plus the cost of BK's own quality staff and the cost of the external auditing company

8.8.3.2 Suppliers

When questioned on the auditing of suppliers, the author was told that Balfour Kilpatrick do audit suppliers and will strike them off their approved suppliers list, but this happened very rarely, especially as the Quality Assurance department were on a shoestring budget. The internal audit was viewed as 'process control' to ensure that checks were being made on site, pro forma were being filled in and status charts were up to date. Again there was no involvement in the vetting of subcontractors. The auditor gave a verbal report on what he had found at the West Ham site, which consisted of two category four non-conformances (non-conformances are rated one for high importance and four for low importance) and an observation. A report would be generated and the local Quality engineer had to ensure that the necessary corrective action and subsequent documentation was acted upon. There was no repository of information from the audits carried out throughout the country, although the quality engineer carrying out the audit believed it was a good idea, but again cited resources as the stumbling block.

8.8.4 Conclusions on the Audit

In summarising the quality audit it was difficult to be positive about the context and manner in which it was applied. The need to check systems and highlight anomalies or errors should have been a useful and symbiotic process to allow the project to benefit and the company to benefit by an increase in its knowledge database (even if that knowledge is of how not to do something) but, the level of detail and the importance attached to the documented quality management system reduced the efficiency and productivity of the operations on site. The data gathered was not used or analysed. The notion of feedback for continuous improvement was not present in part of the whole process. This final postscript illustrates the level of absurdity and paranoia that can be generated by a quality audit.

When jointing took place on a site there was usually a surplus of consumable materials supplied by the factory. The jointing supervisor decided that rather than wasting these materials, he would get the jointers to return them from site to the stores. He would then make up kits that could be used for faults or emergency repairs. The jointers at Walpole dutifully collected all the unused materials and then taken down from the site to the main Balfour Kilpatrick stores. The storeman refused to accept them and chased the author out of the stores claiming he was bringing uncontrolled objects into the stores and the auditor would pounce on them. This is indicative of how the quality system was perceived. It engendered a feeling of mistrust and resentment, which at best created indifference to all quality issues and at worst an active hatred of all attempts at quality improvement. As regards the uncontrolled stores it was discovered that the jointing supervisor had a secret store where it was ‘safe’ to store the ‘goods’ brought in from site!

8.9 Investigating the pertinence of the Quality System at Balfour Kilpatrick

In accordance with the ISO9002 standard Balfour Kilpatrick have followed the typical structure of quality management system documentation, which is illustrated in both quality, and project management texts as compared in Figure 8.5. Converting this diagram into Table 8.1 highlights the correlation between the two textbook systems and Balfour Kilpatrick's implemented system.

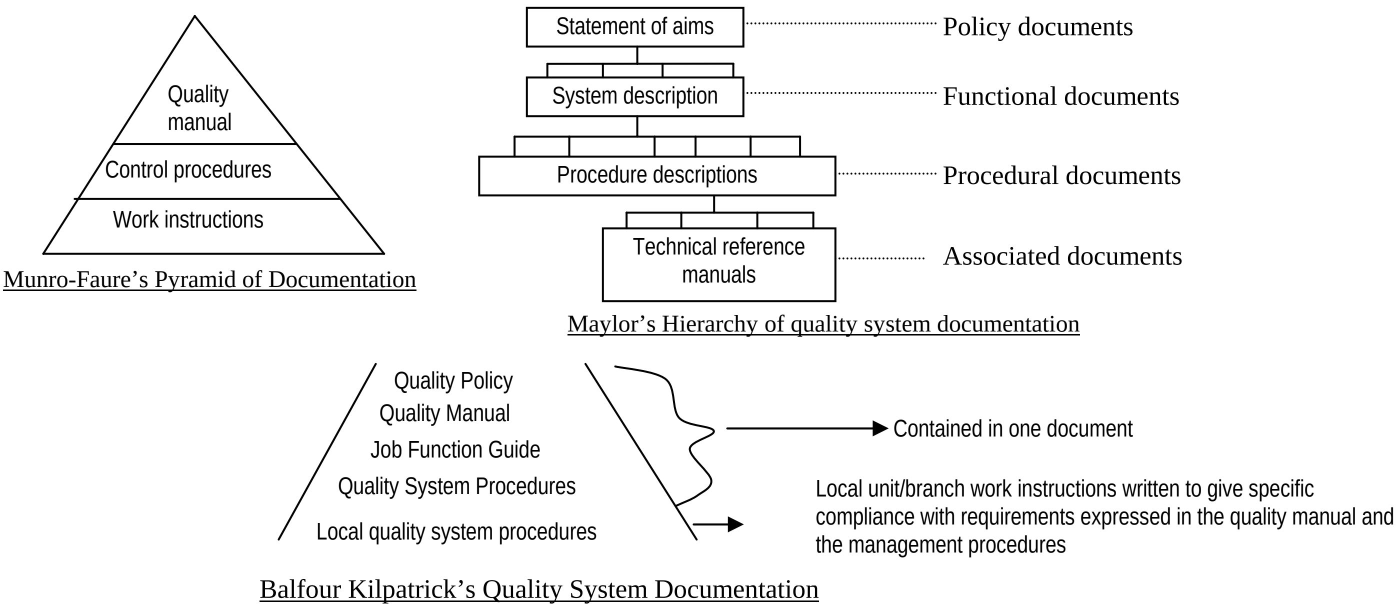

Figure 8.5 Comparing quality management text, project management text and a Companies quality system documentation

The importance of the documentation in the ISO9002 quality system is continually highlighted, therefore the following summary outlines the make up and meanings of the quality documentation in a quality system using the case study company Balfour Kilpatrick's documentation as an example.

Table 8.1 Comparison of quality nomenclatures

Munro-Faure (Pyramid of Documentation)[12]	Maylor's (Hierarchy of quality system documentation)[13]	Balfour Kilpatrick (Quality system documentation)[14]
Quality policy	Statement of Aims	Quality Policy
Quality manual	System description Procedure descriptions	Quality Manual Job Function Guide[v] Quality System Procedures
Work Instructions	Technical reference manuals	Local quality system procedures (including the quality plan)

8.9.1 The Quality Policy

This is the company's stated aims and objectives with respect to quality, how quality shall be managed, what quality systems will be applied and a commitment to allocating bespoke quality personnel. Some organisations augment this with a 'mission statement', which is promoted to the workforce and customers as a visible motto of what they want to achieve. The Quality Policy is usually endorsed by the head of the organisation to illustrate the idea that quality has to be driven 'from the top down'. (Although a senior quality manager at Balfour Kilpatrick believed that it should be from the bottom up! Implying that the quality problems were not predominately at the frontline.) Balfour Kilpatrick's Quality Policy is shown in Appendix No.4.

8.9.2 Quality Manual

This document contains the main themes and procedures of the quality management system. It mimics and cross references to the ISO9002 standard, applying all the ISO 90002 sections to each facet of the organisation. Appendix No 4 shows the contents page of the Balfour

[v] This describes who in the organisation should carry out the different tasks relating to the quality system, it is a good example of the ISO9000's standards need for demarcation and its assumption of that personnel have well defined parameters of work.

Kilpatrick quality manual, and the following is an excerpt from Section 5 Quality System and Quality Planning[15]:

> "This Manual sets out the directions for achievement of the required quality standards.
>
> It is supported by procedures and instructions, and all personnel should make themselves familiar with those procedures, which are applicable to their own department, and those for other departments where they affect their own work.
>
> In order to meet the requirements of any order or contract, specific quality plans will be produced which may take into account customers wishes regarding approval of them and any other documentation. In-house verification of activities is ensured by operator responsibility for quality, supported by inspections, tests, and audits in accordance with applicable quality plans, procedures and customer requirements.
>
> Balfour Kilpatrick Limited Transmission & Cabling Division Management will review the quality manual and system in accordance with Balfour Kilpatrick Transmission and Cabling Division, Cabling Operations Quality System Procedure No.1."

In its introduction the quality manual describes the organisation of Balfour Kilpatrick Ltd Transmission and Cabling Division, and defines the procedures for the maintenance of the quality management system relating to their cabling operations. This quality manual is partly reproduced in Appendix No.4. It also describes how the system is designed to comply with the requirements of ISO9002. The language used in the quality manual is vague and generic and it is obviously transferable to other divisions in the company. This is seen as acceptable by Waller et. al[16] to implement the quality management system for one part (or group) of the organisation, then incorporate it throughout. This acceptance to make the quality system transferable is perhaps indicative of the way in which quality systems made their transition from manufacturing to other industries.

8.9.3 Transplanting the Quality Management System

8.9.3.1 Commercial Advantage?

At Balfour Kilpatrick a recent re-organization (one of many) merged the overhead line and the cabling businesses. The overhead line department in Scotland had to be included within the scope of the quality management system ISO9002 certification. According to the Balfour Kilpatrick quality department (based in Birmingham and primarily involved in the cabling business) the need for this third party certification is ‘so that the division is not placed at a commercial disadvantage by the absence of such certification.’ No evidence was presented as to what this commercial disadvantage was. Which is unusual because the overhead line department in Scotland had increased its workforce approximately fourfold to 160 in the last three years with projects throughout the UK. In the course of this research it was hoped to do a comparison of before and after the implementation of ISO9002 at the overhead line business, but due to the various re-organisations at Balfour Kilpatrick, bringing this part of the organization into the quality system was not a high priority. The feeling of the overhead line personnel probably compounded this, why implement a system that has not been requested by the customer?

8.9.3.2 Transferring the Cost of Quality

The main customers of the overhead line unit were Scottish Hydro Electric and Scottish Power, which according to the overhead line manager had moved the responsibility and cost of quality assurance onto them anyway. In the past on the completion of an overhead line project the Hydro Board would use their personnel to check the quality of the line. Now Balfour Kilpatrick has to check the line, at no extra cost to Scottish Hydro Electric. A demonstration of the cost and responsibility of quality being transferred from the purchaser to the supplier. The proposed ISO9002 quality system that was going to be implemented, in theory, would reduce the need to check completed overhead lines, because the line will be erected using documented procedures that would have been a product of the quality system which also aimed to improve operational processes. In reality will it not be cheaper and more efficient just to carry out the quality inspections and rectify any problems found? Overhead lines often ‘settle’ after erection requiring some remedial work to be carried out.

8.9.4 Demand for the Standard and the vagaries of the market

Is there a demand by the customer for the ISO standard? As stated the Balfour Kilpatrick overhead line unit at Stirling have increased their business dramatically over the last two to three years and have been in operation in Scotland for decades. This is not related to any dramatic change in operations, it is the vagaries of the marketplace that as always, have determined the fortunes of subcontractors like Balfour Kilpatrick. At that time Balfour Kilpatrick’s overhead line unit was doing well due to the investment in overhead lines by the utility companies. This was precipitated by the electricity regulator, to make up for the lack of investment in the electricity distribution network prior to and following privatisation. These favourable conditions are always finite, therefore Balfour Kilpatrick have always ensured that their relationship with the customer has always been a close one. In conjunction with Scottish Hydro, Balfour Kilpatrick have been experimenting with the New Engineering Contract (NEC) a form of contract which has been developed to reduce and prevent conflicts between customer and supplier. This is described in greater detail in Chapter 11, Section 11.5.3.2.

8.9.4.1 Competition

In Scotland there are three or four dominant overhead line subcontractors, which is a situation that the electricity boards are, on the whole, content with. It is very seldom that one subcontractor is allowed to dominate the marketplace; therefore any quality system would have to improve the operational aspects of the unit significantly to produce some commercial advantage. It will be interesting to see if implementing ISO9002 will contribute to the operational running of overhead line projects and increase Balfour Kilpatrick's market share by giving it more commercial advantage with its customers.

The quality manual is designed for the managerial functions in the organisation, which may account for the generic terms used, but it is written as if all personnel in the organisation have access to it. In the project in this case study the quality assurance office decided not to bother issuing a quality manual to the site as the project engineer was only there on a short-term contract. Although the contract was not a particularly unusual project it seemed shortsighted to assume that the project engineer would be abreast of the latest technical and commercial developments in the organization. Five months after the completion of the project the author received a copy of the quality manual. In retrospect this omission did not make any difference either to the project success and more importantly to the customer. This raises important questions as to the purpose behind the quality manual and indeed the implemented quality system, and too who was it important. If the project did not miss the contribution of the quality manual, or if the organization thought it was unnecessary, what was its purpose? Certainly it is needed by the quality personnel to carry out the required quality audits and documentation to guarantee certification to ISO9002, but does that contribute to successful project management?

8.9.5 The Quality Plan

This document which was detailed in the Balfour Kilpatrick Quality manual was the only project specific documentation of the quality management system and as such was the main reference document for any information regarding specific quality requirements as related to the project at Walpole. This was to ensure that Balfour Kilpatrick met their obligations as regards to continued registration as an ISO 9002 registered company and more importantly it was meant to meet the needs of the customers National Grid and BICC Supertension Cables Ltd.

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1.0 SCOPE OF CONTRACT

1.1 GENERAL

Installation of 132kV circuit at NGC Walpole site between existing tower (ODSE) and existing substation (ODSE)

1.2 SPECIAL REQUIREMENTS

In addition to all statutory requirements Balfour Kilpatrick Procedures and Work Instructions, the contracts shall be carried out in accordance with N.G.C Tender Document PTS/UN(S)/C7037, Sub-station and Safety Requirements for contracts on N.G.C. premises NS/E/2.9 (April 1990), NGC Safety Rules (1995) and the National Safety Code of Practice NS MPP2 (Management of Health and Safety Aspects of Contracts).

Figure 8.5 Scope of Contract

8.9.6 The Contents of the Quality Plan

8.9.6.1 Issue Status Record

Each page (or sheet) in the Quality Plan was assigned a unique number and issue status letter. A list of these was included at the start of the quality plan. This issue status record was to ensure the latest correct documented procedure was being adhered to and recorded.

8.9.6.2 Scope of the work

The scope of the work gave a brief synopsis of the project objectives, outlined the relevant external documentation and regulations that were to be adhered to by the project personnel and supplied a copy of the most relevant project programme. Being directed to the programme was also useful, considering that certain members of the project team may be seeing this just prior to the commencement of the project (as was the case for the engineer and the foreman). In the Walpole project the scope of the works was very straightforward with very few special requirements as shown in the example sheet reproduced from the Quality Plan[17] Figure 8.5**.** The site engineer used this part of the plan to familiarise himself with the site and any technical aspects of the project that could difficult to achieve.

8.9.6.3 Organization

This section outlined the responsibilities of the Balfour Kilpatrick contract staff, their position in the organisational structure of the company and to whom they were answerable. Again this appeared to be a useful section of the quality plan, as it left no ambiguity as to who should be doing what. Although it did highlight the increasing documentation that was going to be needed for the quality system, the responsibility for which would fall on the project engineer. It is interesting to note that there was no mention of any of the other personnel involved on the project, the foreman, jointers or civil contractors who were integral

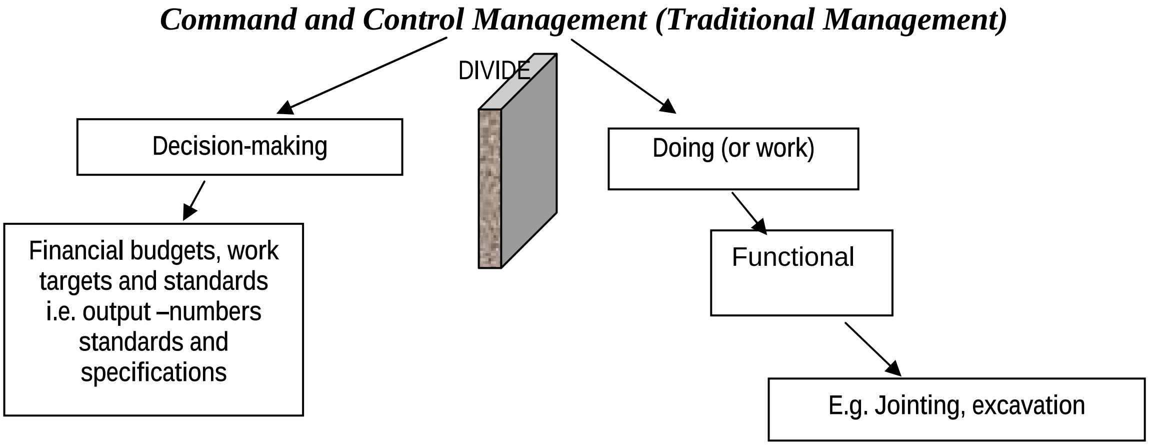

Figure 8.6 The divide created by 'Command and Control Management'

parts of the project activity. The division of the management role and the actual execution of the project activities are something that Seddon[18] in his dissection of the ISO9000 standards believes is one of the many flaws in this type of quality system. He describes this as 'command and control' thinking which is the mainstay of current management practice and philosophy and must changed to a systems approach to allow an organization's 'creative anarchy' to be unleashed. Figure 8.6 illustrates the concept behind this 'command and control' philosophy.

8.9.6.4 Documentation

The net effect of a quality management system's documentation is to implement a system of paper trails, which purports to contribute to a system that prevents and detects any defects or non-conformances before they reach the customer. This is defined as traceability that is ostensibly a quality control based function. Stebbing[19] (1990) defines the parameters for a system for tracability as:

> "a) The traceability of materials, components and equipment, which may contribute to an accident resulting in loss of life, injury or loss of production.
>
> b) The establishment, with certainty, of the number and location of all materials, components and equipment items, which, if found to be defective, should be replaced.
>
> c) The data and information necessary for the preparation of the most efficient maintenance procedures.
>
> d) The data and information necessary for generating future design modifications and improvements.
>
> The extent of traceability to be applied to materials, components and equipment should be specified in the contract documents and should be governed by its application and potential contribution to a safety or loss of production related incident."

The reasoning and ethos behind these categories cannot be faulted; already organizations by law have to have strict records of equipment and materials that have a direct effect on Health and Safety. At Walpole all the scaffolding, lifting equipment, pulleys and winches had to have relevant up to date safety certification. Scaffolding was checked regularly to ensure its continued integrity.

Part (d) is the one of the illusive feedback loops that project management organizations need, to learn, to improve and to profit. The obvious example (again!) is the platform at the tower where a combination of poorly executed processes almost led to a serious accident. Statutory accident books were reluctantly filled in, repairs were swiftly made, and some personnel at National Grid were exploring the process of recrimination. Yet the need to prevent this happening again appeared to be a very low priority. Responsibility (or blame) had to be devolved to someone before anything else. The collection of data, analysis of why something went wrong did not appear to matter. Mayler[20] recognises this as one of the problems in 'the pure project organisation' that typifies the construction industry:

> "…where there are significant events occurring in a project, it is very hard for the lessons of these to be passed on to future projects as the people who have carried out the 'do' part of the project are not around for the 'review' and 'act' part. They cannot benefit therefore from the review process. Progress in improving work methods is likely to be slower."

The following sections provide a list of all the documents, specifications and procedures that could be used on the contract.

8.9.6.5 The Quality Assurance Status Chart

The Quality Assurance Status Chart was a status chart to monitor which documents had been filled out in accordance with the quality system. The chart had to be completed after each procedure was carried out and documented i.e. documentation for documentation! To those on site taking the documentation to this level appeared to be a pointless monitoring exercise. It appeared as if the project engineer needed this visual reminder to tell him that certain pro forma had to be filled in at certain times. Yet the visiting quality representative placed great importance on the completion of this chart. This emphasis on secondary documents being evidence of the implementation of a quality system was not seen as a particularly good indictment of the quality system. Unfortunately, this was common throughout the system and other project personnel (on other projects) also expressed grave reservations about its validity.

8.9.6.6 Balfour Kilpatrick Safety Manual

Although late to arrive this was one manual that was available on site. It documented who was responsible for the various Health and Safety procedures around the project including what statutory requirements were needed to comply with current legislation. The success of this document is based on the compulsory nature of the legislation now in force and a growing awareness by organisations of their obligations to make their employees aware of the dangers inherent in the industry.

8.9.6.7 Jointing Guidelines and Advice

These were the technical documents used to joint the cables. Formerly known as Jointing Instructions the name change was in order to devolve responsibility away from the BICC factory (who issue the documents) onto the Balfour Kilpatrick jointers. This type of change although superficially trivial does undermine the supplier – customer relationship. It gives the impression that once the goods (in this case joints, sealing end terminations and the cable itself) leave the factory there is no comeback i.e. they have left the factory in perfect condition and it is the site personnel that have damaged them, assembled them wrong etc.

8.9.6.8 Contract and Special Construction Drawings

These were the bulk of the technical drawings on site including cable routes, trench cross sections, special constructions, safe working areas in the live substation, cable cross sections and make up, bonding and earthing schemes and any sketches that were unique to the project i.e. one off fabrications. This was one area where the implementation of a rigid documentation policy was genuinely useful. The frequent update and changing of drawings and methods can lead to expensive mistakes. The Walpole contract had two unusual (special) constructions to carry out. The first was building a ‘cable bridge’ over an existing live cable route in the substation (as shown in Plate 8.4).

The second was the erection of steel cable ladders from the base of the tower to the platform 9 metres above. As this was the second circuit to be done there already existed drawings from the last contract. National Grid had carried out the design and they had also commissioned the manufacture of the steelwork from a steel fabrication company in Scotland. The first circuit’s steelwork had been a disaster. The manufacturers had not interpreted the drawings correctly and the steelwork that had been sent to site had to be altered or scrapped. Further drawings were done and the cable ladders were finally erected. This process generated a large number of drawings (from National Grid) that were on site and had to be catalogued. The second circuit had its own set of steelwork drawings that were to be used to check the finished product. This was essential, as the poor standard of the platform appeared to be indicative of the level of quality applied by both National Grids own steel erecting team and the steel fabrication company. Having a documented system for receiving and transferring drawings was essential, to ensure the latest revision was being used, to prove that the finished product did or (as in this case) did not meet the required specification. As the steelwork required extensive alteration on site and Balfour Kilpatrick had to charge for this, proof had to be produced to convince the project manager of our case.

The project manager from National Grid acknowledged the poor quality of both the design and the fabrication of the cable ladders, although he was keen that it was altered on site 'as cheaply as possible'. When Balfour Kilpatrick submitted its claim there still was a dispute as to the time involved in carrying out the alterations. Where claims like this are open to dispute, having a documented drawing system in place does have merits. A proviso to this is having a system that allows some flexibility. After the incident at the platform described in the last chapter, some minor items of steelwork had to be quickly designed and fabricated. The site engineer in conjunction with the draughtsman at head office did this, producing sketches and getting the items fabricated locally. The relevant documentation followed later. Criticisms of the drawing system include the length of time that documents can take to be approved. Frequently, provisional drawings (or programmes) had to be used on site because the final 'quality approved' version had not been processed through the office administrative system.

8.9.7 Balfour Kilpatrick Engineering Instruction Letters

These had been in existence with the company for a long time and were perhaps the only useful piece of relevant feedback from projects that existed in the organization. These 'letters' were information on new techniques or incidents that had happened on sites throughout the country. Each qualified engineer was on a mailing list for these instruction letters that were issued by the Chief Engineer of the company. New methods of doing things and amendments to existing letters were distributed when necessary. The feedback consisted of recommendations of how to avoid repeating the errors of a particular project activity, or the latest thinking behind a certain process.

8.9.7.1 New technology new problems

When a project involves relatively new technology or materials, (in this case cross-linked polythene cables), the execution of these projects may uncover previously unforeseen problems. With the cross-linked polythene cables it was discovered that they emit gas from the resin insulation after being cut, in preparation for jointing. This type of cable is also very susceptible to the ingress of water, which can render the cable inoperable. Both of these problems were discovered on projects. The simple flooding of a joint bay caused the ingress of water incident, which led to a multimillion-pound lawsuit being brought on the company by a client. Health and Safety is also a prime topic for the engineering instruction letters that can flag potential dangers experienced in one project as an example to others. The example of the platform design at Walpole could have come under this category.

8.9.7.2 Practical and useful

The simplicity of the system added to its usefulness. Apart from returning an acknowledgements slip, there was no more action to be taken by the engineer, other than digesting the information and relating it to the circumstances in his projects. The communication of what went wrong in other areas was not an indictment of the personnel on that project, it was seen as a way of preventing and informing to promote good practise, and ultimately increase project success. Perhaps due to the technical nature of the information, the emphasis was more on knowledge improvement than on blame. In analysing this simple form of feedback it is interesting to note that the quality system did not appear to have an equivalent 'useful' form of feedback system that contributed to the knowledge of the project personnel. This database of shared knowledge was technical in nature, and built up into a useful reference document for new and experienced engineers alike.

It seems too simplistic to suggest that something as simple as a database could produce tangible, useful (generic) project feedback, but possibly for an organization like Balfour Kilpatrick this would be launching point for a organization wide knowledge base. What form and media this would use is ultimately dependent on the investment by the company, but Information Systems in conjunction with the existing technology they currently possess could provide the system they require as discussed in Appendix No.5.

<u>Estimated cost of using the quality system at Walpole</u>
As project engineer at Walpole I would conservatively estimate that it would take at least one day a week to carry out all the necessary quality procedures – primarily filling out the quality documentation – to meet the requirements of the existing quality system. The estimated cost £300/week (the cost to the customer for one days use of a project engineer) plus the loss in productivity to the project whilst this is being carried out.
The argument against this is that the quality system should be saving costs, as it will be continuously improving the methods of working and eliminating waste. Unfortunately this was not the case, the quality system at Balfour Kilpatrick did not appear to be geared to do either.

The West Ham 400kV Quad Booster project mentioned earlier in this chapter was a similar case involving more unproductive work in maintaining the quality system

8.9.8 Past Experience

In 1987 on a large supertension contract in Glasgow[21], the author witnessed the beginnings of quality assurance at Balfour Kilpatrick (then known as BICC Construction). The quality engineer implementing the quality system explained that by having standard procedures and systems throughout the company there would be less chance for error, e.g. wrong drawings would not be issued, materials would be correctly ordered, technical measurements would be checked etc. The other advantage was that once the system had been implemented company wide, the standardisation would allow personnel to integrate quickly into any site they were sent to. This appeared to make sense; even the validity of filling out up to 200 ‘pro formas’ was not questioned. The actual completion of the quality documentation always happened long after the event and usually prior to the threat of an audit. The fact was that none of the project staff on site had the time to fill the additional quality documentation. Like most projects in the construction industry there was seldom a surfeit of manpower and when faced with this extra workload, personnel did what was needed to comply with the audits. This meant frantic activity prior to the audits:

- Forms were filled out retrospectively.
- The site would be rearranged to conform to what was believed was the required standard.
- Materials that did not have relevant quality documentation (which was sometimes inevitable) were hidden.
- Oil pressure gauges had ‘for indication only’ labels put on them; vacuum gauges with no calibration certificates were secreted away (or frantic calls to BICC in Erith demanding the certificates to be sent up were made).
- All documentation was filled in whether factual or not.

Whilst this ‘work’ was carried out the normal project activities had to carry on (the quality system and the project activities in reality did not correspond). The increased tension this produced in all the staff on the project was certainly detrimental to the project as a whole. Its subsequent effect on what could be called the ‘real’ or ‘tangible’ quality on the job i.e. successfully carrying out each project activity in a ‘professional’ manner, with the ultimate aim of complete project success, was only negative. This has parallels with case study by Abdel Hamid described in Chapter 5, section 5.23, 5.25 where the quality system implemented required such a high degree of maintenance from the project managers, that it had a detrimental effect on the project staff and the project itself. The irony of this scenario is that the system has evolved within the organization, albeit after clients imposed the need for ISO9000.

8.9.9 Identifying the underlying interrelationships by using a system archetype

In Chapter 5, section 5.3.3 the concept of 'system archetypes' was introduced. It was

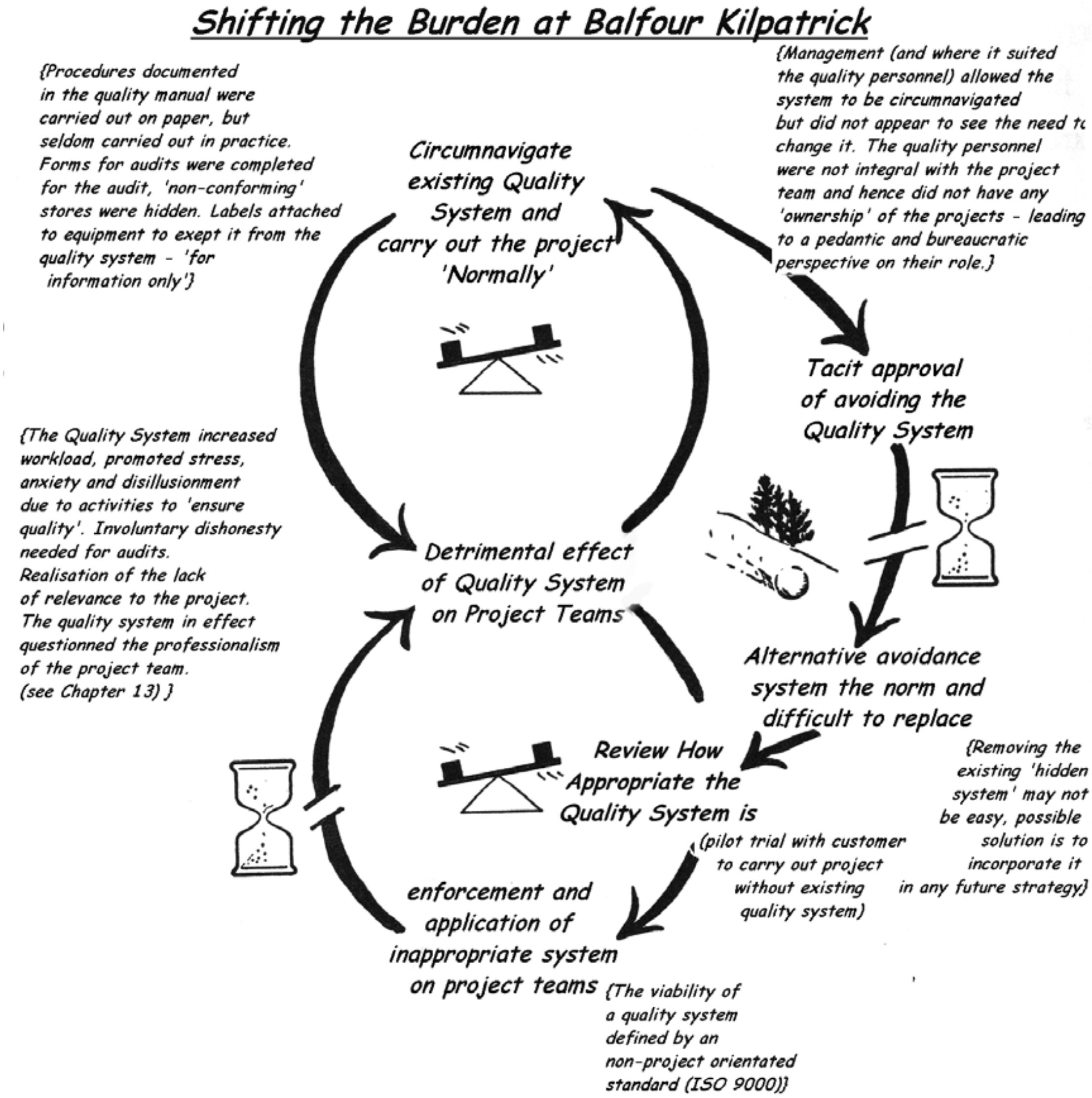

Figure 8.7 **Applying the 'Shifting the Burden' archetype to Balfour Kilpatrick**

apparent when studying these archetypes (after the case study had been created) that there was strong parallels with what takes place in Balfour Kilpatrick in particular Senge's[22] 'Shifting the Burden' archetype (Chapter 5, figures 5.6a) and b)). Adapting and applying the 'Shifting the Burden' system archetype to Balfour Kilpatrick is shown in Figure 8.7. The rationale behind applying this to Balfour Kilpatrick is as follows. The 'problem symptom' is the detrimental effect of the ISO9002 quality system on project teams, this in turn leads to the project personnel circumnavigating the system (the 'symptomatic solution'). The 'side effect' or 'addiction' is the tacit approval of this avoidance of the quality system and the adoption of this way of working, i.e. two parallel systems. The 'root problem' is the enforcement and application of an inappropriate quality system (ISO9002) on the project team.

8.10 Relating systemic metaphors to the case study

In addition to the introduction of systems archetypes, Chapter 5 also introduced systemic metaphors from Flood and Jackson[23]. Relating the metaphors to this case study, the machine metaphor closely resembled the quality system that has been used as a 'quality veneer' at Balfour Kilpatrick, concentrating on the bureaucracy and efficiency of individual parts. The

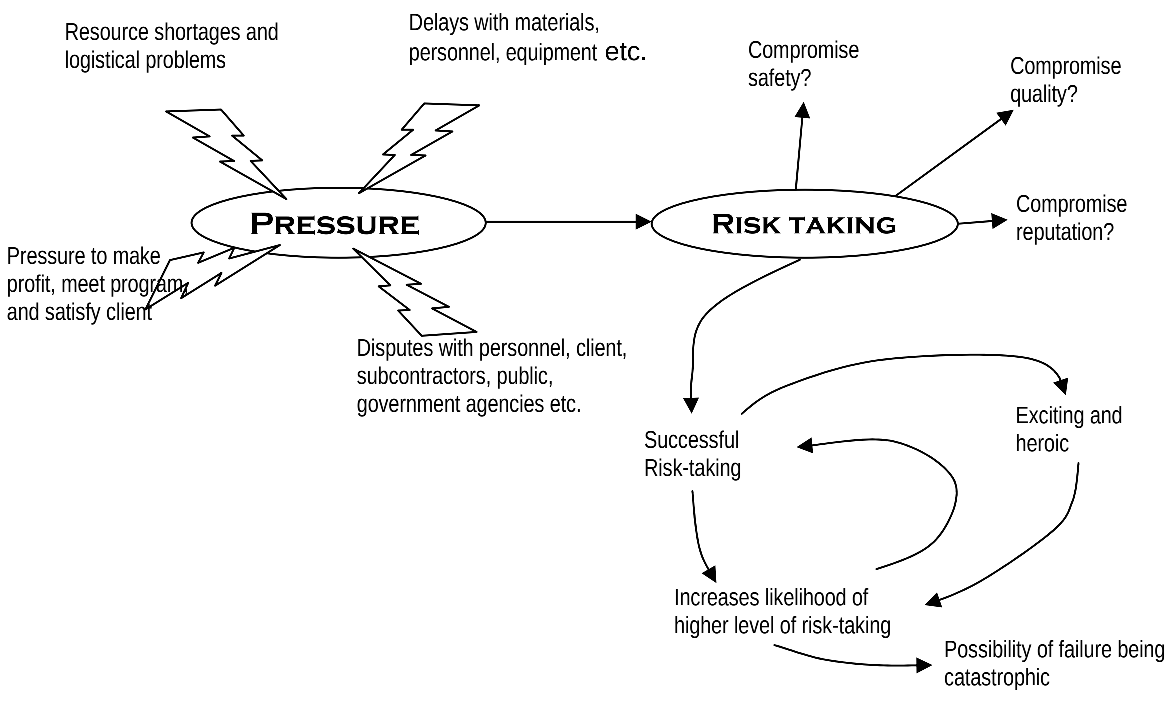

Figure 8.8 Contributors to risk in a project environment

political metaphor is also in evidence because of the subterfuge adopted to circumnavigate the quality system. Again, this relates to Weber's theories of bureaucracy first introduced in Chapter 3, Section 3.4.1.1. The emphasis on the importance of continuing to be registered to the ISO9000 quality standard produces conflicts of interest that usually result in an alternative 'underground' solution being found. Quality personnel in effect have the political advantage of senior management backing without the responsibility or ownership of an individual project. This allows them to become 'devils advocates' a role that can be a prerequisite to conflict.

The 'culture' metaphor was also apparent in Balfour Kilpatrick and in the previous case study in Chapter 7, CRC. These 'unspoken but familiar ways of thinking and acting' are difficult to quantify and elaborate on. The author's perception of the project 'culture' that existed in both these organizations is based on his observations and his own mental models, which themselves have been based on both experience (or pre-understanding) and research of the topic. They are also not unique to project management:

- Underlying desire to finish the project despite any difficulties, this can lead to risk taking which appears to be another integral part of project management.
- The ability to adapt to a change in the environment.
- Flatter organizational structure with greater levels of communication between frontline and management.
- Adversarial approach in some circumstances contributed to performance breakdown.
- Ownership of project can produce autocratic behaviour unless dissipated by other project team members.
- Risk culture akin to 'heroism' in Senge example. Figure 8.8 is an attempt by the author to

illustrate his ideas regarding the contributors to risk. The diagram is incomplete in that the increased risks will feedback to create more pressure. A ‘positive reinforcing loop’.

8.10.1 Identifying ‘quality’ mental models

Of the mental models identified by Roberts and Thomson[24] in Chapter 5, Section 5.6.2, the most identifiable mental model at Balfour Kilpatrick is Quality Control, where a system has been implemented that endeavours to record activities and create accountability through documented procedures. The CRC case study in the previous chapter also has some similarities to the ‘quality control’ mental model despite not having any formal quality assurance system due to the autocratic nature of the management. Roberts et al[22], elaborates the quality control mental model by describing the behaviour of managers of this mental model as ‘more likely to look over people’s shoulders to measure and assess their performance, making all important decisions themselves.’

At CRC this autocratic behaviour was quite noticeable and although its origins could be traced to the limited number of personnel available to carry out work, it was possibly sustained more than necessary, indeed it could have been a contributory factor in the demise of the company. With both CRC and BK the Status Quo mental model could also be relevant but the mental model would have to be modified. The mental model relating to quality at BK could be described as:

> **Notional (or perceived) quality control with existing status quo (business as usual):** Implementing a program of quality control/assurance to gain access to markets, whilst executing projects and management of projects in the organizations historical manner.

8.10.2 Relating ‘Learning Breakdown’ to the case study

From the examples of Kim’s[25] ‘learning breakdown’ discussed in Chapter 5, Section 5.7.1, this case study correlates closest with ‘fragmented learning’. The experience and learning gathered by each individual of the project team during the cabling project was dissipated once the project had ended. The organization gained little or no long-term benefit from the project. The project team were subjected to a variety of experiences and undoubtedly each would have their own perception of what took place, and how important it was to the success of the project. Regardless of this the information could have been collated, then disseminated in the organization in an attempt to enhance future projects. To do this, would certainly need an alteration to the existing shared mental models in the company (and industry-wide mental models) i.e. an alteration to the ‘culture metaphor’ outlined in Chapter 5, Table 5.1. At present a willingness to share difficult experiences, failed activities and recognising poor practice is an anathema to the organization. These things are usually discussed in a social setting, which is useful and enjoyable, although hardly beneficial to the organization! If this blame free atmosphere could be transplanted into an organizational setting perhaps it would be more conducive to altering shared mental models. Having a ‘knowledge conduit’ like this may also reduce ‘superficial learning’ by providing a reason for individuals to examine what they do and why. The line between ‘crisis management’ and project management can often be a fine one due to commercial pressures, to capture ideas that may improve (however innocuous they appear) the project can be vital.

8.10.3 Relating System Dynamics to the case study

Figure 8.9 is an adaptation of the system dynamics template Administrative Main Chain[26], which in its generic form is used to depict the sequence of events in an administrative process. The model attempts to emulate the existing industry standard ISO9000 quality system administrative process in use at companies like Balfour Kilpatrick. Using the template in this fashion does give some insight into the way in which a model has to be constructed. It also emphasises the complexity of the order and way in which tasks are carried out in a project and the interdependencies that exist. There must be assumptions in the model as to the manner in which the administrative process is carried out, i.e. there is a degree of

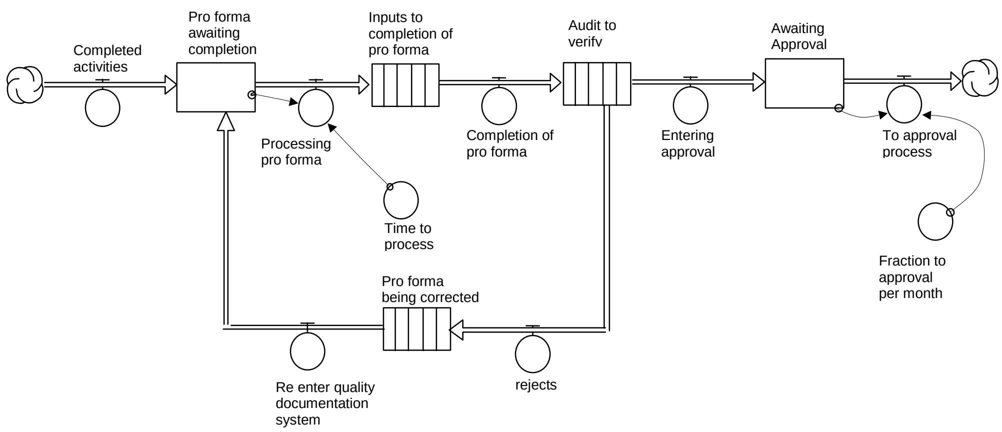

Figure 8.9 The quality system administrative process at Balfour Kilpatrick

repetition and that the framework illustrated matches that used. The benefit of this type of model is its dynamic ability; the process is triggered by a completed activity. The working pattern of the project staff involved in this 'administrative process' would also have a bearing on the various areas of the model. In the Balfour Kilpatrick case study a large volume of administration caused by the quality system coincided with the most important activities of the project, for example the cable installation, which had to take priority.

The main chain infrastructure of particular interest was the 'Sequential Work Flow Main

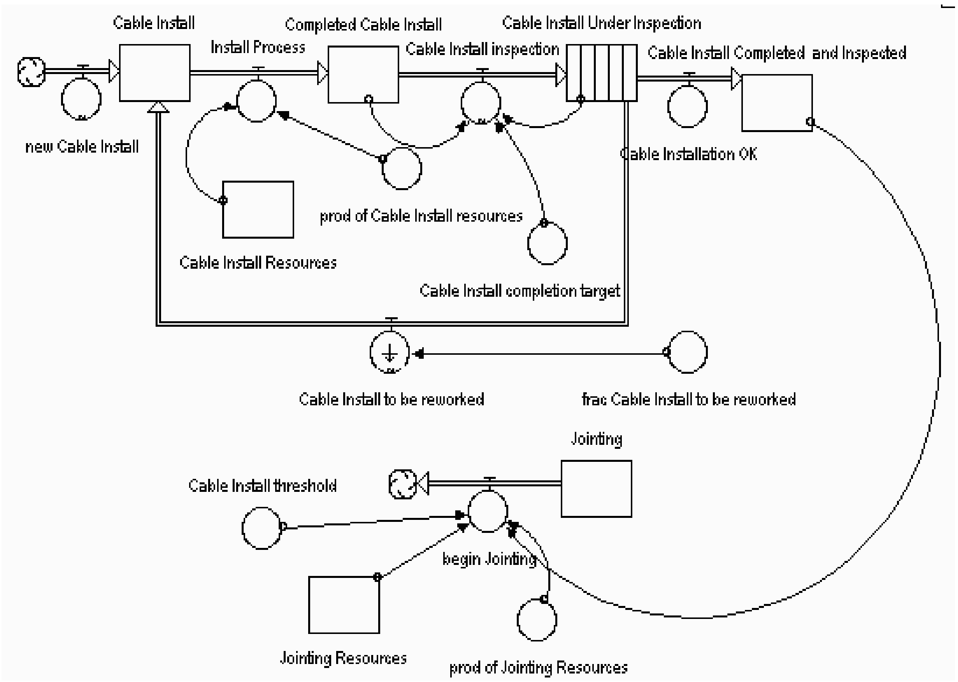

Figure 8.10 The Work flow Main Chain Infrastructure template applied to Balfour Kilpatrick

Chain', which represents 'a generic representation of a sequential work completion process'[27]. This is a type of generic project management template, which can be used to simulate project management issues. Again, like the previous template an attempt has been

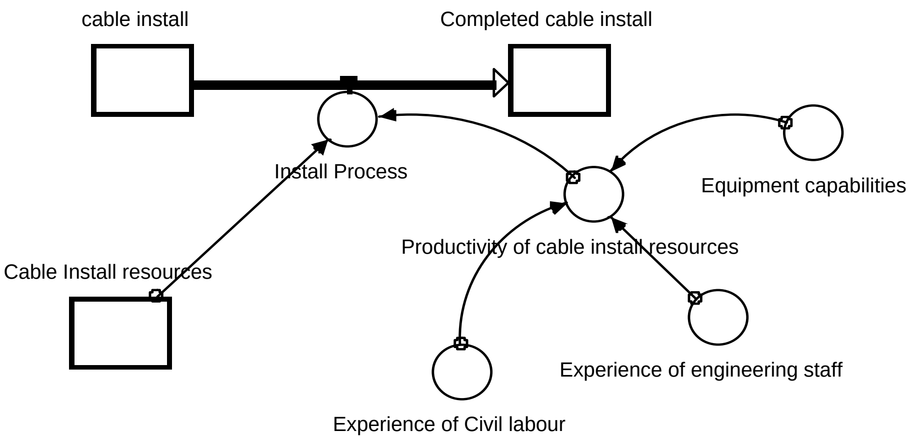

Figure 8.11 Expanding the install process

made as shown in Figure 8.11 to apply the template to this case study. What the model illustrates is the installation of a cable followed by the jointing of the cable. This example also illustrates the modularity of the system dynamics technique, where parts of the organization can be modelled in isolation which can then contributed to the larger picture For example, in this case study there was a number of natural ‘boundaries’ that could have been used to build up a system dynamics model. The reason for the project was the need by National Grid to extend a substation to cater for the input of energy from a new power station being built nearby. The reasons for building the power station did not directly affect the cable project other than its conception. Certainly if a model was constructed at a higher level then it could take into account factors like, government policy, advances in technology, finance, etc.

8.10.3.1 Using System Dynamics to identify strategic capability

Another example of where system dynamics could be used is at a strategic level. At Balfour Kilpatrick’s overhead line department in Stirling, preparations are being made by the business development manager, to investigate possible markets that have up till now been out with their operational boundary. An organizational restructuring which has combined the overhead line division and the underground cabling divisions has brought this about. The market for electricity has undergone a radical change, with Regional Electricity Companies (REC’s) being able to supply power nation wide. Balfour Kilpatrick will have to capitalise on this to remain competitive. The combination of the two types of cabling overhead and underground has been tried before, both times with little success. The notion that there are common generic properties within both divisions is always seen as a way in which to cut costs (the quality system being a case in point). If the same approach is taken again, it is likely to fail. Instead of seeing the amalgamation as a cost cutting exercise, it should perhaps concentrate on providing a turn key solution for customers cabling needs and exchanging ideas of best practice which are genuinely cross-discipline. As a longer-term research project it would be useful to use system dynamics to model BK's strategy for this new combined division, to gauge its chances of success. Indeed SD is perhaps better suited to a high level strategic organizational problem rather than operational 'coalface' issues.

8.11 Conclusions

The main purpose of the BK case study was to fulfil the first primary objective of this research, '*To investigate the pertinence of the models implied by existing quality initiatives in a real project environment and their possible contribution to future project success'*. In common with the CRC case study, the BK case study has been primarily exploratory, yet as discussed in Chapter 2, its role has been to determine the relevance of an existing quality system in a project environment providing evidence to refute or confirm the research's main hypothesis. The Balfour Kilpatrick case study has also provided an insight into the role of an industry standard quality system in a project environment. It was expected that as the type of project carried out by Balfour Kilpatrick was nearer to an operations management type model, that its projects would have been better suited to the ISO9002 quality system. This and the role of the system to foster continuous improvement were not valid. The type of data gathered was of questionable relevance, and what was gathered was not analysed. The remit of the quality engineers and quality department, did not include functional assistance e.g. pursuing errant suppliers, resolving disputes which seriously impact on project quality (e.g. Crossmores), carrying out investigations into the real reasons for activity or project failure. The incident with the tower platform, which was substandard, could have been investigated and recorded by the quality department then any recommendations and findings distributed throughout the organization. The quality system and personnel at Balfour Kilpatrick needed to be given a completely new direction, one that is focused on the activities that actually affect the quality of an activity in a project i.e. the outcomes of the process, not the process itself. The relevance of a ‘generic’ quality system like ISO9002 needs to be addressed, because as this case study illustrates it was not providing any tangible benefits. Balfour Kilpatrick’s project staff carried out the ‘quality activities’ just to comply with the standard, not for the benefit of the project, which is an illogical waste of Balfour Kilpatrick’s most important and limited resource – their staff. In conclusion, the role of the implemented quality system as a vehicle to provide information and guidance to facilitate future project success was untenable.

As with the previous case study, Table 8.1 provides a cross reference guide to the areas from the Balfour Kilpatrick case study that are relevant to the objectives of the research and to the general debate of the role of quality in projects. Summarizing these areas from this case study are as follows:

- The examination of the usefulness of the formal quality system used on this project and its ability to provide a feedback channel to promote future project success.
- Identifying the project orientated behaviour patterns (systems archetypes) that were present in this case study.
- Balfour Kilpatrick’s relationship with National Grid had been a long-standing one, and at an operational level it provided a relatively stable background with which to implement the project.
- Paradoxically, Balfour Kilpatrick’s relationship with its subcontractor was fraught with problems the root of which appeared to be a guaranteed lack of continuity of work, with cost being the key driver in determining who wins the contract.
- The risk assessment process on this project, and its impact on project quality and the

theory behind the CDM legislation.

- With evidence of cost being used as a key driver on this project, the LAS case study provides the details of what effect this has on project quality.

Table 8. 1 Cross Reference Table

Balfour Kilpatrick experience	**Subsection**	**Relevance to research objectives and the general debate of the role of quality in the management of projects**	**Chapter(s) and subsection(s)**
Impact of a recognised quality system and its use as a learning infrastructure	8.23, 8.25	The relevance of the implemented quality systems ISO9002. Investigating the pertinence of the industry standard quality system in a real project environment and its contribution to project success (1^{st} Objective)	Chapter 8, Sections 8.7.1.4, 8.10 and 8.12 Chapter 11, Section 11.3.1.3
Examples of System Thinking ‘archetype behaviour’	8.22.2	Example of Systems Thinking ‘archetype behaviour and associated mental models’	Chapter 9, Sections 9.3.3.1, 9.6.2
Relationship with customer - National Grid	8.6, 5.6.4	Example of successful client/customer relationship and single source suppliers	Chapter 8, Section 8.3.4.1 Chapter 11, Section 11.5 Chapter 10, Section 10.8.5
Continuity of relationship with supplier Crossmores	8.8.3, 8.9, 8.22.1	How project quality is determined by supplier (contractor) relationships and single source suppliers	Chapter 8, Section 8.11 Chapter 11, Section 11.5.3 Chapter 12, Section 12.3.2
Risk assessment	8.24	CDM legislation, NEC and partnering and its impact on project quality	Chapter 11, Sections 11.4.1.1, 11.5.3 Appendix No.2
Cost as a driver in	8.22.3	The consequences of	Chapter 7, Section

Balfour Kilpatrick experience	**Subsection**	**Relevance to research objectives and the general debate of the role of quality in the management of projects**	**Chapter(s) and subsection(s)**
project decision-making		using cost as a key project driver as opposed to quality	7.2.9, 7.3.4.1
Design issues	8.20.1, 8.22.2, 8.22.3	The impact of design on project quality.	Chapter 11, Section 11.8.1.3

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[11] Munro-Faure, Lesley and Malcolm, (1993), *Implementing Total Quality Management*, FT Pitman, p.72.

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[18] Seddon, J., pp.57-59.

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[20] Maylor, H., p.118.

[21] This was a £3M contract to install two 275kV cable circuits into the centre of Glasgow. The circuits supplied approximately half of the city of Glasgow's electricity requirements.

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Chapter 9

Case Study No.3 db Houston Ltd.

9.1 Chapter Synopsis

This chapter examines the quality criteria, which affect the projects carried out by an information systems company. The company, db Houston Ltd, operates in an environment where change is rapid. This is attributable to changes in technology and the economics of the technology, which create rapid changes in the use of Information Systems (IT) by their clients. In addition, most of db Houston's business is allied to one main client group with the attendant risk that this involves. As with the other case studies, this case focuses on a company that carries out a number of short time-scale projects, which has the benefit of allowing the complete project life cycle to be studied. As noted in the CRC case study in Chapter 7, the role of quality in small firms has been rather ignored in the quality literature. A similar situation exists in the literature available on quality in project management. Boon and Ram[1] in an insightful article on quality, small firms and action research, highlight this point:

> "The role of quality in small firms is not particularly conspicuous within broader debates on the subject. The implicit message seems to be that quality in its various guises is applicable to all firms regardless of context."

A distinguishing feature of this case is that the company has an integral role in providing support once the project is completed. The quality of activities carried out at the installation/execution phase of the project is therefore crucial to prevent long-term costs and possible loss of customer confidence. The uniqueness of the projects carried out by the company is not immediately apparent but the physical installation of the network system is usually unique, as is the configuration of the interface between the existing hardware, software and the new system. However, compared to the other projects examined in this thesis db Houston's projects are arguable the least unique, with areas of their work more akin to operations management than project management. The quality of service that they provide post-project is an integral part of the project that they have initially executed. The life cycle of a db Houston project includes a large percentage of support, which can eventually lead to extensions, or revision of the original project. It is a similar project life-cycle to that of software development profiled by Hughes and Cotterell[2], where maintenance and support can also be viewed as a series of minor projects. The inclusion of maintenance and support in the project life-cycle allows this case study to examine the relevance of the service quality model SERQUAL developed by Parasuraman, Zeithaml and Berry[3] and whether it is appropriate in the context of a project. The case study also examines how db Houston, satisfies the projects sponsors 'real' needs as opposed to simply meeting the contract specification and how the project sponsor perceives the quality of the service that they receive. This will expand the debate about the three levels of quality in projects discussed earlier in the thesis, particularly the meeting of the specification laid down by the client and meeting the client's 'real' needs. Also examined are the possible benefits of creating a more procedure based quality system to deal with circumstances where an increasing workload and a fixed resource means that the chance of a project activity being poorly implemented are heightened in times of high demand.

9.1.1 Research approach

As with CRC Gabions and Balfour Kilpatrick, the opportunity for research at db Houston emerged as a consequence of work carried out for the company. Following and taking part in the company's projects meant that it was possible to witness which activities created the most significant impact on project quality. As a combined researcher/consultant, the approach to obtaining primary data from the companies researched was an open process where all parties were aware of the research being carried out. This is what Taylor and Bogdan[4] describe as an 'overt' approach. The fact that the management in many organizations are not always aware of the relevant academic theory (in this case quality) creates in the author's opinion a need for the researcher to clearly articulate what he or she is trying to achieve. If this is not done at the beginning of the project the researcher's/consultant's role is clearly disingenuous. Through the course of this research, the initial opportunity to access data arose principally from the author's role as a consultant. Therefore, the client organization often did not have complete cognisance of the topic being researched. The research element of the process, rather than being a hindrance to the operational role of the author in the project team, was often a chance for people in the organization to find out about the theory behind concepts like quality management, which in turn generated valuable data. With the three case studies carried out using the participant observation approach (CRC, BK and db Houston) there was not one occasion where the participants reacted negatively to the research process. The author believes that these discussions allowed the dual responsibilities required of the researcher outlined by Gummesson to be fulfilled[5]:

> "In the capacity of change agents and consultants, they work with the development of their own theoretical understanding and the reporting of the research to the academic community."

9.1.2 Small Businesses

Where it is required small businesses are not except from registration to ISO9000, although the costs involved in achieving and maintaining registration can be prohibitive which is a salient fact when 90% of British industry is still made up of companies employing less than 10 people (Waller et. all[6]). Enquiries were made to find out what it costs to gain certification to ISO9002 for a small business from an assessment company – Lloyd's Register Quality Assurance. The enquiries were based on a small computer company[i], which consisted of four personnel and primarily carried out the installation of PC network systems.

This particular assessment company charged a minimum fixed fee of £3,400(+vat), which covered a three-year certification process. This consisted of:

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[i] Permission was granted by db Houston Ltd to make enquiries on their behalf to the certification company

- A one day appraisal of the existing quality system (or existing systems).
- Followed by (6-8 weeks later) by a one-day assessment of the quality system.
- Four one-day surveillance visits spaced at nine monthly intervals.
- After three years the last surveillance visit is a full audit and certificate renewal, leading onto another three-year cycle.

The four surveillance visits (audits) would be targeted at different facets of the business, e.g. purchasing, design, or installation to ensure it was carrying out the requirements of the organizations own quality management system. The disruption this would cause to a small business where employees usually have more than one role must be detrimental to their day to day operations. The Federation of Small Businesses has in the past campaigned against the pressure induced on its members by bigger businesses, to certify to ISO9000 at great expense and little benefit[7]. Therefore despite the availability of consultancy packages like this, the ISO9000 standards appear to be geared towards medium to large organisations, where there is a ready market for companies that need to attain the standard. Typically in project management the role of subcontractors is essential for the completion of a project. Is there a need for such organizations to have some form of certification, or is it the responsibility of the larger client organization to take on the role of quality assessor?

9.2 The Company

9.2.1 Background

db Houston Ltd was formed in 1993 by Robin Dunlop and Crawford Brysland. Both had previously worked as system analysts for the oil company BP Exploration. Following a re-organization of the company, the opportunity arose to enter business on their own. Initially their role was to provide support and advice on large-scale computer networks primarily in a corporate environment. Their goal was to move away from relying on large-scale businesses to niche market's that were perceived as having more stability and allowed better continuity of work. To this end they have now built up a considerable client base in the area of health care based IT systems for general medical practices and small-scale health centres.

9.2.2 Core business

db Houston's main function is to carry out complete customised computer network installations, from design to installation including support and maintenance. The primary objective of db Houston's projects are to create information systems that facilitate the integration between information technology and the human processes that take place in a medical practice. Bocij et. al.[8] define the difference between the term information technology (IT) and information systems (IS) as being one of scope, where IT refers to the technology used and IS refers to the application of the technology as a integral part of a business process.

One of the key functions after the installation phase of a project is db Houston's ability to

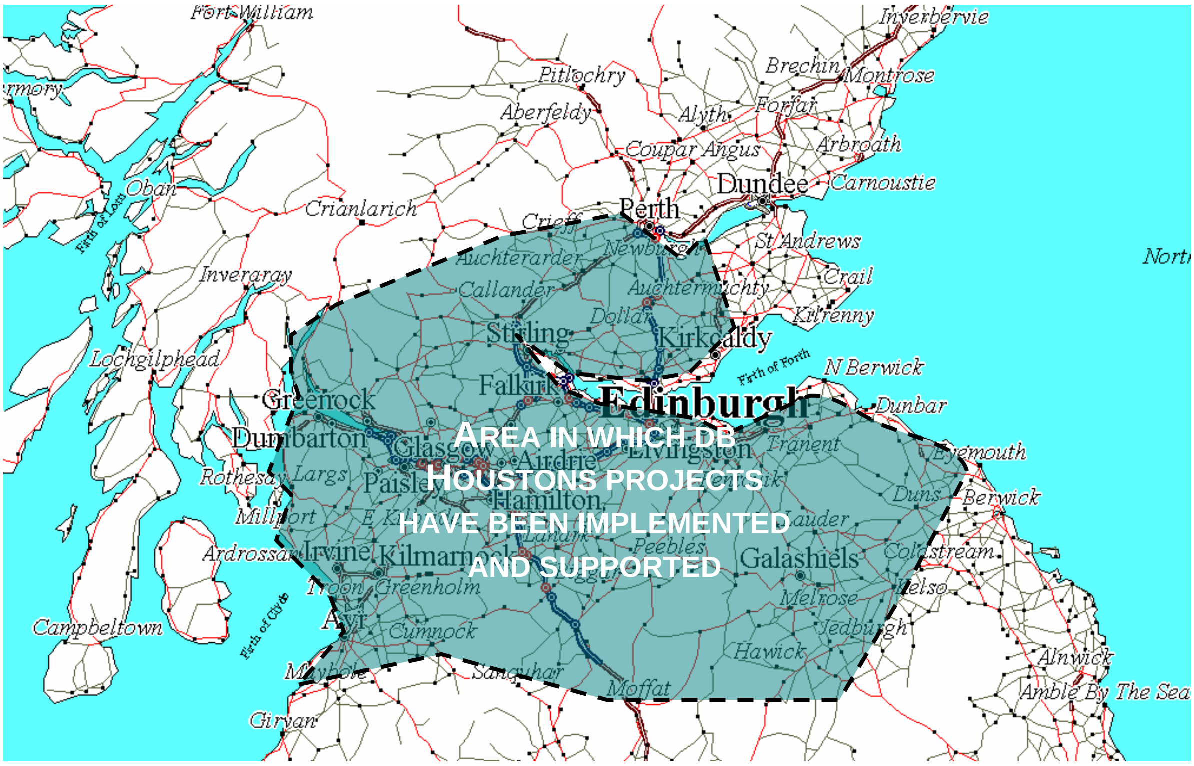

Figure 9.1 **Geographical area denoting the network projects installed and supported by db Houston**

offer a 'Managed Network Support' contract. This customisable package of contracts defined the scope of the support and maintenance services carried out by the company. It emphasised the advantages of transferring the responsibility of supporting the IT function outwith the day to day running of the Medical Practice or Health Centre. Technical Director Robin Dunlop believed that the advantages to the client of this were as follows:

- The contract maintained the focus on the 'function' of the installed computer system.
- Support costs were minimised by extracting maximum benefit from high reliability products and manufacturers warranties.
- Covering aspects of a system that extend beyond a typical PC hardware contract and thereby providing solutions to day-to-day problems.
- Commitment to the development and use of technologies by the customer through training, development and support.

db Houston's client group was primarily medical general practices and small health centres, although they also carried out work for a number of the companies in the Arts – theatre companies, youth orchestras etc. At the time of writing, they supported approximately 90 networks around Scotland. The actual graphical location of these sites was quite large, encompassing the Scottish Borders, Tayside, Fife, Central and Strathclyde. One basic criterion that determined which contracts were viable was the time it took to reach an installed network from the company offices in Paisley Renfrewshire. The distance from the office was important, as had an effect on their ability to support a network if disaster recovery was required. Figure 9.1 illustrates the geographical area that db Houston covered.

9.2.3 Experience and Ability

Both directors had backgrounds in corporate IT on mission critical technology, with a high exposure to a variety of different types of system. In all probability, they had been exposed to the cutting edge of Information Systems at their previous employer British Petroleum (BP).

Expertise in the operating system Unix gained in the corporate environment also helped them to break into their chosen niche market. They had successfully transferred and adapted skills gained in the corporate sector to smaller information systems with the emphasis on providing reliable, high quality information systems.

9.2.4 Technological factors

The technological progress of the abilities of Personal Computers (PCs) during the 1980s and 1990s has meant that the growth of users has been significant. Unix based workstations were generally considered the most reliable basis for information systems that could run on a wide range of hardware platforms (Cleary[9]). db Houston was able to take advantage of these factors, as the preferred operating system on most GP's networks was a variant of Unix.

9.2.5 Open systems

Previous systems installed in the medical practices were not usually 'open systems' but consisted of proprietary equipment and software mirroring larger corporate set-ups. (The term 'open systems' has become a generic phrase used to describe information systems that have the capability to be assembled using software and hardware from different vendors which work in a completely co-ordinated system[10]). Having the ability to install and maintain network systems using open systems technology and creating the kind of reliability and backup that was more akin to a corporate environment enhanced the company's reputation and client base.

9.3 A Typical Project

A typical project for db Houston began with a request from a medical practice or occasionally one of the Scottish health boards to submit a tender for consideration. Following submission and approval of the tender, an order was placed for the necessary equipment. The server was assembled, configured and tested at db Houston that allowed it to be tailored for specific sites. The PCs and other equipment were sent either straight to site or to db Houston's offices just before the installation date. By using 'brand name' PCs from the German manufacturer Siemens, db Houston had been able to obtain a constant and reliable source of good quality equipment. With their limited infrastructure, it was preferable for equipment to be delivered to site by the PC supplier, a consideration that had to be taken into account when choosing suppliers. If the supplier is reliable enough to eliminate the need for a particular resource or the duplication of a resource, this has significant benefits for the implementation of the project. By eliminating the need to transport PCs to the site, more time can be spent pursuing activities that have greater added value. It is this principle that db Houston had applied to their choice of supplier. If the PCs are reliable and do not require significant amounts of time spent on maintaining them it allowed db Houston to allocate their time to more significant issues that improve the service given to the client and contribute to the overall viability of the company.

The network cabling that was required for a typical IT system was usually installed before the delivery of the equipment to the site. This was one function that db Houston had usually carried out themselves to eliminate the problems that arise from incidents similar to the one described in Section 9.4.6. It perhaps appears strange that two company directors involved in installing computer systems should be crawling through roof spaces, under floors when this part of their work could be sub-contracted. However, as the cabling was a significant point of contact with the client, the two directors believed that it was imperative that cabling was carried out correctly, to specification and with a minimum of disruption to the client. To reduce the disturbance to the medical practice the cabling and network points were installed in the evenings, which had the added benefit of allowing undisturbed access.

The pre-configured server, PCs and other ancillary pieces of equipment were installed just before the changeover from old system to new. This took place during office hours to allow the staff present to familiarise themselves with the new equipment. In addition, it allowed any further configuration of the system to take place before the system was handed over and finally went operational. When the installation of the network was completed, the role of db Houston became that of a service orientated company supporting the installed computer network and ensuring the integrity of the medical practices data.

9.3.1 Defining the Project Stakeholders

The key project stakeholders were as follows:

- The medical practice that wanted to purchase the computer network was the primary customer. Medical practices were usually a partnership of General Practitioners that operate in one or two specific locations utilising a common building and support staff. Typically a medical practice would consist of a number of doctors (anything from two to ten), nursing staff (especially in the larger health centres and more recent models of medical practice) and attendant support administrative staff, i.e. practice manager, secretaries, clerks etc.
- There was more than one project sponsor for the systems installed. The GP’s chose which performing organization that they wanted to carry out the project and initially provided the financial resources. The other project sponsor was the local Health Board, which actually reimbursed the GP’s once the project had been completed. Therefore, db Houston had close contact with both sponsors, providing common information to both on what kind of system is required. In this role, there is no scope for ambiguity because the objectives were the same for both sponsors: the installation of a base level specification hardware system that will run the prerequisite software. For db Houston the main sponsor was the GP medical practice as they were the ultimate owners and users of the system

installed. The Health Boards were in effect the project financiers and had a pivotal role in the environment which db Houston operated in. Their strategies and policies on how information systems were implemented and supported had a profound effect on db Houston's projects.

- The software used by the medical practice also determined the base specification for the system, in this case a patient management system called GPASS - General Practice Administration System for Scotland. Therefore, companies that installed computer networks in medical practices had to meet the minimum criteria specified by GPASS, which influenced the suppliers chosen. The company that supplied and installed GPASS is part of the Information and Statistics Division Scotland (ISD), which in turn was a division of the Common Services Agency (CSA) of the NHS in Scotland. The role of the ISD was to gather data about the care given to people who use the health service. GPASS software was issued free to the GP practices and was used extensively all over Scotland and Northern Ireland (over 855 Scottish practices and a further 150 in Northern Ireland[11].) Therefore, the company GPASS could be classified as an indirect customer albeit a very important one.
- The final indirect project stakeholders are the patients whose medical information was accessed through the system. In theory, the patients should benefit from the improved service provided by the medical practice due to the installed information system. The patients were not part of the initial project scope i.e. the system installation, but any subsequent decisions which effect the support of the IS system would have had a direct impact on the quality of service which they received.

9.3.2 Technical Requirements

To achieve the most cost-effective solution and keep the hardware system capable of running GPASS a balance had to be obtained between meeting the base level specification and retaining equipment that could be integrated into the new system. This is described by Cleary[12] as ‘rightsizing’, utilising existing hardware until it is uneconomic to retain. The latest versions of GPASS had moved from using UNIX as its operating system to Microsoft Windows NT. This had necessitated an increase in hardware specification which had a knock on effect on the medical practices. This constituted a considerable change to the networks in many of the medical practices. Previous UNIX based versions of GPASS (many of which were still in existence) typically did not require the same hardware overhead that was required by the Windows NT operating system. The UNIX based systems consisted of a

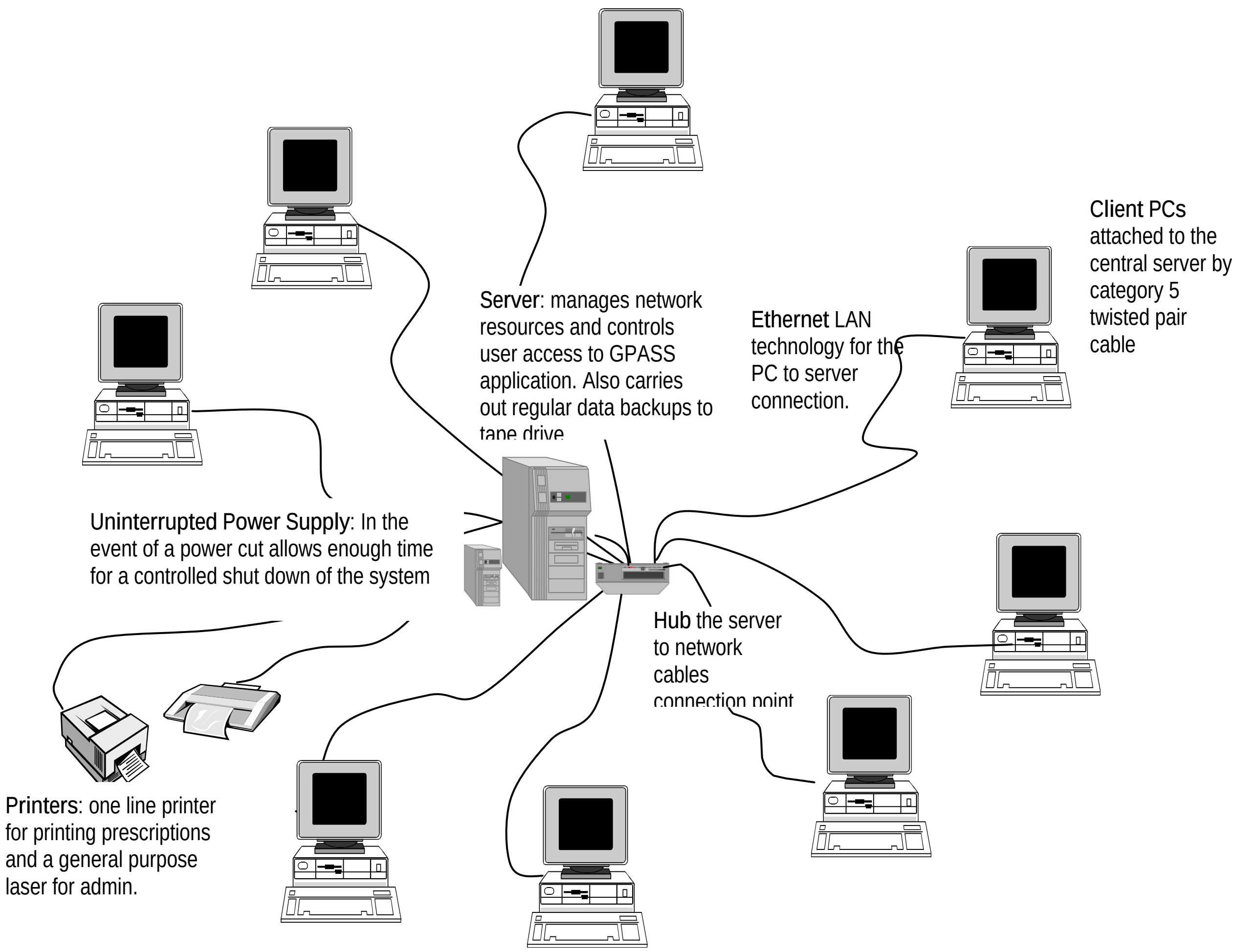

Figure 9.2. A typical Local Area Network (LAN) configuration in a medical practice

central server connected to either ‘dumb’ client workstation terminals or PCs equipped with terminal emulation software. Newer systems had tended to move away from workstation terminals to desktop PCs. In addition to the need for the PC to run the GPASS software there is also a greater need for the users to have access to common business applications such as word processing, spreadsheets and databases. Other recent requirements were email and Internet facilities, particularly for the GPs. The goal of the NHS was to have all the GPs in Scotland connected to a form of Wide Area Network (WAN), thus allowing the interchange of information. The GP connection was to ‘NHS-NET’, which was provided through a single firewalled Internet connection point. (db Houston expressed concern that in reality this was not particularly secure).

9.3.3 A typical network computer system

A typical network configuration will normally support on average 12 users. The topology of the local area networks installed is a star arrangement, which uses a file/server configuration as shown in Figure 9.2. The changeover from old to new system was often carried out in a phased approach with the new system being installed in tandem with the existing system before the switch took place. The aim was to create as little disruption as possible to the day-to-day running of the medical practice.

9.4 Implementing the Information Systems Project

The approach that db Houston had taken in carrying out their projects mirrored their earlier work in the corporate sector, with the emphasis on the need for robust and reliable information systems. This often meant that propriety hardware and software (what Cleary[13] refers to as ‘mission critical’ technology) performed an essential organizational role. Case Study No. 4 (the London Ambulance Service reported in Chapter 10) illustrates a project that failed in its attempt to implement mission critical technology

9.4.1 Uniqueness of the projects carried out by db Houston

The specialised nature of the market in which db Houston operated meant that many of the activities that they carry out are generic to all their projects. The classification of their work as project based is primarily accounted for by:

1. The different locations that each computer network was installed.
2. The variability of the existing hardware and software which had to be 'dovetailed' into the new system.
3. The types of building in which the systems were installed varied enormously, which meant the network cable installation was unique at each site.
4. The implementation of a new system had specific objectives and deadlines. Frequently there was an immediate cutover from the old system to the new system.

Once the system was installed the project lifecycle moved onto the operations and support phase. The smoothness of the transition from project to support phase was determined by the activities carried out during the project, therefore this case study will include key issues that arose post project.

9.4.1.1 Uniqueness in Context

Defining levels of uniqueness for projects can be subjective. High technology, large scale projects like the NASA space shuttle or the Channel Tunnel are easily definable, yet categorising smaller projects is more difficult. The author believes that each project organization should be examined in context, i.e. what it achieves in relation to its resources. Therefore, what appears to be a low scale, low-tech project for one industry may be unique and high risk in another. In the first case study, CRC Gabions carried out projects with very limited resources, yet with innovative use of new technology and entrepreneurial flair they achieved considerable success. In comparison with CRC the projects carried out by db Houston were small but involved arguably higher technology. While CRC actively went out to seek new projects to widen their commercial scope, db Houston have sought to consolidate their position in a niche market by limiting the majority of their projects to one type of client.

Consequently, the uniqueness of their projects has diminished, allowing expertise to be built up in that particular market. Chapter 11 elaborates on this further and illustrates it with a causal loop diagram (Chapter 11, Figure 11.5). Note that db Houston had used their expertise to strengthen market share rather than expand into different avenues like CRC. In discussing project uniqueness, the relative experience of the two main project stakeholders, the project

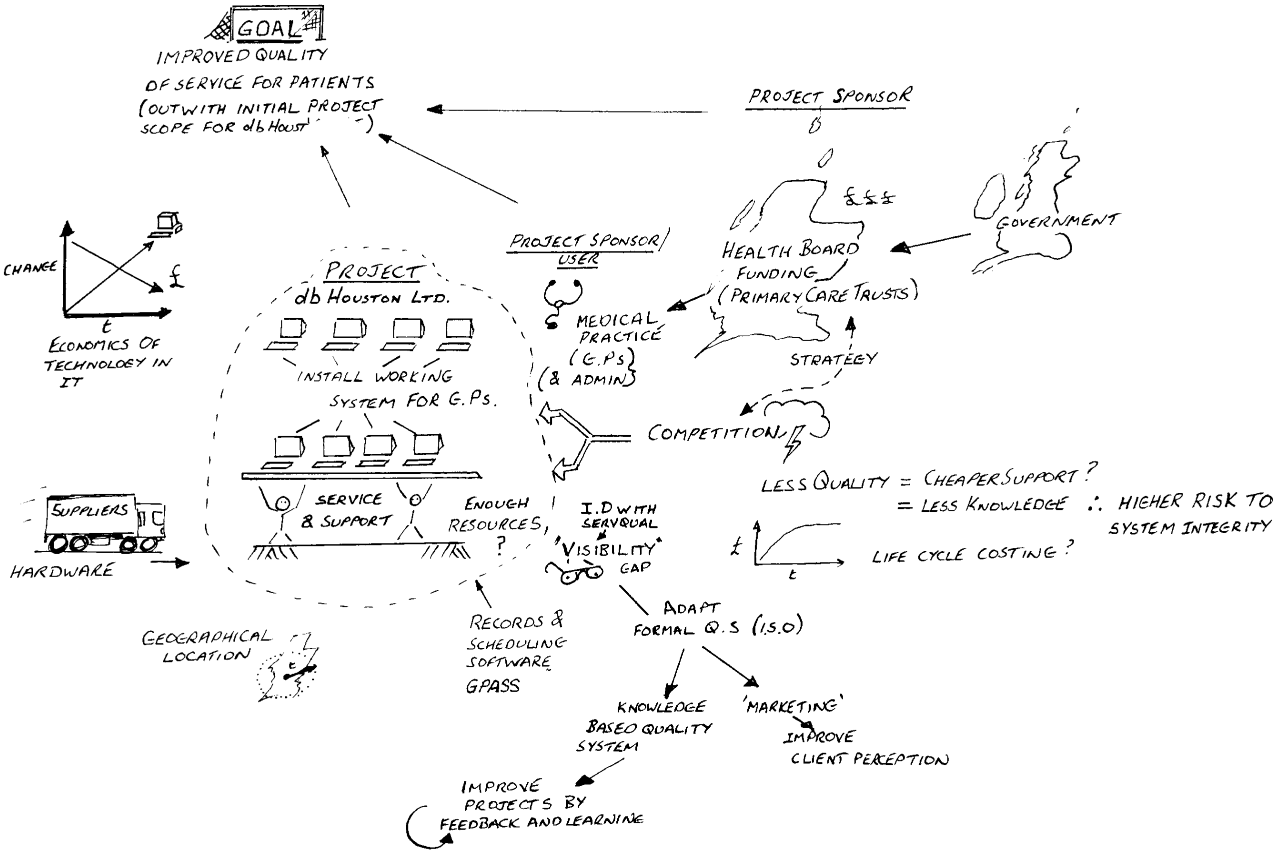

Figure 9.3 Rich Picture for db Houston

sponsor and the contractor is often an essential factor to the project's outcome. In this case study the role played by the medical practice is discussed in section 9.2.8.1

9.4.2 Post project support as part of the project

The ‘rich picture’ in Figure 9.3 illustrates the environmental factors that affected a db Houston project. From this, the project is defined as the installation of a working computer system plus the support that it will need after the system has been handed over to the customer. Simon[14] has described this as an integral part of the System Development Life Cycle (SDLC) where maintenance is usually a large part of the overall cost of the system.

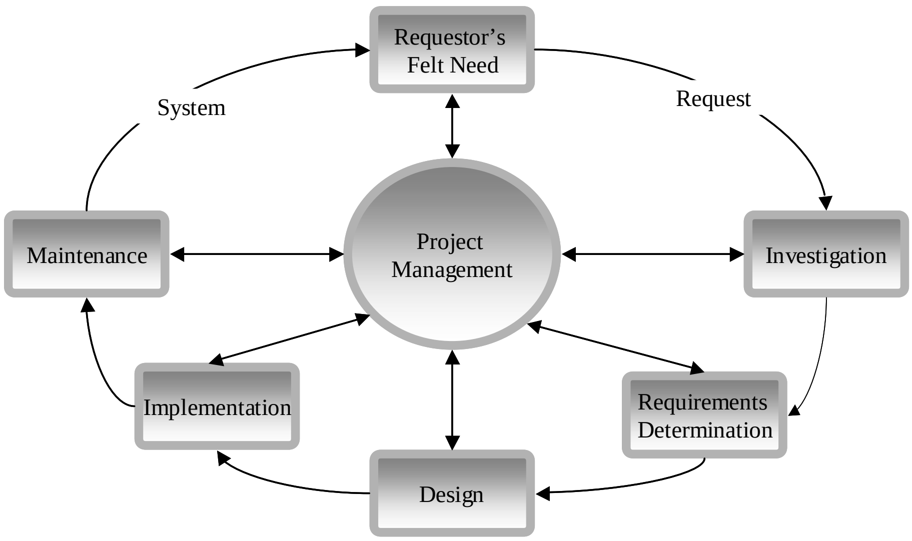

Figure 9.4 System Development Life Cycle (SLDC)
(Extract from Simon Understanding & Using Information Technology West,)

This is a ‘traditional’ method of developing an information system with project management being the central discipline as illustrated in Figure 9.4.

A medical practice that chose db Houston to install their computer system was not committed to using them to support the system. Therefore defining the support was as crucial as defining the technical specification of the system, but often more difficult. Service level targets had been created with an emphasis on specifying the scope of the support as shown in Table 9.1.

Table 9.1 Service Level Agreements (db Houston)

Level Of Support	Service Level Targets (the response that db Houston aim to meet or exceed)		
User Phoned Back	80% within 2 hours	95% within 3 hours	100% within 4 hours
'Critical' Site Visit	75% within 3 hours	90% within 5hours	100% within 8 hours
'Sub-Critical' Site Visit	75% within 4 hours	90% within 6 hours	100% within 8 hours
'Critical' systems reinstatement	75% within 3 hours	90% within 6 hours	100% within 8 hours
'Sub-Critical' systems reinstatement	75% within 4 hours	90% within 6 hours	100% within 8 hours

db Houston viewed this as an important step in creating a framework for some form of system which quantified the work that was carried out for the client group. This was essential as the client group (users and non-users) typically viewed the installed computer network system as a whole entity, with little differentiation of the problems that occured. Therefore, to tailor the support, db Houston offered different contract schedules to specify what was covered. They also ranked the various components of a network system into critical, sub-critical and non-critical categories. This level of detail was seen as essential to ensure that the company received some form of return for its intellectual expertise, which they believed could be eroded by competitors who installed networks without the appropriate knowledge to provide adequate support.

It is recognised that this support function was in effect an operation and as such is remote from the initial project implementation. However, the correct implementation of the project was crucial to the further 'operational support' function of the company, and as support is often built into the life cycle costing of many projects it should not be underestimated. Db Houston had strived to achieve a stable level of operational management for the Information Systems they implemented. It was possible to achieve this for the majority of the sites, but with the rapid change in the technology utilised there was a rolling process of update and renewal that created subsequent operational difficulties in maintaining the service level targets. Extra personnel had been taken on to ensure that the high level of support was maintained, which reinforced the importance of creating reliable network systems at the project stage.

9.5 SERVQUAL and Reliability

In the typical db Houston project, the main concern of the client was the service provided by the installed system and its support. Measures of service quality should provide a valuable insight into the quality of projects undertaken by companies like db Houston.

In Information Systems high reliability is often believed to be synonymous with high quality

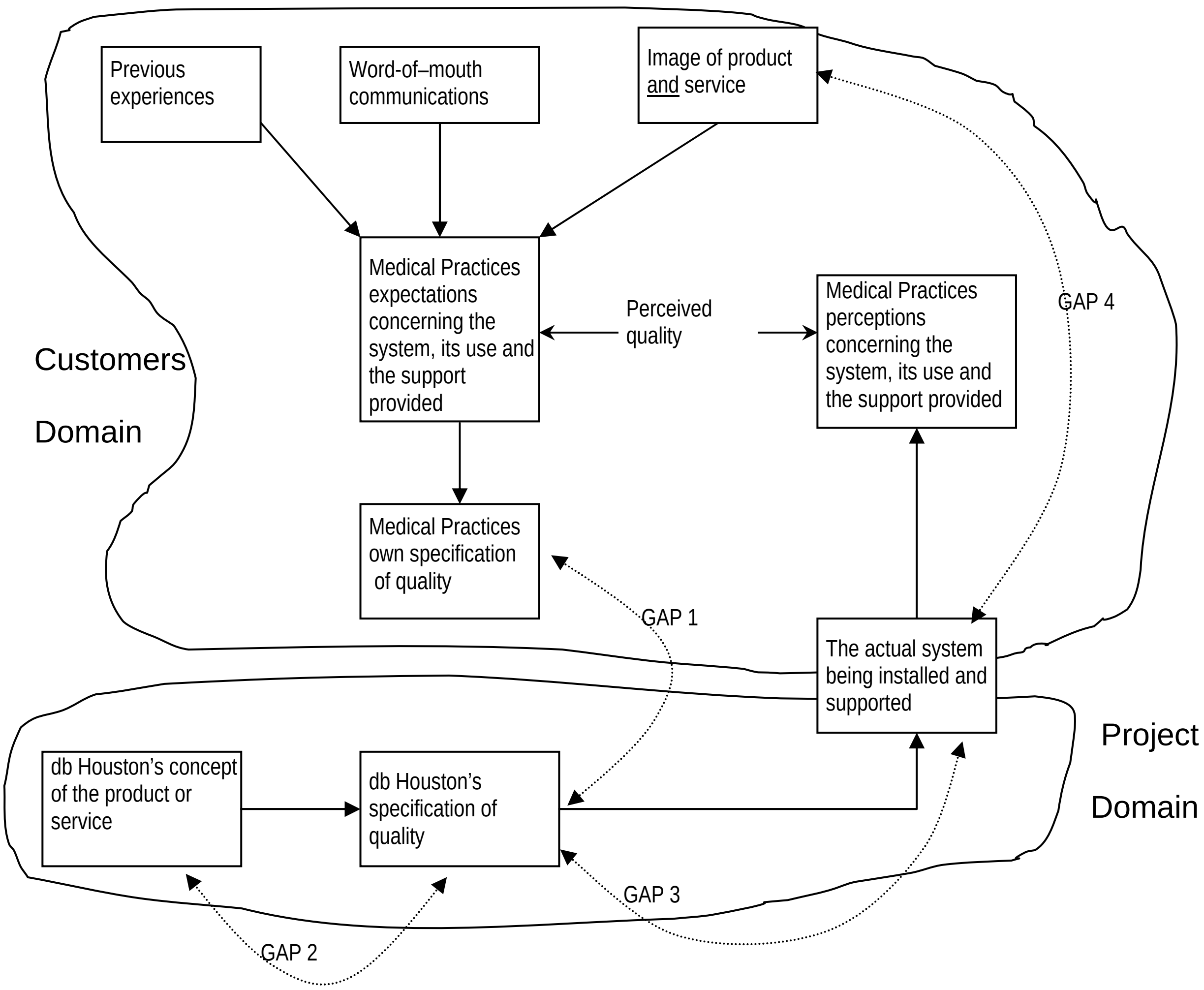

Figure 9.5 The SERVQUAL model showing the possible gaps between customers expectations and their perception of a product or service (Based on Slack et. al. Operations Management 2nd Ed, p639, Pitman, (1998)

and is seen as one of the five key underlying factors that can be used in the SERVQUAL service quality model[15]. Service quality is defined as a function of the gap between customer expectations of a service and their perceptions of the actual service delivery. Despite earlier quotes (Antilla, Chapter 4) the attribute of reliability, which is linked to service quality, is a major tangible aspect of the service that db Houston provided. Whilst not discounting the intangible aspects of service quality, it is not sufficient simply to have a veneer of competence; there must be technical substance behind it.

The illustration in Figure 9.5 is an adaptation of the SERVQUAL model taken from Slack et al.[16]. These authors argue that the operations management view of quality is an attempt to meet the ‘customers expectations’ while the customer’s view of quality is what he or she perceives the product or service to be. From this quality is defined as the ‘fit’ between customer expectations and their perception of the delivered product or service. Therefore, if the customer’s expectation is greater than their perception then the perceived quality is poor, conversely if the customer’s perception is higher than their expectation then the perceived quality is good. When expectation equals perception the perceived quality is acceptable. In the context of project management, this model would appear to highlight an important concept: the differentiation between perception and reality.

In a study on measuring service quality in local government, Donnelly et al[17] provide a useful synopsis of the SERQUAL model and the rationale behind its use. Data collection is principally based on a structured set of statements in a questionnaire format. These are designed to assess five key dimensions in service quality: tangibles, reliability, responsiveness, assurance and empathy. The apparent advantage with this type of survey is that it attempts to determine the customers’ expectations of service quality, providing feedback that is ‘obtained in a rigorous but cost-effective manner to feed directly into management monitoring and performance review systems[18]'. The questionnaire purports to be applicable to a wide range of service organizations due to its generic construction from 'considerable empirical psychometric testing and trials'.

9.5.1.1 SERVQUAL and Information Systems

In more detailed articles specifically on IS service quality there is some debate as to the claims of the applicability of the SERVQUAL questionnaire. Van Dyke, Kappelman and Prybutok[19] suggest that the use of models such as SERVQUAL may be flawed. Their primary concerns revolve around three areas:

- Conceptual problems, the use of two 'constructs', perceptions and expectations to express a third, perceived service quality in operational terms. As pointed out by Kettinger and Lee[20], 'SERVQUAL is too simplistic to measure this complex cognitive evaluation process.'
- The ambiguity of the 'expectations' concept.
- The suitability of using the SERVQUAL model as a generic measure of service quality.

Dyke et al. concluded that the SERVQUAL model, either adapted for information systems or the original generic model, is a suitable measure of service quality. In the same journal, vigorous responses to this article fuelled the debate on the validity of the model. Kettinger and Lee[21] offered an IS-adapted SERVQUAL model, which attempted to address the conceptual and empirical criticisms of Van Dyke et al. The consensus from the debate was that the measurement of service quality in information systems was a very important issue, but one which needed further research. Kettinger and Lee's position put forward the most pragmatic point of view:

> "We, however, stress the need for a practical point of view that is careful not to lose sight of the big picture of the IS service quality research paradigm by expediently retrofitting arguments from one group of marketing researchers into the IS community. Specifically, we take the position that measures should not be discarded

> until such time as their underlying theory and practicality for IS have been conceptually and empirically discredited. Until that time, IS researchers should concentrate on improving service quality measures".

Ultimately the debate on the SERVQUAL methodology highlights the difficulty in defining or measuring the quality of a service and it is perhaps idealistic to assume that one model will fit all areas. However, the SERVQUAL model offers some useful insights. To achieve 'high perceived quality' Slack allocates organizational responsibility to different functional areas such as marketing, product/service development and operations. In this case study (as in the others) the roles of functional groups are not clearly differentiated, either due to the organizational structure, the organizational size or the type of work they carry out.

9.5.1.2 Evolving Expectations

One principal difference in the PM environment is timescale. As the project progresses the customer will learn more about what is possible and also develop a greater appreciation of the real requirements. Thus, the customer's expectations may well evolve. Even if the contractual specifications capture the customer's original expectations and the contractor satisfies these specifications, a significant gap may appear between the customer's evolved expectations and the perception of the delivered system. Globerson[22] discusses similar points relating to the change in the customer's expectations. He relates the level of change in customer expectations to the time between the initial system requirements and the final system delivery. The longer the time the higher the probability that the customer will initiate changes to the initial design. Also discussed is the fact that customers do not always have the information required to make informed choices at the system design stage and may not be able to express their needs in an appropriate manner. To counteract this Globerson advocates continuous customer involvement to 'introduce the necessary changes into the original plan'. This assumes that the customer wants to be involved in the system design; the project process and they have the 'technical' ability and comprehension to make a valid contribution.

Gauging the evolution of the customers' expectations in respect to db Houston's projects is again a difficult process. The abilities of the users of the system, in this case the GP's and administrative staff, had a significant effect on their expectations. With some users, until the system demonstrates that it can save time, reduce effort and improve the efficiency of the processes the users are involved with, many are unsure of what to expect. Globerson cites DeCotis, Dyer, Pinto and Mantel and their identification of three distinct facets of project performance, which can be used as benchmarks of project success. Table 2 summarizes these aspects which display similarities to the SERVQUAL model in their use of subjectivity.

Table 9. 2 Three distinctive measures of project success for benchmarking

Aspects of project performance	**Description**
The implementation process	Time, cost and conformance to specification[ii] (the archetypal measures of project success)
The perceived value of the project	A subjective judgement applied to the project implementation
Client satisfaction with the perceived project	A subjective judgement applied to the completed project

9.5.2 Customer perceptions

Gap 4 in the SERVQUAL model (Figure 9.2) describes the gap between ensuring the promises made to customers can be delivered in reality. For db Houston that created something of a dilemma. Just prior to the entry into the market of a competitor, db Houston decided to identify and quantify what services they carried out for their customers. This culminated in the creation of the 'Managed Network Support Contract' described in Section 9.3.4. The problem that was then perceived was one of visibility and the possible customer perception that presence at the site equated to obtaining value for money. While the author was describing the SERVQUAL model to db Houston, one of the directors asked if the model accounted for cost i.e. was there any reconciliation between perception of quality and cost?

> *"When db Houston carry out a project a key issue is to carry out a hassle-free installation. We pride ourselves in getting the installation 'right-first-time' and thinking for our customer, i.e. covering all the eventualities and requirements. If there are few problems after installation, that signifies a quality job, and with our limited manpower resources it also makes economic sense not to keep returning to the site to effect repairs."*

> *"What is galling is when a competitor carrying out support sends in poorly trained staff to solve a problem on a system, they spend 6 hours tinkering with it with no knowledge of what they are doing and don't resolve the problem. Twice we have witnessed this because we have had to go in and retrieve the situation. Yet, some customers perceive this as getting a quality service because they (the competitor) have someone on site for a long time! We resolve a problem in an hour with no fuss or bother and are perceived as being expensive! The reason the competitors can offer cheap support contracts is that they employ people with no experience, little training and consequently are cheap to employ. There is no attempt to equate the cost of the loss of productive time to the medical practice with apparent cheaper support contract offered by the competitor" [Extract of Interview with Technical Director Robin Dunlop June 1999]*

db Houston were meeting and exceeding their Service Level Agreements (SLAs) and meeting the criteria of Gap 4 in the SERVQUAL model. This gap is described by Slack[23] as 'ensuring that the promises made to customers concerning the product or service can in reality be delivered by the operation', with the main organizational responsibility being assigned to the marketing function. This has been achieved by db Houston but the 'image' of the service did not reflect the earlier effort of the project implementation or the correlation between time and knowledge. Gap 3, shown in Figure 9.5, which determines the product or services conformance to specification, was not a problem for db Houston.

[ii] It was interesting to note that there was no mention of quality as the third project dimension

The product/service design cycle in Figure 9.6 from Slack et. al[24]. illustrates the iterative feedback loop that is expected from evaluating the conformance of the quality characteristics of an operation. db Houston's evaluation of conformance occured project by project and the

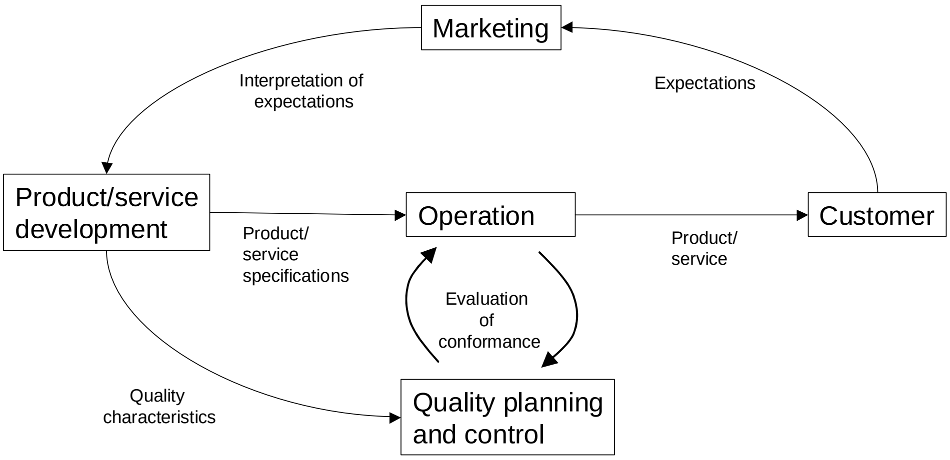

Figure 9.6 Product/service development cycle (Slack et al.)

continued renewal of support contracts. What was more important to db Houston was the evaluation of performance rather than evaluation of conformance. The concept of evaluating to conformance (with its roots in quality control) arguably sets boundaries that could stifle the creative thinking needed in a project environment.

9.6 Existing Quality Systems

The company did not have any formal quality system in place. When asked if the company would benefit from a industry standard quality system, Crawford Brysland believed that although they had benefited from creating formal procedures for technical areas and contract scheduling, he did not perceive any advantage from any of the ISO9000 standards, although he did admit that it may have had an effect if they were in a different market. At that time db Houston's existing customers were not interested in their IS subcontractors achieving this type of certification. Implementing a certified quality management system for the company was seen as an impractical proposition due to:

- The impact on their limited manpower.

- Little or no advantage in their existing market.

9.6.1 Identifying and 'formalising' tasks

db Houston viewed formalising the tasks carried out throughout the project life-cycle as a way of devolving the company's way of working to others:

> *"Formalising tasks should enable de-coupling key people from the project and allow less experienced personnel or contractor staff to perform with the "Company" style. This requires effort. Short term gain – nil. Long term gain (if you are still in business) – good." [Extract of interview with Technical Director Robin Dunlop June 1999]*

The most tangible example of the benefits of formalising tasks occurred when there was a threat of competition for the support function of the projects carried out. Before this there was no real defined scope for many of the services carried out by the company. Whilst it elicited a reputation for responsiveness and knowledge from their customer base (and contributed to the expansion of the number of IT systems they installed and supported) it became a question of diminishing returns due to their limited manpower resource. Creating boundaries on what was carried out for the customer produced a qualitative form of measurement and allowed db Houston to capitalise on their 'intellectual property' i.e. their knowledge.

> *"The 'Managed Network Support' contract was conceived before the threat – if you like the threat was foreseen. When the threat became reality the contract aided us immensely by providing a concise reply to the challenge." [Extract of interview with Technical Director Robin Dunlop June 1999]*

Creating the support contract was not particularly easy as the complementary yet differing styles of the two directors meant that compromise had to be reached. The two directors had different views about what constituted a quality service. Identifying processes is not difficult yet quantifying them can be.

9.7 An example of an Informal Quality System

db Houston exhibited the same characteristics as CRC Gabions Ltd in the sense that they had an 'informal quality system'. The way in which they built up their client base was very similar, relying on successful projects and word-of-mouth to expand their businesses. However, informal quality systems do not provide valid feedback on what kind of service db Houston provided. Commercial Director Crawford Brysland believed that one problem was getting valid first hand feedback from their clients. He felt that clients were reluctant to complain because they were aware of the organizational structure of the company i.e. a small personal business, which emphasised providing a professional personal service. There was no formal mechanism for the client to provide feedback on the service that they received from db Houston. It was something that db Houston hoped to address by surveying their existing clients in order to build up a profile of how they perceived the service that they received. It is hoped that this will form part of future research as discussed in Chapter 13.

9.7.1 Change

New information systems inevitably involve change and this can have a visible effect on the management of the project. As db Houston aimed to support the system after installation, it was imperative that the change process did not create a negative perception of the work carried out. A small percentage of the projects also coincided with other modifications to the medical practice. These ranged from extensions to the existing buildings to complete new buildings. The changes to the physical structure of the buildings sometimes reflected changes taking place to the model of healthcare that was being provided, in effect a type of small-scale business re-engineering project. Increasingly medical practices are including other primary health care provision such as specialist clinics, pharmacy and the ability to carry out small-scale surgery. Changes like these can create a negative climate in which to implement a new information system. Bocij et. al describe the way in which users of a new information system can create problems for this type of project[25]:

> "While outright hostility manifesting itself as sabotage of the system is not unheard of, what is more common is that users will try to project blame onto the system and identify major faults where only minor bugs exists. This will obviously damage the reputation of the system and senior managers will want to know what is wrong with the project".

This will obviously impact on the perceived quality of the IS project which can have a detrimental effect to the project company's reputation. When asked if the change created in the clients work environment by the IT project led to problems for db Houston Robin Dunlop answered:

> *"Yes, problems. Advancing technology erodes certain skills. In reality - fundamentals remain the same, management depends a good understanding of concepts and should not be technology tied. The real risk to good systems is rooted in the ease of use of applications, not their difficulty. This encourages rapid development of applications with insufficient analysis. The old guard "Analyst" is often forgotten, the process as a discrete job may be defunct - but the process as a process is still crucial." [Extract of Interview with Technical Director Robin Dunlop June 1999]*

9.7.2 The effects of 'uncontrolled stakeholders' on quality

Installing a network in a completely new building in effect created additional stakeholders in the project process. This can have a marked effect on the quality of activities in the project. When a new building was being constructed for a medical practice, it was common practice to try and liase with the company carrying out the building works. The aim was to ensure that the network had been accommodated for in the original plans of the building. Frequently there was no provision for installing cables or network points and that created real difficulties for db Houston and the medical practice. Cables are easy to install and can be hidden inside walls if adequate provision is made during a buildings design, fitting them retrospectively is expensive and difficult.

In one example, the architect had not provided the necessary conduit to allow network cable to go from one floor to another. db Houston discovered this when the building works were being carried out. The architect and the builder did not appear to be overly concerned with this. Using their own electrician they forced the cables down the conduit stripping the connections that had been previously made and placing great stress on the cables. The medical practice manager, the customer's representative, could see no harm in this. The cables were through the conduit and that was all that mattered. There was no comprehension of the damage that had been done to the cables, the terminations and the number of repeat trips that had to be made by db Houston to rectify the problem. Whilst the material costs were relatively small, the limited personnel resources that were available to db Houston (like CRC in Chapter 4) meant that extra visits to site were at the expense of scheduled work. This created more scheduling problems in addition to further client dissatisfaction.

These seemingly inconsequential events often escalated into more taxing problems for both parties. If in the future there were any problems with the network cabling at that practice it is unlikely that db Houston will be able to withdraw from the problem. Although it was not a situation of their making, they in effect were linked to the system that they installed and this was reinforced by the support they offered in their maintenance contracts.

When a new medical practice is being built, the main contractor is often completely unconcerned in the installation of the network cabling. This appears to be a common trait that is sometimes reinforced by the physical plans supplied by the architect. It is perhaps understandable that builders do not see the network system as particularly important. After all, to them it is just another utility and one that is perceived to be a lower priority than electricity, water and heating. Yet, the role played by the computer system is now a strategic part of any medical practice, as pointed out by Technical Director Robin Dunlop:

" As soon as you rely on your computer system as an integral part of your business the reliability of the system becomes paramount. In comparison, a law or an accountancy practice can still operate if their computer systems are not operational. Medical practices place a heavy reliance on their computer systems, scheduling patients for appointments, keeping medical records etc. If the system goes down, there is a crisis in the practice. It becomes comparable to a point-of-sales operation." [Extract of interview with Technical Director Robin Dunlop June 1999]

9.7.2.1 Views on customer intervention

The first example highlights the problems that can arise from the intervention of the customer in a project. In an interview with Crawford Brysland, he stated that customer intervention could create problems; especially if they often did not appreciate the technical requirements of the project. The majority of problems occurs post-project and is attributable to user error. The installed system is technically correct but the users are not completely familiar with it.

Crawford Brysland defined an ideal customer, as one, which 'appreciated where their responsibility lies'. He estimated that approximately 20% of their customers fell into this category. When asked if it was important to have a 'project champion' within the customer's representatives Technical Director Robin Dunlop answered:

"Project champions make things easy. They are not necessarily the smartest people, often the most effective are quiet spoken reasonable people. Having a single point of contact being able to understand what you are doing for them is key to a success."

Despite this, in comparison to the projects in the CRC case study there appeared to be less of a role for a 'project champion' and customer intervention. With these projects, the erosion of the 'customer knows best' idiom is justified by the project organization's desire to create the computer system that meets the customers' actual needs (comparable to the second level of quality in Chapter 1). This has to be reconciled with the concept of 'perceived quality' i.e. the gap between the customers perceptions of the project outcomes and the customer's expectations. db Houston's 'Managed Network Support Contract' has perhaps helped to shape the customers perception concerning the quality of the projects that they carry out. Therefore, unlike the CRC case study in Chapter 5, db Houston placed less emphasis on the role of the customer during the implementation stage of the project.

9.8 Conclusions

9.8.1 Measures of Quality

For db Houston the major tangible and intangible measures of quality could be defined as follows:

- The installation of an IS network with as little impact as possible on the day-to-day running of a medical practice, achieved by customising the installation of the system to fit around the client. Gauges by the number of return visits to the medical practice to work on the system.
- Service Level Agreements, identifying and meeting the targets for support as defined by the agreements shown in Table No 9.1. Once created and in place the SLA's become a template for the minimum specification criteria for support.
- Meeting the expectations of the clients by ensuring that the information technology provided becomes an information system, capable of enhancing the process of managing a medical practice; the expectations could well be greater than the simple contractual specification.

9.8.2 Influences of Quality

Identifying the aspects of db Houston's projects, which influenced quality, could be summarized as, the design of the system, which include the recommended specification of the hardware, the routing of the network cables, the utilisation and integration of existing IT equipment, the scheduling of the installation and the changeover to the new system. The minimum specification of the system has to run the GPASS software therefore this is a set requirement, which has to be met. Subsequently this has a low impact on quality.

The reliability of the equipment installed into the medical practices is another key influence on quality. Repairing unreliable hardware does not add value to the work that db Houston carries out, it affects the limited manpower available. Also important is the reliability of supply and the ability to deliver in a timely fashion. The competition between suppliers of computer hardware means that there is no lack of available suppliers comparable to the one that db Houston uses. Therefore, another supplier could be used without a large degree of disruption to the project stakeholders. Support issues need be addressed if this happened, ranking this aspect of projects as a low to medium impact on quality.

The stability and robustness of the main software applications installed on the system has a large bearing on the resources needed by db Houston to support the medical practices. The primary software being GPASS supported by the operating software Microsoft Windows NT and on earlier systems SCO-UNIX. Most medical practices also used mainstream business applications like the Microsoft Office and Lotus SmartSuite. Most of the support issues involved with db Houston’s projects were software related. Hardware reliability was not seen as an issue. Key problems included user error, and administering the network operating system. Networks once installed were administered by the medical practice, a task usually carried out by the practice manager or the GPs themselves. The ability to transfer ownership of the system to the client and to provide timely support was a crucial part of the project process, as the client could have a marked impact on the running of the network and hence the level of support needed. This was a ‘quality critical’ part of a db Houston project.

Following on from this, if the user group receive little or no training in using the software applications then db Houston was directly affected. The training of the user group was largely outwith the remit of db Houston and in common with many organizations training was seldom allocated enough resources. Some Health Boards were limiting the number of users that received training on the GPASS software, which would increase the demand for support, which itself is under review by some Health Boards.

What db Houston were striving to achieve was expansion of their operational capability whilst consolidating and expanding their existing client base.

The influence on quality by third parties could be divided into two areas, the strategic level and project implementation level. The role played by the Health Boards (or Primary Care Trusts) in determining the future strategy to be applied for supporting their medical practices. The second area is the impact to successful project implementation by third parties carrying out works in parallel which had to integrate with the computer network e.g. building works, support equipment etc. The acquisition and dissemination of knowledge on individual projects to allow the delegation of support personnel to take place.

9.8.3 Roles

Where there was ambiguity on the role of the project sponsor (in this case the Health Board Trusts) uncertainty increased with the other project stakeholders. This had a knock on effect on the quality of the service that the main project sponsor (the medical practice) received. db Houston had to work with the changes that were created by the strategy of the Health Boards to try and capitalise on the quality of the service they provided. The difficulty was in pre-empting any strategic initiative by highlighting their contribution to the running of the medical practices that they supported. Frequently they have the support of existing clients in areas where the Health Board wanted to change the level and the type of support provided.

9.8.4 SERVQUAL and implementing a Quality System

The company's perception of their own visibility and their customer's perception of the service that they provide have to be identified. SERVQUAL appeared to be the most appropriate methodology to achieve this information. SERVQUAL would also contribute to gathering feedback from the project stakeholders to address the concerns raised in Section 9.8. The contribution of a quality system would have to be at two levels, to increase the visibility of the work that db Houston do, and to increase the operational capability of the company. The effectiveness of being certified to the ISO standards as a marketing tool is an unknown quantity, the market that db Houston was in did not require it, yet it could be one way of marketing the quality of the projects that they carry out. The relevance of the existing form of these industry standard quality systems for db Houston is questionable, as Hughes and Cotterell[26] point out:

> "It has been suggested that obtaining certification can be an expensive and time-consuming process that can put smaller, but still well-run businesses at a disadvantage."

Yet, now it is possibly the only way in which the company can demonstrate the quality of its projects, especially to non-technically aware project stakeholders. To implement an industry standard quality system would only be useful if it could be radically revised to become a useful knowledge based system, which actually contributes to future project success.

As with the previous case study, Table 9.3 provides a cross reference guide to the areas from the db Houston case study that are relevant to the objectives of the research and to the general debate of the role of quality in projects.

Table 9. 3 Cross Reference Table

db Houston experience	**Subsection**	**Relevance to research objectives and the general debate of the role of quality in the management of projects**	**Chapter(s) and subsection(s)**
SERVQUAL/Service Level Agreements as tangible measures of quality	9.9.4	Applying SERVQUAL to a IS project. Investigating the pertinence of the SERVQUAL model and its possible contribution to future project success (1st research objective)	Chapter 13, Section 13.3.4
Consolidating Project Knowledge to create 'stable' market	9.9.2	db Houston as an example of a company that does not want to increase its 'bid scope' in the Learning Projects Model Contribution to the formulation of the 'alternative' model for the management of quality in projects (2nd research objective0	Chapter 11 Section 11.8.1.2
Informal Quality systems	9.8	Informal 'v' Formal Quality systems in a project environment	Chapter 11, Section 11.3.1.4
Customer intervention and the role of project champion	9.9.3, 9.8.2.1	Their contribution to the success of the project.	Chapter 7, Section 7.4.7.1

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[24] Slack, N., Chambers, S., Harland, C., Harrison, A. and Johnston, R., p.642.

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Chapter 10

Case Study No.4 the London Ambulance Service

10.1 Chapter Synopsis

The purpose of this case study, created from secondary data, is as a triangulation point for the research, and will aim to conclude whether or not some form of quality management system or technique would have either have successfully terminated the project or chosen a more suitable consortium of contractors. In 1992 the London Ambulance Service experienced a disastrous and very public failure of their computer-aided despatch (CAD) system, which had been brought in to replace the manually operated despatch system. The failure had been precipitated by the procurement and implementation of the new complex CAD system which had been primarily put in place as an attempt to improve the 'performance and reliability[1]' of the existing service. The result was a collapse of the new computer based system whilst in operation, leading to a potentially fatal breakdown[i] of communications with ambulance crews. This led to the Page Inquiry by the South West Regional Health Authority[2] into how the project to procure and implement the system failed so badly when it became operational. The terms of reference of the Inquiry Team were as follows:

> "To examine the operation of the CAD system, including:
>
> a) the circumstances surrounding its failures on Monday and Tuesday 26 and 27 October and Wednesday 4 November 1992
>
> b) the process of its procurement
>
> and to identify the lessons to be learned for the operation and management of the London Ambulance Service against the imperatives of delivering service at the required standard, demonstrating good working relationships and restoring public confidence."

The computer-aided despatch system was primarily the implementation of a highly technical and complex information technology system that had to meet the needs of the LAS and its

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[i] It should be noted that the Inquiry into the LAS stated that "in no case has a coroners' court concluded that the late arrival of an ambulance caused a patients death" referring to the media stories which were published at the time which speculated about the consequences of the system failure on the patients at that time.

users. The fundamental errors that took place in this project are not only unique to IT based activities therefore this case study is seen as a beneficial project to analyse. As an organization in the public sector the London Ambulance Service is held very accountable to the general public. This has produced various in depth articles and data on the project, which arose from the various inquiries, and investigations that took place after the systems failure in 1992. The following sources provide the main reference data for background to this chapter:

- Finkelstein A. Report of the Inquiry into the London Ambulance Service (February 1993), *International Workshop on Software Specification and Design* Case Study.
- Flowers S. *Software failure: management failure*, John Wiley & Sons Chichester (1996).
- Hougham M., (1996) 'London Ambulance Service computer-aided despatch system,' *International Journal of Project Management*, Vol. 14, No. 2, pp. 103-110,.

The material available on the LAS is almost unique in the respect that as a failed project in the public sector it was open to a great deal of scrutiny and analysis which is available in the public domain. Flowers[3] states:

> "The report into the LAS Inquiry is a remarkable document since it provides a detailed view into the many aspects of a major IS development that failed. In this it is almost unique."

Attaining similar 'post-mortem' information on high tech project failures in the private sector is not as forthcoming usually under the auspices of commercial sensitivity. In a project where so much has been fundamentally flawed right from the outset, it is apparent that some form of framework could have been of some benefit (even as an early warning mechanism) to the LAS. As mentioned in Chapter 2 the role of this case study is to provide a triangulation point for the research, and will aim to conclude whether or not some form of quality management system or technique would have either have successfully terminated the project or chosen a more suitable consortium. Indeed, the pertinence of the limited quality initiatives that were in place in this case study can also be examined. In contrast to the other case studies this chapter contains some significant pieces of analysis in addition to the case study itself primarily due to the construction of the case study from existing sources.

10.2 The LAS - the largest ambulance service in the world[4]

The LAS cover a geographical area of 600 square miles surrounded by the M25 motorway as shown in Figure 10.1 making it the largest ambulance service in the world. The service

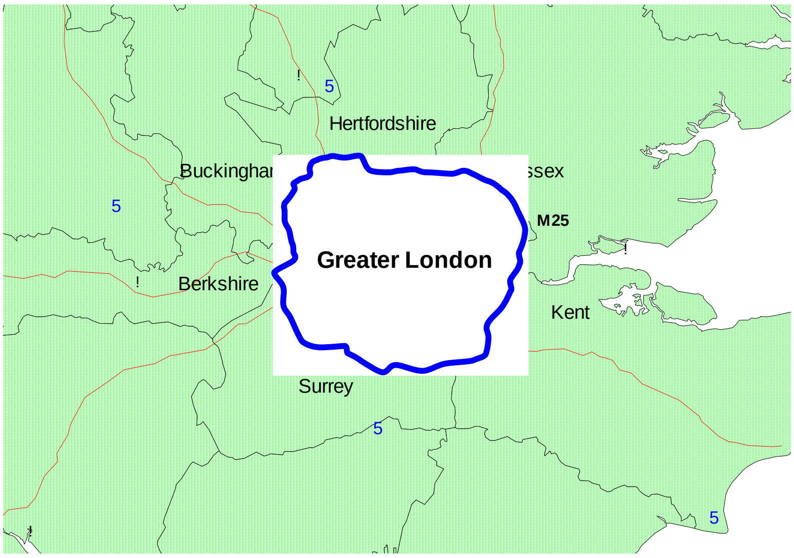

Figure 10.1 Geographical area covered by the LAS

covers 6.8 million residents in this area, a number that increases with the influx of commuting workers during the day and carries over 5,000 patients daily. It receives between 2,000 and 2,500 calls daily including 1,300 to 1,600 emergency 999 calls that the computer aided despatch system has to cope with.

10.2.1 The impetus for change

In the late 1980's the LAS was under enormous pressure to increase its performance. The service was not reaching the nationally agreed Operational Research Consultancy (ORCON) performance figures. The specified time for the ambulance crew to receive the instructions triggered by an emergency call was 3 minutes. The crew was then required to arrive at the scene of the accident within 14 minutes. The LAS were not reaching these targets.

10.2.2 The existing system

The existing despatch system at this time was completely manual, although attempts had been made to implement a computer based system in the early eighties[5]. This had proved unsuccessful in testing, partly due to a change in specification leading to the abandonment of the project in October 1990 at an estimated cost of £7.5 million[6]. Despite this parts of the system were later upgraded and integrated into the new CAD project. It is unlikely that this would have contributed to the successful implementation of the system, although it obviously appeared to have short-term financial benefits for the procurement of the system.

The problems with the manual system were that it was slow and relied on the physical movement of instructions, manual checking of maps, manual checking of ambulance availability and voice communication with the ambulances created bottlenecks in the system. It also relied on the efficiency of the staff, which like all humans can be prone to making mistakes. The new CAD system had to achieve the following objectives to meet the 'command and control' functions required:

- Receive the call, confirm details and locate the incident.
- Identify which ambulance to send.
- Communicate the details of the incident to the ambulance.
- Resource management by positioning of suitably equipped and staffed vehicles to minimise response times.
- Supply management information to assess performance and assist in future planning and resource scheduling.

10.2.3 Hidden Agenda

In addition, the CAD system was seen as a panacea to other problems that had beset the service in their recent history. These included poor industrial relations, outmoded work practices (as perceived by the management) and no reliable information on resource utilization. The introduction of the new CAD system was seen as a catalyst that could justify the changes to working practices that the management team wanted. By taking decision making away from the control room staff the system would reduce any power they had, again allowing for more change. Throughout the entire project, there was little or no consultation with the prospective users of the system – the ambulance staff and the despatch staff. The results of a staff attitude survey carried out by Price-Waterhouse in January 1993[7] are shown in Figure 10.2 highlighting the poor atmosphere in the LAS.

10.2.4 The specification for the system

The CAD system requirements specification (SRS) was overseen by a project committee, the Director of Support Services (the chairman), the system manager, a system analyst (on contract to LAS at the time) and the Control Room Services Manager. Ambulance crews were not part of the committee due to a breakdown in workforce consultation at the LAS.

10.2.4.1 A specification in flux

At this stage, there was no formal approval or sign off of the completed specification[8] i.e. the specification was not 'frozen.' As can be seen from examples in more recent projects this can culminate in design changes at project execution which cause more delay than the sum of

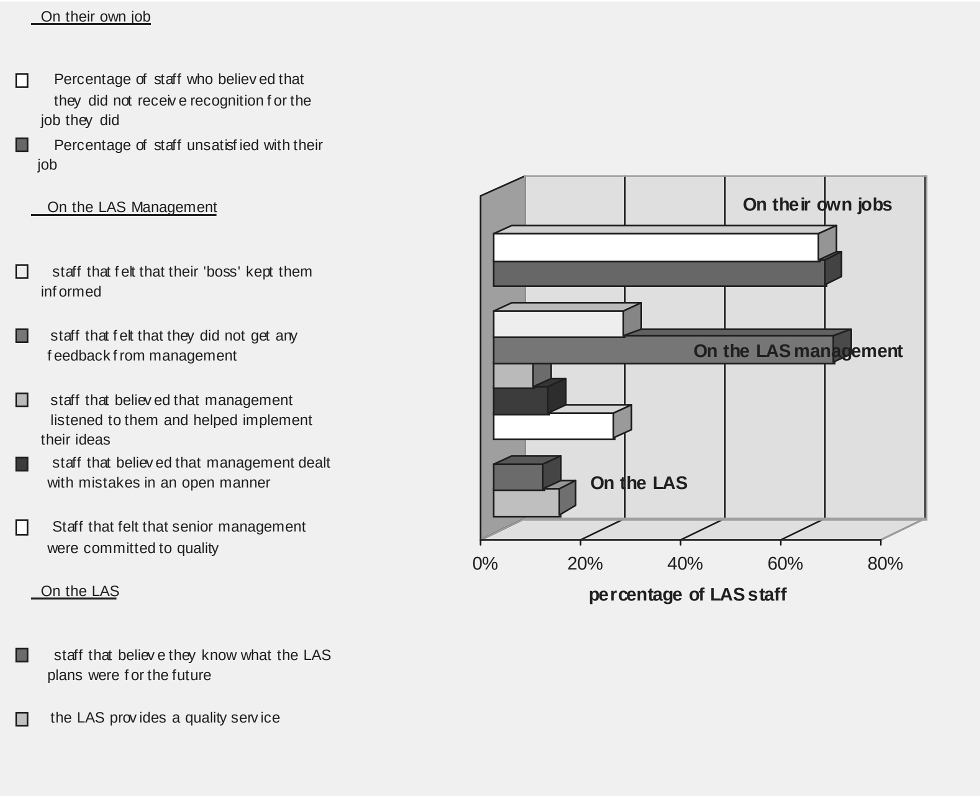

Figure 10.2 Price Waterhouse - London Ambulance Service Staff Attitude Survey

their parts. As will be described later in this chapter (Section 10.3.2.1) Quality Function Deployment (QFD) is one technique that could have been used in developing the SRS. QFD attempts to match and correlate the customer's expectations and needs with the engineering and technical capabilities of the product or service being offered. The user interface was one such example of change in the system specification. A graphical user interface (Microsoft Windows 3.0) was decided upon instead of the original text based interface. This subsequently had an adverse effect on the ability of the hardware to run the CAD application, which would contribute to the overall system failure experienced in November 1992.

10.2.5 Working practices, and the management of change

In addition to the completed SRS a new set of working practices had been drawn up at the same time although without the help of the Central Ambulance Control staff or the ambulance crews, who were an integral part of the whole system. It could be argued that this is not that unusual. At Balfour Kilpatrick (Chapter 8) problems during the project implementation phase were frequently created by the senior management formulating strategies that would have a large impact on working practices without the consultation of the personnel involved, usually at the estimation stage. As labour costs are usually the largest part of project organization overheads, it is common to look for ways of carrying out the same work with fewer personnel. An example of this can be seen in Chapter 8, Section 8.6.10 where negotiations with the cable jointers had to take place to ensure the project's schedule was kept on time. The unique nature of projects means that change can be encountered on a regular basis. Problems appear to arise when there is a difference in the objectives that change is perceived to bring about. Archetypal management looks for cost reduction and the workforce is perceived as being unwilling to change. In reality the LAS control room staff were not against change, the resistance to the new CAD system was perceived to be no greater than in other organizations.[9]

10.2.6 The gap between the project contract and project implementation

Problems appear to exist when an organizations management does not have the requisite knowledge of the project objectives/obligations, which correlates with an unwillingness to listen or communicate with the people who carry out the project work. In discussing project management and project managers, Wearne[10] outlines the conduct of contractual links between client and supplier. The manner in which authority is traditionally delegated is described as follows:

- Contractual links between supplier and client are made at a senior level of management (e.g. director) between the two parties.

- The authority to communicate from the client to the supplier and vice versa is then delegated at least two levels downward.

This is seen as common behaviour in most industries. Committing to a contract is seen as much riskier than ‘carrying out the obligations in the contract.’ Therefore, it is a task left to top management, whether they are a group or an individual. This is understandable, as the senior management in an organization would be expected to possess a global strategic view of the organizations objectives. With the CAD project, the LAS appeared to follow this template[11]:

> “…the logical hierarchy of decisions has corresponded to the classical hierarchy of management.”

Once the decision had been made to use the Apricot, System Options, Datatrack consortium the actual successful execution of the project appeared to be of secondary importance to the management board. By accepting the lowest bid, they had achieved their objective, their responsibility in effect had ended. The ad hoc project team that evolved with the CAD project was then unwittingly left to implement a project that was doomed at conception.

10.2.7 A gap hypothesis

Despite the advent of increasingly ‘flat pyramid’ organizations, the gap between a project contract and the project implementation appears to be a prime factor in a projects success or failure. This gap is also mirrored in the CAD project, amplified by the autocratic behaviour of the executives. The Chief Executive of the LAS set the project deadline for the CAD project that was described by one of the Inquiry team[12] as:

> “…impossible, and we use that term advisedly”.

The timetable and deadline was not discussion with the LAS Board. This has a parallel in quality management; Macdonald[13] refers to the barriers of communication that lead to the failure of many quality initiatives:

> "But the most important barrier which militates against successful implementation is the gap between the intention of executives and the wholehearted commitment of managers and employees.
>
> A typical behaviour pattern exhibited by executives in the launch of a quality initiative can be summarised as:
>
> making the decision with little knowledge of the implication on the systems or people who have to implement them."

T.Capers Jones[14] identifies the lack of reliable information reaching the top management on the actual state of the project as one of two key problems in large scale IS projects (the other having a project champion or sponsor – will be discussed later). This implies that the top management has the prerequisite knowledge to deal with any problems that have arisen at the 'coalface' of the project. But is there a more fundamental problem with a lack of understanding and knowledge of what the project is going to offer and achieve for the organisation? Are the mental models of the customer sufficiently in tune with the reality of what the project can achieve? In her examination of the failed TAURUS[ii] (Transfer and Automated Registration of Uncertified Stock) project, Currie[15] identifies the failure in the preliminary phases of the project:

> "...to conceptualise, the project in technical, political, organizational and managerial terms."

There was evidence of a lack of any clear project sponsor coupled with a number of different groups pursuing their own interests. Currie[16] in carrying out empirical research on managing large scale IT projects at a UK bank unearths further evidence of how senior management are probably not best qualified to make strategic decisions on such projects:

> "One line of enquiry regarding the career progression of individuals into senior management found little evidence of a technical background. This had created a 'shortfall' in business related technical skills which the Director of Technology

recognised as a key reason to 'restructure' the Technology Division."

10.2.8 Further evidence of gaps

The gap between the project contract and the reality of the project implementation is not unique to the LAS. One estimator at Balfour Kilpatrick recounted his experience of how one particular director had lopped £20K off of an estimate (20% of the project value). When questioned by the estimator on how this was going to be achieved the director said that money could be recouped by charging for extras on site. The directors actions were commensurate with the customers desire to go for the cheapest bid every time. Therefore he offered a very cheap contract to the customer, and then he expected the project staff to execute the project using the bare minimum of resources and by charging the customer extra at every opportunity.

10.2.9 Consultation between stakeholders – a key quality attribute in projects?

In the LAS and BK cases there was an assumption that the management was always capable of determining the best use of personnel resources often despite not having any direct experience of the work themselves or without consultation with the personnel involved. Communication and feedback is not sought therefore any decision taken on the alteration of working practices has a higher chance of leading to failure. To achieve project success Wearne[17] registers the importance of 'representation in decisions':

> "Success requires the downstream parties to be involved in deciding how to achieve the objectives of projects and, sometimes in setting the objectives themselves. Human systems do not work well if the people who make the initial decisions do not involve those who will be affected later."

[ii] The TAURUS project was an attempt to create an automated securities dealing system throughout the Stock Exchange, Bank of England and other financial institutions in the city. It was abandoned in March 1993 at an estimated cost of £400 million.

Quality systems promoted by the ISO 9000 series of standards at present do not contribute to this process. Feedback from quality procedures are not used for learning. One of Seddon's[18] arguments against ISO9000 is that it 'starts from the flawed presumption that work is best controlled by specifying and controlling procedures'. Procedures in existing quality systems that are written to enhance the level of quality (usually by a form of monitoring and measurement) do not necessarily provide a conduit of feedback for those personnel actually doing the work. The personnel are not involved in the quality process. In the construction industry there can be a very hierarchical culture and a clear division between the management and the workforce is best epitomized by the saying:

> "The management work from the neck up and the workforce work from the neck down."

Good project teams transcend this division, pooling ideas, techniques and opinions from all sources on the project. This is what existing quality initiatives have failed to capture. In Chapter 1, Section 1.4, Seddon's[19] concept of 'creative anarchy' was introduced. What this research proposes is that successful project organizations encapsulate this as part of their organizational culture. When a system is based purely on monitoring and lacks the ability to encourage an open forum, the innovation, resourcefulness and flexibility that can be exhibited by all project stakeholders in a good project team will depend entirely on personal attributes. It is recognized that there still has to be a decision-maker (or decision-makers), but it is seldom the case that a project manager can have too much information from which to make a decision.

10.2.10 The key role of the project champion for client and supplier

Even at the point of implementing the CAD project, there was no committed project sponsor (or champion[iii]) for the LAS. Wearne[20] describes this key attribute to a successful project:

> "Every project large or small needs a real promoter, a project champion who is committed to its success."

Wearne does not elaborate whether or not there should be a project promoter on both the customer's and contractor side as well. The importance of this is possibly missed in many project management texts. The CRC case study (Chapter 7, Section 7.4.7.1) on the canal pipeline project highlighted the key role played by the British Waterways chief engineer. He had a passionate belief that the projects being carried out to improve the Forth and Clyde canal, would eventually lead to more investment, (in the form of lottery/millennium funding – which has now come to fruition[21]) culminating in the complete restoration of a canal link between the east and west coasts of Scotland. Having a project sponsor on both sides' benefits both parties, with closer cooperation promoting faster decision making, it also lessens the chance of the project failing to meet the customers expectations. If the customer has a project champion they tend to act in the role of facilitator, both in their own organization and with external third parties that are affected by the project, realizing that it heightens the chance of project success. In the Balfour Kilpatrick case study in Chapter 8, National Grid's project manager (the client) acted in this role. By resolving any disputes between Balfour Kilpatrick and other National Grid departments not directly involved with the project, he created a mutually beneficial relationship. A contractor is more likely to flag up any possible problems with a customer that has ownership of the project, therefore allowing pre-emptive action to be taken, to the benefit of both parties.

The importance of a project sponsor is also stressed by Reiss[22] and is identified, as one of two key problem areas in large-scale information system projects by T. Caper Jones[23]. The

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[iii] In this context project sponsor/champion/promoter are one and the same, they describe someone who has a desire to see the project fulfill its objectives and has sufficient authority and responsibility to assist it in these

presence of a project sponsor is also a key factor in assuring that the project meets the desired quality. From the case studies carried out in this research the desired or perceived quality is commensurate with what the project sponsor wants. This makes the presence of the project sponsor essential.

10.2.10.1 The requirement for project promotion at all levels

It is apparent that having a project champion at the upper levels of the organization is a contributory factor to project success, after analysing the case studies it is also apparent that this is true at all levels of the project. In the LAS case study, the company System Option, was not able to, or more significantly not willing to carry out the role of lead contractor in the project. The role of lead contractor had to encapsulate the project management function for the group. Once this happened, not only did the project lack a project champion at the Board level it also lacked a promoter in the lead contractor of the CAD consortium.

In an interview with one overhead line engineer at Balfour Kilpatrick, one key factor that he identified in the degradation of quality was the need for project personnel to have ownership of the projects that they were involved with. When the overhead line squads were assigned to work on one job from start to finish, the level of quality was consistent. The customer then decided to change how the squad was utilized, instead of working on one complete project from start to finish, they were transferred between projects to the work on small parts of the overhead line for short periods of time. Quality has consequently suffered from the lack of continuity, leading to a downturn in profit and an increased chance of customer dissatisfaction. Ownership is an overused term in a number quality management text. It is typically used with terms like ‘empowerment’ and ‘facilitating’ as a way of conveying an often-mythical corporate ethos that in reality is unworkable due to traditional ‘command and

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aims.

control' organizational hierarchies. Yet, despite this, it is apparent in the project environment the concept of a 'team', a group of people who will perform better than the sum of their individual attributes have to 'own' the project or more accurately believe that they can achieve the objectives that are set and see them through from start to finish.

10.2.10.2 Choosing the consortium to provide the CAD system

The original team that formulated the system requirement specification (SRS) became a small sub-team to choose the consortium that would build the system. The System Manager and the contract system analyst were attributed with creating the actual SRS. The aim of this team was to technically evaluate the tenders. As succinctly summarized by Hougham[24]:

> "Thus, a contractor and a systems manager (who incidentally, was arguably unsuitably qualified and knew that he was to be replaced and made redundant) were put in charge of the procurement of an extremely complex and high-risk computer system."

The CAD system was put out to tender on the 7th Feb 1991 and as shown in the Chronology of Major Events[25] in Appendix 3, a consortium was picked to build the system by May 1991. The winning consortium of Apricot, System Options, and Datatrak had to complete the system by 8th January 1992. The tendered bid from the consortium of £973,463 was £700,000 less than its nearest rival, yet there was no questions from either the LAS or the external assessor of the procurement process as to how the consortium were going to achieve the same objectives with 70% less capital.

10.2.11 The validation of the CAD project by assessment

The role of the external assessor (the Scottish Ambulance Service) was similar to that of an external quality auditor as described Chapter 4, Section 4.3.6.2. As an external assessor the Scottish Ambulance Service did not assess the technical feasibility of the project what was assessed was the integrity of the *process* of choosing a bespoke system not the choice itself i.e. the process not the outcome. The fact that the process had been cleared by an external assessor allowed the project to continue oblivious to the fact that the highest risk part of the project, the choice of supplier was flawed. This mirrors quality auditing where the integrity of the system is seen as paramount to the success of the quality initiative, this will then in theory create a better organization. Yet the questions regarding the validity of the system (or in the case of the LAS the process) remain unanswered. It is relevant to note that once the selection of a consortium had been made, the project team for the development phase of the project increased considerably with representatives from most departments apart from the prospective users, the ambulance crews. The lack of emphasis on the technical attributes of the system is indicative of the concerns of the LAS board. It reinforces the hypothesis that cost was the primary concern of the management, and once that had been pegged at the desired level, the technical attributes of the project were of secondary importance.

10.3 Why the Project Failed

In analysing the failure of the LAS project there is no one area, which can be attributed as the prime cause. There was a chain reaction of failures culminating in the eventual operational failure of the CAD system as a mission critical[iv] application. The culture, the procurement process, the inexperience of the contractors, the lack of involvement by the end users, the absence of any project management are just a few of the factors that in themselves could have contributed to project failure. The LAS CAD project did not exhibit just one or two of these problems it encompassed them all.

10.3.1 The principal and contributory causes of failure

Flowers[26] compartmentalizes the causes for failure into principal and contributory groups as shown in Table 10.1.

[iv] Mission critical in this context refers to a project which can have an effect on a possible life threatening situation

Table 10.1 Primary and Contributory causes of failure (Adapted from Flowers, 1996)

Primary causes	System Design
	Management Ethos
Contributory Causes	Inexperience of Supplier
	Inadequate testing
	Timetable
	Poor Quality Assurance
	Poor Training
	Inadequate Project Management

Hougham[27] puts forward his own reasons as to why the project failed which although similar to Flowers, places more emphasis on the inadequacy of the organization to control the project due to the lack of project management expertise. As mentioned in the introduction, Hougham believed that this project should have been carried out as a business re-engineering project, which shall be examined later in Section 10.3.5.

10.3.2 The Design of the System

> " At the heart of this disaster was the creation of a system design that was based on a perfect world where technology works as it is supposed to, people do as they are told, unexpected things never happen, and problems can be designed away. While technically feasible this approach to system design takes little account of the real world where technology is unreliable, people don't do what you want them to, and the unexpected always happens, and problems don't just go away.[28]"

It would be convenient to relate the failure of the CAD system to the design of the system, certainly it has a pivotal role in the subsequent collapse of the system, but in retrospect the design was a product of the combination of objectives that were not all technically based. Full automation was seen as more efficient than a human operator was but as pointed out by Hougham[29] there are situations 'where human brain power is superior to computer logic.' The CAD system could not take into account the need for human intervention, i.e. the entering of information that was from outwith the system like local knowledge. For example, the impact that major events like a football matches or parades were going to have on progress of ambulances in that locality.

System Options the reluctant software contractor in the consortium did not appreciate the mission critical nature of the software that had to be produced for the CAD system:

> "The development team did not have a full appreciation of the importance of these elements or, at least, of the consequences of failure, or less than perfect performance, of any one part"

Ironically, System Options were given the task of leading the consortium. The software was indeed the critical part of the system and as such was primarily being developed as a bespoke system.

10.3.2.1 The rationale for using Quality Function Deployment (QFD)

It is apparent from the case material on the LAS that there was a serious lack of input of information from key project stakeholders in regards to the actual systems requirements. Although that was indicative of the environment at the time, there also was no design process or framework with which to identify vital system requirements. The impact of having no design process has already been mentioned as a major contribution to the systems failure. One quality management technique that could have formalized the design process and possibly identified key attributes needed by the CAD system is Quality Function Deployment (QFD) first introduced in Chapter 4, Section 4.3.5.2. QFD is a technique that documents the overall design logic[30] behind the choices made in creating a design. It achieves this by a series of interlocking matrixes that translate the customer/user requirements into product and

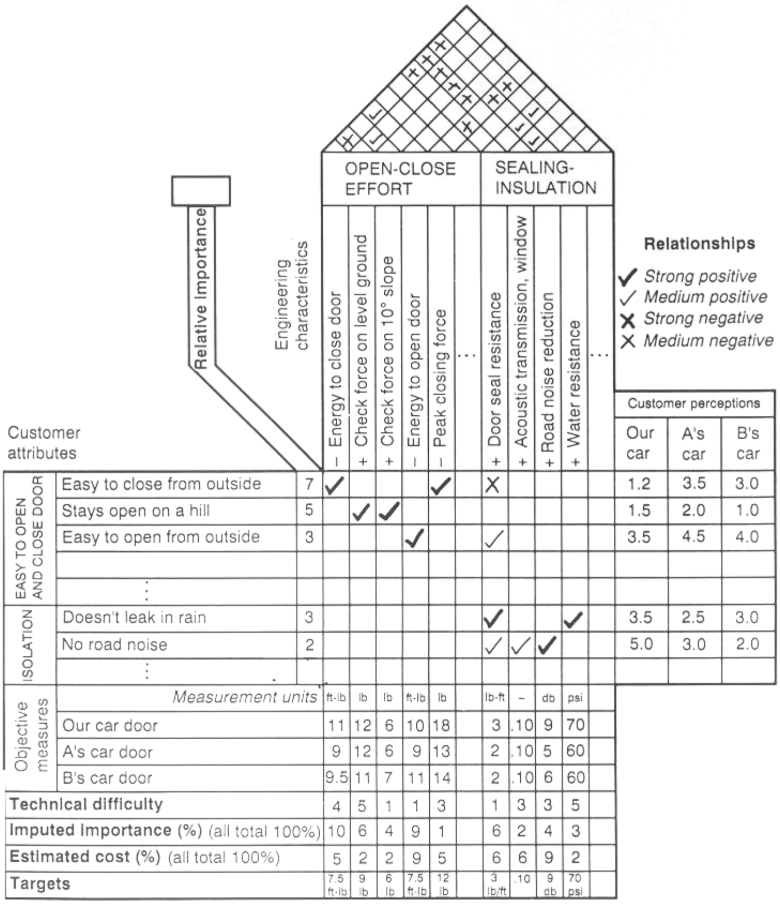

Figure 10.3 The QFD matrix (Hauser and Clausing)

process characteristics. Figure 10.3 illustrates a detailed example of a QFD matrix (sometimes also known as the 'house of quality') for the requirements of a car door, reproduced from Hauser and Clausing.[31]According to Akao[32], QFD is defined as:

> "…is a method for developing a design quality aimed at satisfying the consumer and then translating the consumer's demand into design targets and major quality assurance points to be used throughout the production phase. …(QFD) is a way to assure the design quality while the product is still in the design stage."

QFD was primarily developed in a production environment although it lends itself to be used as a project based tool. Indeed Munro and Faure[33] stipulate that the 'project team' and 'management' must be committed to ensure results from using QFD. Applied to the LAS case study it could have possibly pre-empted the problems that beset the project. At the very least it could have created an awareness of each groups needs and abilities, and forced the LAS to consider the customers requirements, a key requirement of QFD.

10.3.2.2 Culture – Management Ethos

With the advent of massive management cuts and a change of leadership, it is perhaps not surprising that there was a culture of fear at the LAS amongst the remaining management staff. Admission of failure did not take place, which exacerbated the inherent flaws in the project procurement process. It is a common observation in all the case material on the LAS, that if a project manager had been in overall charge of the project there would at the very least have been some recognition that the project would not reach its goals. In discussions with project staff at National Grid (The client organization in Chapter 8) some believed the advent of privatization had created a 'blame culture', which led to reluctance in making decisions, in case there were any negative repercussions. Schedule and cost are everything and function and performance in service are minor. In respect to this case study, Paul Williams of the Inquiry Team, commented that, 'the timetable was impossible, and we use that term advisedly' (the Guardian, 26 Feb, 1993). The lack of real world awareness was reflected in the naive implementation of the CAD system.

10.3.3 The effect of the absence of Quality Assurance in the CAD Project

The CAD project despite the mission critical nature of the final system lacked a formalised quality assurance system to monitor the effectiveness of the work being carried out. The system that was in place was self-governed and wholly ineffective. At the start of the project a company associated with one of the unsuccessful tender bids offered to implement an independent Quality Assurance system, but this was not even considered. Again, cost was cited as the main reason[34]:

> "It is worth noting that ISL (a consultancy firm originally working for one of the unsuccessful tenderers) did, following a later direct approach to LAS and a subsequent invitation from the Director of Support Services, submit a proposal for QA. They did not receive a response. The project team felt at the time the SO (System Options) could be responsible for their own QA and that the external cost should be avoided."

The importance of an independent quality assurance system to an information technology project of this magnitude is that it increases the probability that the software will be totally reliable as discussed in the Abdel-Hamid example in Chapter 6, Section 6.8. The quality control activities in the QA system played an integral part in the testing of software as it progressed towards completion. Figure 10.4 is a theoretical software development model from Muench[35] which illustrates the iterative nature of the process i.e. the requirement stages, design stages, build stages, and the evaluate/test stages.

The software contractor had a limited self-imposed quality system that was rendered ineffective primarily due to unrecorded changes to the software by the developers, which in

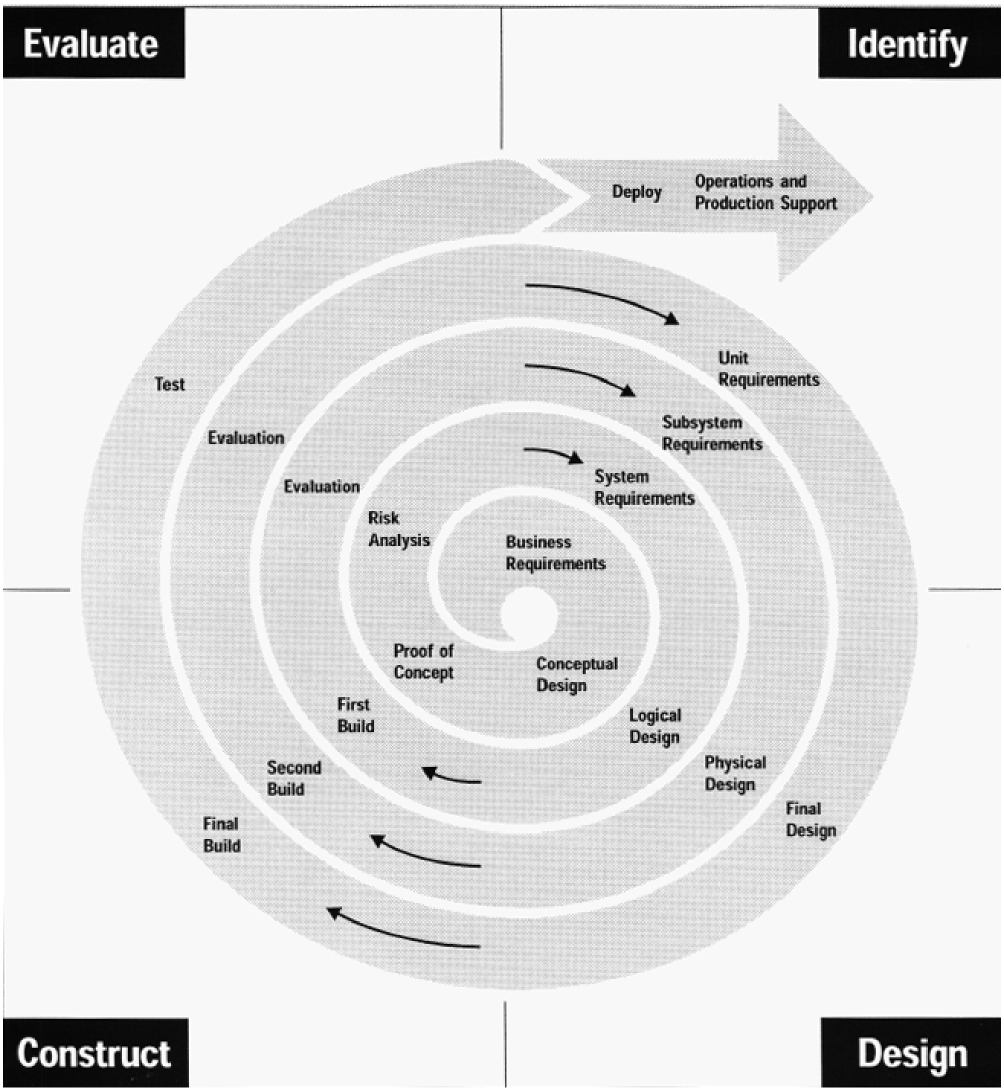

Figure 10.4 Representative Software Development Life Cycle – (Muench, 1996)

turn introduced further bugs into the system (one of the key problem in IT projects outlined by T.Capers Jones as discussed previously in section 10.2.8) The consequence of the poor quality control culminated in the CAD system crashing whilst in operation on 4th November 1992. This was a direct consequence of a software developer leaving extraneous code in the system, just prior to the failure.

10.3.4 The procurement process

The unrealistic implementation date in combination with the underestimation of the total system cost calls signifies the fragmented approach to procurement at the LAS. Coupled with an unrealistic expectation of what the system would achieve. The changes to the external and the internal environment with the introduction of a market led philosophy to what was fundamentally a public sector monopoly, highlighted the scarcity of resources available for a new system.

10.3.4.1 A suppliers perspective on the procurement process

At Balfour Kilpatrick (the case study organization in Chapter 8), the workload was determined by the number of new projects that were put up for tender from the Regional Electricity Companies (REC’s). In Scotland, there are two electricity companies Scottish Power and the Scottish Hydro Board. Following the privatisation of the electricity industry there was a noticeable emphasis on accepting the lowest tender price, regardless of the ability, or track record of the contractor. The resulting project was more likely to be carried out in an unsatisfactory manner, which inevitably leads to a larger cost in the future. One cable contract carried out by BK for Scottish Hydro was 40% less than the nearest bid of BK’s nearest competitors. The viability of the project and how it was going to be implemented at that cost was not questioned despite the trepidation of the project engineer who was going to manage the contract. The project schedule was also very tight, with a specific milestone to be reached every week (corresponding to a section of cable) with the final deadline being an integral part of a larger project. Hence the cable contract was on the critical path of the overall project. At that time Balfour Kilpatrick’s overhead line unit in Scotland had to cope with a lack of work, due to the lack of investment in the electricity infrastructure by the two Scottish electricity companies. The decision was taken to use overhead line personnel to carry out the project at Forfar guided by a small number of experienced cable personnel. This would achieve two aims, use an underutilized resource, and prevent the need for any redundancies in the overhead line unit. Whether the overhead line personnel were capable of the work was not seen as an insurmountable problem.

10.3.4.1.1 Justification for undercutting

The low price bid for the contract was also justified by the director at the time, who believed that additional monies could be claimed through identifying extras, i.e. activities that the customer could be charged for outwith the contract specification. Offering to carry out the jointing of the cable after the contract was underway, was perceived as making the project more financially acceptable. It was also believed that there was more projects coming up for tender and any losses would be recouped on subsequent work. The customer had foreseen this likelihood and had produced a contract that made the claiming of extras virtually impossible. At that time projects of this type had a bill of quantities that broke down each part of the contract into different activities e.g. excavation per m^3, supply of infill material per m^3, installation of cable per m, each activity having its own price. The customer and the supplier would measure and agree the work as it progressed and the cost to the customer was based on the bill of quantities rates. This way any deviations that arose in the execution of the project e.g. larger excavation size due to other existing utilities, would cover any extra expense incurred by the supplier.

10.3.4.2 Fixed price contracts

At Forfar, the contract was simplified into a lump sum fixed price contract. It specified that BK had to supply and install the cable to the correct specification for the agreed price. Any deviations in the contract were the sole responsibility of Balfour Kilpatrick and seen as part of the lump sum. At face value this appears to benefit the customer, any extra work carried out during the project that occurs due to unforeseen problems (technical or otherwise) is paid for by the supplier. This eliminates the need for constant measuring and monitoring by the customer as the price is fixed. The supplier is now forced to take more risk. A fixed price contract should be based on an accurate and precise survey of the project and will have a profit margin, which takes into account any possible alterations during its execution. In the market place, where price is seen as an overriding criterion in many tender bids, suppliers like Balfour Kilpatrick reduce the price of their bids in order to win contracts but still strive for the same profit margin. Therefore any contingency built into a contract is reduced or removed altogether. In effect, the supplier gambles that the project will not encounter any deviations from its intended programme or specification. The onus is then on the supplier to cut cost throughout the project, which paradoxically increases the risk and reduces the likelihood of its successful implementation. Successful projects often depend on a degree of flexibility; it is often impossible to specify the project 100% in advance. A contractor is unlikely to provide the essential flexibility at a reasonable cost if the original contract is too restrictive.

Although the scale of the Balfour Kilpatrick project carried out for Scottish Hydro Electric was considerably smaller than the LAS CAD system, the procurement process placed great emphasis on the cheapest option. Railtrack in the case study on the Lochy viaduct project also viewed cost as the primary driver in their decision to award the contract to a relatively unknown contractor as opposed to CRC. Railtrack informed Mr. Clements the director at CRC that their bid was unreasonably high and they would not accept its conditions.

10.3.4.3 Transferring the Risk and Private Finance Initiatives

Large organizations like Railtrack, National Grid, and Scottish Hydro Electric appear to promote the culture where a supplier must accept all the risk associated with a project as well as delivering the lowest price. Private Finance Initiative (PFI) schemes[v] have become a popular form of project funding in the public sector as it is seen as a way of transferring the

[v] Also known as Private Public Partnership schemes (PPP) by the present government

higher risk elements of a project onto the supplying party as discussed later in Table 10.2. There is a global lack of responsibility to make decisions regarding the choice and implementation of projects, which can be mirrored, by the lack of decision-making that appears at an operational level. It could be speculated that this has been exacerbated by the trend to reduce or eliminate the amount of actual projects carried out in-house by these organizations hence losing the necessary operational expertise required to identify a good or a bad project proposal. At the LAS there was very little thought given to the feasibility of the project both technically and operationally, possibly because of a lack of knowledge of information technology.

Organizations often seem to overestimate the abilities of an information system, expecting it to produce massive gains in business performance. Like the LAS the reasoning behind the TAURUS project was not just seen as the implementation of an IT system as highlighted by Currie[36]:

> "The rationale for TAURUS was fourfold. First the ISE believed that computerisation was necessary to remain competitive in a global market. Second, dematerialisation was perceived as synonymous with greater efficiency and reduced bureaucracy. Third, the financial benefits of TAURUS were believed to be immense and in accordance with the 'downsizing' and job rationalisation of the ISE."

The project objectives are not just contained within a finite defined boundary but extend to become an integral part of an overall business strategy or a business process. Hougham[37] believes it is this lack of integration with the overall business strategy that led to the failure of the LAS CAD project:

> "The management did not appreciate that this was a business re-engineering project and tried to run it as a project for the purchase and installation of information technology."

To the author this implies that a holistic view has to be taken of strategic projects of this nature, and the theories of business process re-engineering should be applied to projects of this magnitude. Despite offering this reason as one of the failures for the project, Hougham doesn't elaborate on what a business re-engineering project could have achieved had it been applied.

10.3.5 Business Process Re-engineering

Hougham[37] believes that the management of the LAS did not realize that the implementation of the CAD system was more than just the introduction of new technology, but a Business Process Engineering project. The term 'Business Process Re-engineering' (BPR) is synonymous with two particular management theorists Hammer and Champy. The widely used definition of BPR[38] is that it is:

> "…the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed"

BPR is also heavily linked to 'quality' and 'information technology' as described by Micklethwaite and Wooldridge[39] in their robust critique of the practice and the reasoning behind its popularity. Indeed they argue that Total Quality Management and the increasingly availability of desktop computing contributed to the fast uptake of BPR as a worthwhile practice. The rationale behind BPR is that to be competitive an organization must re-invent the processes that it uses to supply the services or product that it provides preferably utilising information technology to enhance the process. In doing this it will create opportunities by 'redefining the scope of the organizations business[40]'. The ethos of continuous improvement, which underpins TQM, is seen as too slow in today's business environment and more immediate results are gained through BPR.

Systems dynamics also has advocates of BPR. The link between BPR and TQM is illustrated by Richmond[41] in the ithink Process Improvement Module as shown in Figure 10.5. He emphasises that BPR does not replace TQM, it merely moves it to a follow-on position in the 'process improvement cycle'. To implement BPR there is a premise that the 'process' is fundamentally 'broken' allowing the re-engineering project to start with a clean sheet[42]:

> "They [the advocates of BPR] argue against making incremental improvements in processes that are in need of radical redesign – i.e., don't re-arrange deck chairs on the Titanic"

In the case of the LAS CAD project, it is evident that certain core competencies were far from ideal, but it is also apparent that at the time, there was not the ability or more importantly the resources to attempt this type of radical endeavour. Therefore, it is believed that Hougham's assertion that the CAD project should have been carried out as a re-engineering project could be seen as rather idealistic, despite the fact that many large-scale information systems projects are seen as 'key enablers[43]' to business process re-engineering projects.

At a more general level, Micklethwaite and Wooldridge[44] believe that management theories

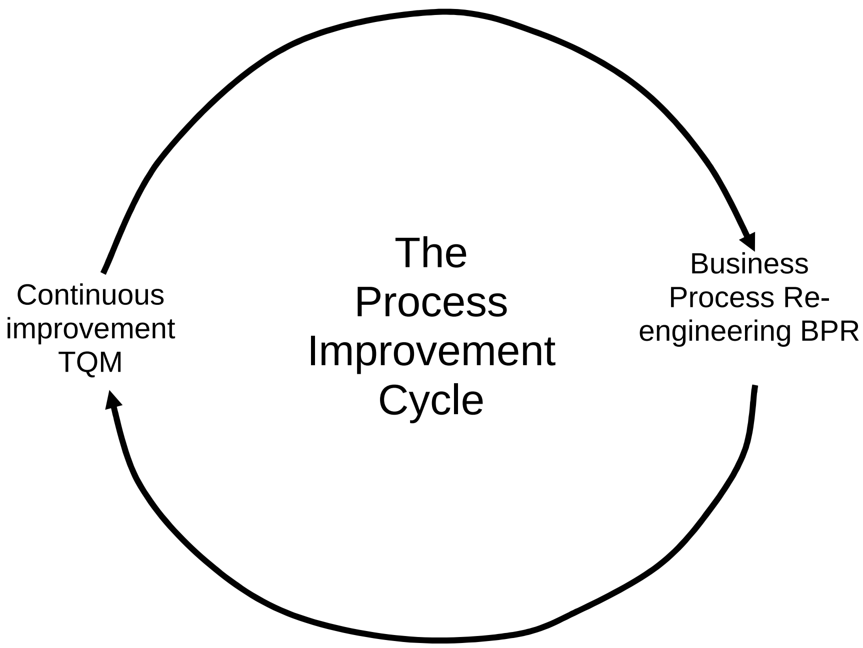

Figure 10.5 The Process Improvement Cycle

are frequently proved to be lacking when applied to public sector businesses especially those in health and education. They list downsizing, re-engineering and total quality management as the 'three most popular fads' in the public sector, highlighting the paradox that these management theories are 'substantially incompatible'. Opinion and evidence appears to be a divided as noticed by Homa[45] on whether or not quality initiatives are a precursor to re-engineering projects.

10.3.6 Exploring the procurement decision and the theory of 'Groupthink'

Systems Options the reluctant contractor – was told about the earlier abandonment of a previous project due to the earlier software house underestimating the complexity of the software needed. Bearing this in mind it is surprising that the LAS committee did not have any doubts regarding the winning consortiums price or ability to carry out the work. At £973,463 it was £700,000 cheaper[46] than the next nearest bid. Flowers[47] believed that there was some evidence of the phenomenon of 'group-think', which refers to a process of group dynamics formulated by Janis. Janis[48] argues that there are crucial situations where executive groups have made poor and unsound policy decisions (particularly in a critical situation), which are symptomatic of reaching conclusions in a group. Table 10.2 gives a framework of the symptoms as described by Jarvis[49] of "defective decision making" and complemented by examples from the cases studied in this research.

Table 10.2 Identifying symptoms of 'Groupthink' in the Case Study Examples

Symptoms of "defective decision making" attributed to 'Group-Think	Case Study Examples
Major omissions in surveying alternatives. The group fails to explore all possible alternatives. Maybe one idea only is focused on with scant attention to other ideas. There are omissions in surveying group objectives. The group fails to consider all possible objectives available to choose from. The best objectives may not be chosen	With the LAS the focus on cost appeared to be a deciding criteria for the senior management team. The Board of the LAS made the final decision on what was the winning consortium. There was no documented evidence of any discussion taking place as to the discrepancies between the bids or the external assessors comments.

Symptoms of “defective decision making” attributed to ‘Group-Think	**Case Study Examples**
	No alternatives to the ‘quantum leap’ approach taken in implementing the new CAD system appear to have been examined e.g. a phased approach to implementation combining the existing manual system with the new elements.
Costs and risks of preferred options are insufficiently explored. Assumptions are made and possible negative outcomes readily discounted or overlooked.	It could be speculated that the decision by Railtrack to use an untried contractor and an untried method in repairing the Lochy Bridge was not examined in depth, conversely Railtrack believed that once the project has been accepted the risk and liability are transferred onto the supplier. With the LAS, legal redress after a previous IT project failure[vi], could have contributed to a belief that in the event of the project failing, there could be similar action taken to ensure no financial loss was accrued. This is supposition but it is valid in terms of how organisations operate. Minimise the risk financially operationally and legally by transferring the onus to the supplier. In 1996 Smith System Engineering[50] carried out a review of the LAS mobile communications systems to recommend a strategy to address its current and future mobile communications needs in support of its entire ambulance fleet. Part of the study identified which technical and procurement options would provide an opportunity to

[vi] After abandoning a project at the cost of £7.5million in 1990 the LAS sought damages from the suppliers of the failed system, a settlement was reached in 1991 (Flowers S, p54)

Symptoms of "defective decision making" attributed to 'Group-Think	**Case Study Examples**
	exploit PFI (Private Finance Initiative) in a cost effective manner, thus enabling the LAS to transfer major elements of risk to the private sector. Existing quality systems stress that one of the benefits of having a documented quality system is that it can aid in reducing the risk to the organization. This is done by passing the risk onto the supplier.
Information searches are superficial and lack penetration There is a failure to obtain all possible data needed for decisional effectiveness. Information searches are incomplete, with poor techniques and often selective filtering of the results when communicated to others.	Two of the supplier references for System Options the lead contractor of the consortium to supply the CAD system to the LAS referred to the companies resources already being heavily committed on other projects. Although an external assessor (the Scottish Ambulance Service) approved the selection process it did make an important proviso regarding the management's need to ensure that a bespoke system was justifiable.
There is bias and selectivity in processing available information The group tends to choose certain information excluding valuable items that "do not fit their picture".	It is questionable that Railtrack gave serious attention to the tender supplied by CRC to carry out the repairs to the Lochy Bridge. The fact that the project was based around a significantly different method was in hindsight possibly too radical a departure from their existing experience. The many consultants that Railtrack employ to assist their project teams would certainly reinforce this as the project solution offered was outside their expertise. Also the CRC bid was prepared to minimize the risk to the bridge and to the company itself, resulting in a price which Railtrack deemed to be too

Symptoms of "defective decision making" attributed to 'Group-Think	**Case Study Examples**
	expensive.
Rejected alternatives are seldom and objectively re-examined. Alternatives, which may be rich in potential, are left discarded and unheeded.	Following the proposition by CRC for the Lochy Bridge project, Railtrack would not justify their reasons for refusing the CRC bid outwith of the price being too high. The London Ambulance Service rejected the idea of having an independent Quality Assurance system implemented on the project consortium by another company. It is doubtful that this would have prevented the project from failure but it may have given warning of forthcoming problems.
The "groupthink" group fails to work out implementation, monitoring, and contingency plans in sufficient detail - considering worst case scenarios etc and overassuming which is/is not possible. Possible consequences and future problems are ignored or glossed over.	In the LAS decisions and recommendations were passed between teams and committees with no real project driver appearing to be present at any stage. There is an air of detachment, as if at each stage of the procurement process someone else will take responsibility for the project.

10.4 Comparisons with the LAS CAD project

There are parallels between the LAS case study and the primary case studies carried out in this research. Like Railtrack and Balfour Kilpatrick the LAS used project cost as the primary factor in their choice of 'performing organization[vii]'. In the Lochy Viaduct project (Chapter 7, Section 7.3) Railtrack took a risk in choosing the lowest price to carry out the work and to use an unknown contractor to carry out the work. Railtrack in common with the LAS have seen some major upheavals in their operating environment in recent years, with the fragmentation of the rail network into different commercial functions, and a reduction in

[vii] Definition of performing organization – the enterprise whose employees are most directly involved in doing the work of the project (PMBOK, p15)

government capital expenditure.

Unlike the LAS, Railtrack and Balfour Kilpatrick are geared towards working in a project orientated environment, and as such possess the prerequisite project management expertise (either in-house or provided by external consultants) to lessen the risk of failure. This is important as although the Lochy project (Chapter 7, Section 7.3) outlined a failure in respect to the main activity of the project, (the sinking of the specialist excavator in close proximity to the bridge) the situation was redeemed and the project completed. On a smaller scale the Lochy Viaduct project was also ‘mission critical’, the safety of the trains and passengers using the bridge and the safety of the contractors carrying out the works was the primary concern. The difference between Railtrack and the LAS was in how that risk was quantified and delegated. Railtrack left prospective subcontracted organizations in no doubt as to whom was responsible if the project failed. The risk both financial and operational lay completely with the performing organization. This does not appear to have been as explicit in the LAS project (although perhaps there was the assumption that a fall back on legal redress would be possible as with the previous failed IS project). With no proper project management in place an unfeasible project was inaugurated, this continued unrecognized until it was too late.

It is worth noting the difference in how risk is perceived and dealt with. Both Balfour Kilpatrick and CRC were well aware of the risks involved with the type of projects that they carried out, due to the accumulated experience of working in a project environment and as contractors in a competitive commercial environment. The management at both of those organizations would take financial and operational risks in an effort to create more work and increase the prosperity of their companies. In effect they would attempt to manage the risk, (not always successfully) balancing it with the financial demands of the organization, throughout the project life cycle.

In studying the material on the LAS it becomes apparent that the management are not even aware either commercially or operationally how much of a risk they were taking. As a public sector organization with a number of different project stakeholders, that was not routinely involved in commissioning projects, it would always have been a difficult task to create a coherent unified approach to specifying the aims and objectives required by the CAD system. In the demoralized environment at that time, where sweeping changes to management had been carried out and industrial relations were very poor, the lack of leadership needed to drive the CAD project was just not present, leading to inevitable consequences.

10.5 Conclusions

The key failure in this project occurred prior to any involvement of the consortium that carried out the project. None of the requirements seen at the start of the spiral in the Software Development Life Cycle in Figure 10 4 were met by the LAS, which included:

- The Business requirements.
- The Conceptual Design.
- The Proof of Concept.
- The Risk Analysis.
- The System Requirements.

Indeed the iteration of Identify, Design, Construct, and Evaluate shown in the model was missing throughout the whole project. The over riding concern of staying within an unsubstantiated project budget had eclipsed all other factors to be taken into account. It has been well documented that the CAD system was seen as panacea to more problems than just the poor response times.

On initial analysis, it appears that there is a case for implementing a quality assurance system

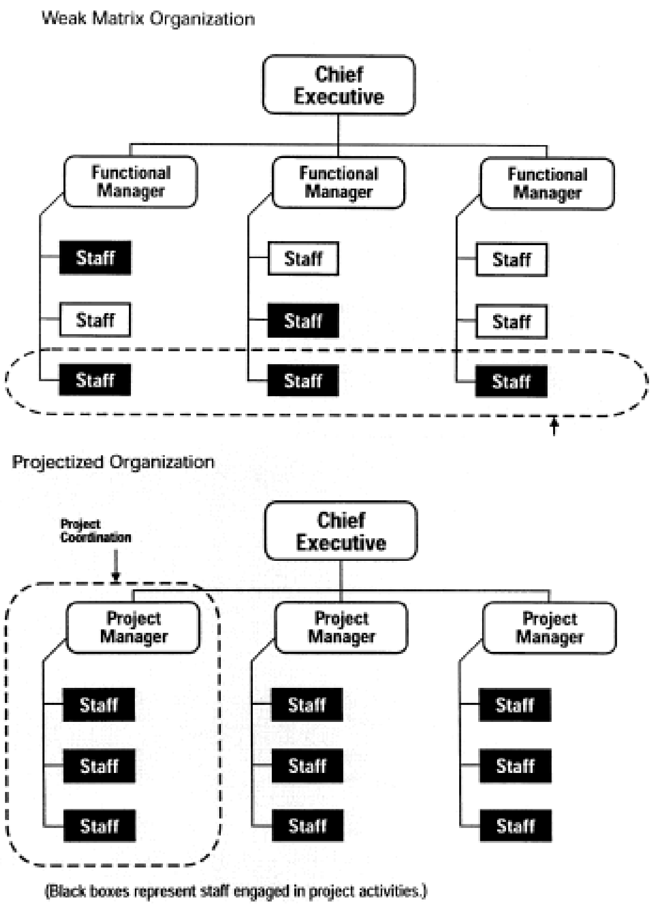

Figure 10.6 Contrasting organizational structures

in mission critical projects of this type, yet in all the case study material there was no differentiation between quality assurance and quality control. This may seem pedantic as quality control is usually encapsulated in some form in a formal quality assurance system, but as pointed out by T.Capers Jones[51] the most frequent cause of disaster in software projects is poor project management and inadequate quality control. Another observation that is mentioned in the same article is that a matrix management system in an organisation produces a greater software project failure rate than a hierarchical structure. The Project Management Institute[52] representations of a 'projectized organization' and a 'weak matrix organization' are contrasted in Figure 10.6 and reinforce this viewpoint. It is not known if the LAS organizational structure bore any relationship to the weak matrix structure shown but the fact remains that there was a dearth of project management ability. The key decisions that were made were determined by a committee technically and managerially isolated from the key project stakeholders.

Following the extensive inquiries into the system crash, the LAS took a radically different approach to their technological requirements and the consequences of their implementation. The strategy outlined by Tighe[53]was designed to:

- Reduced complexity of operations.
- Concentrated upon key deliverables.
- Paid attention to staff and their needs.
- Establish a workable but acceptable pace for delivery and implementation.
- Build upon a number of new infra structure changes (these were a combination of new hardware systems, and 're-engineered' control procedures).

In 1996 an interim system was implemented. It is interesting to note that unlike its predecessor this system was prototyped with the users, who also had an input to the process. The business needs were also continually reviewed to guarantee the LAS's requirements were also being met. The spectacular and public failure of the project has resulted in the London Ambulance Service re-evaluating their approach to both operations and project management having learnt from their project failure. Argyris (cited by Micklethwait and Wooldridge[54]) argues that 'failure is a better teacher than success':

> "Success can only generate what Argyris calls 'single loop' learning (I did X and it worked); failure, on the other hand, can generate 'double loop learning', in which people question the assumptions behind their failures as well as the failures themselves."

This concept shall be examined further in relation to project success and failure in subsequent chapters. As with the previous case studies, Table 10.3 provides a cross reference guide to the areas from the LAS case study that are relevant to the objectives of the research and to the general debate of the role of quality in projects.

Table 10 3 Cross Reference Table

LAS experience	**Subsection**	**Relevance to research objectives and the general debate of the role of quality in the management of projects**	**Chapter(s) and subsection(s)**
External assessment as a method of determining project capability	10.2.11	Investigating the pertinence of the models implied by existing quality initiatives…[the research's first objective] The audit function as a valid form of improving quality in a project environment	Chapter 8, Section 8.8.3
Risk transfer	10.3.4.3, Table 10.2	Risk in existing quality systems, risk assessment risk transfer.	Chapter 11, Section 11.4
Project accountability	10.2.6	Project environment as a	Chapter 11. Section 11.5.3.4 Chapter 12, Section 12.2.3
Project champions	10.2.7, 10.2.10	Advantages of positive relationship between client and contractor	Chapter 7, Section 7.4.7.1, Chapter 9, Section 9.7.2.1
Cost as a driver in project decision-making	10.2.9, 10.2.12	The consequences of using cost as a key project driver as opposed to quality	Chapter 7, 7.3.6
Design issues	10.3.2	The impact of design on project quality.	Chapter 8, Section 8.6.9

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Chapter 11

Synthesis of Findings

11.1 Chapter Synopsis

This chapter synthesises the various elements that have been examined observed and investigated throughout this research. It strives to provide responses to the main aim of the research stated in Chapter 1 and repeated here:

1. *To investigate the pertinence of the models implied by existing quality initiatives in a real project environment and their possible contribution to future project success.*

This chapter will also in the course of examining the case studies tentatively define the concepts, which will be exploited in Chapter 12 to create an alternative model for quality in projects. In drawing together the findings of this research, it will become apparent that there is a growing need for organizations to harness the knowledge that is inherent within their own personnel. Flourishing project organizations have managed to capture knowledge from past projects to feed forward and improve their chances of future project success. However, this is seldom an explicit process. Quality management, with the systems it promotes, should be able to make a considerable contribution to this feed forward process. Nevertheless, quality management is not always seen as an integral part of the strategy of success for project organizations: some appear to view it as an extraneous system that appears not to have the backing of the vast majority of its users.

11.2 The pertinence of quality systems in common project management practice

11.2.1 The Importance of Quality; Comparing Theory vs. Practice

Quality is described by the Project Management Institute[1] as one of the essential elements in project management (PM). This can be found in other PM texts, Dingle[2] states that everyone in a project must be involved in quality. Yet, the author's initial experience, his 'pre-understanding' of quality in PM did not reflect this importance. To recapitulate, the concept of 'pre-understanding' defined by Gummesson[3] was that it referred to a person's:

> "insights into a specific problem and social environment before they start a research program or consulting assignment; it is the input."

When working in a project environment the author's experience was that very few people appeared to take quality management as a serious aspect of PM, with the exception of the designated 'quality representatives'. A quick, efficient method of confirming the generality of this personal experience of quality management in project management was required before embarking on detailed research. As outlined in Chapter 2, (Section 2.2.1.2)

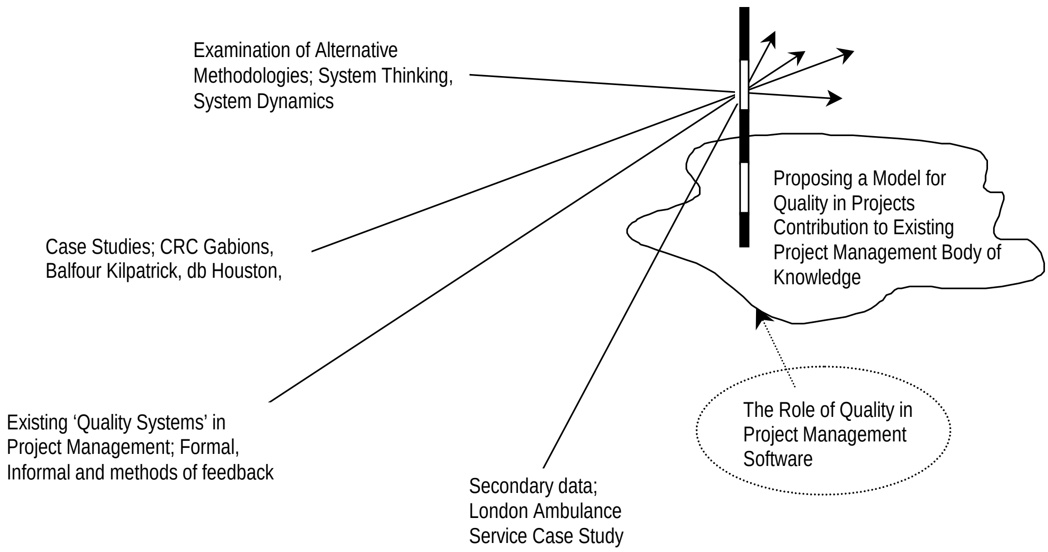

Figure 11.1 The key 'triangulation points' which contribute to the research.

questionnaires were not believed to be an appropriate form of data collection in this instance due to:

1. The limited timescale available and the accuracy of the answers.
2. The difficulty in creating valid unambiguous questions that could be answered in context.

3. The limitation a questionnaire would place on other sources of data. As discussed in Chapter 2, studying a complete project allowed access to more than one source of data, providing a breadth and depth of data that is not available from questionnaires.

Action research, as outlined in Chapter 2, highlights the validity of using 'pre-understanding' as a basis for accessing accurate data. Therefore, to utilise the author's pre-understanding the techniques of 'participant observation' and in part 'action research' were used to gather primary data to created the main case studies. The objectives of the initial research were to draw comparisons between the theory of quality in project management and the practice of quality in project management. A survey carried out by Abdul-Rahman[4] on projects in the construction industry provided tangible evidence that the application of quality management and its systems were limited in project management, which gave credence to the personal preconceptions of the author. What was striking about Abdul-Rahman's article despite the title of the paper, was the absence of any examination of the appropriateness of the quality system to construction projects, in particular how it has been interpreted for the management of quality in projects. Poor implementation of the quality system was seen as a 'factor that leads to poor quality in construction, even when a quality assurance system exists'.

Consequently, this led to the examination (and subsequent rejection) of project management software as a possible triangulation point for the research as illustrated in Figure 11.1.

11.2.1.1 Rationale behind examining PM software as determinate of quality practice

As discussed in Chapter 4, Section 4.4 there is very little definitive information on the practice of quality in project management in the literature therefore it was decided to use project management software as a gauge to its current state. If quality management had been incorporated into project management in practice, it might be expected that this would be reflected in the commercial software: there are over 200 competing software applications[5] so if QM is a vital part of current PM practice, it should be mirrored by the importance placed on the role of quality in PM software. Following the first examination of this thesis, it has been recognized that this was not a rigorous enough indicator. Despite this the author has felt that the information presented in sections 11.2.1.2 – 11.2.1.7 provides a useful background to the reader on the role of Project Management Information Systems and PM software which has some relevance to the discussions in Chapter 12.

11.2.1.2 Project Management Information Systems and PM Software

A Project Management Information System (PMIS) is defined by Nicholas[6] as a system or methodology which allows the project manager to gather, retain, process and disseminate the kind of information that is needed to manage a project. Nicholas points out that a PMIS can be a manual or automated system. In the course of this research, the author discovered that using PM software in practice could not necessarily create a complete PMIS. Typically, PM software just contributes to the complete PMIS and it would be more appropriate to define a PMIS as a combination of both automated and manual systems. Therefore, although PM software in itself is an 'automated system' it has to be used in context with the other tasks and functions required in the management of projects and as such are not a standalone solution. Leavitt and Nunn[7], stress that users often know how to run the software but they do not know how to disseminate the information they have created:

> " They don't know what it's telling them or why it's telling them what it is. They don't know how to use the information the software produces. They don't need software training – they need project management training."

How the software is used is also determined by the size of the project (or number of projects) what role the project team member has and if there is sufficient time available to devote to the inputting of data. When Microsoft Project was used on the Balfour Kilpatrick project (Chapter 8) the actual abilities of the package were not particularly stressed; due to the trade-off between inputting data versus managing the project, the form of the contract (lump sum contract), the availability of accurate costing and the actual documentary requirements of the project sponsor. The project in the Balfour Kilpatrick case study was relatively small, therefore the role of managing the project was a ‘hands on’ process, and there was insufficient time or resource to spend inputting the continual changes to the project programme.

11.2.1.3 Rate of change in available technology

It is indicative of the rate of change in the capabilities of PC’s and project management software packages that the different categories of PMIS have become increasingly blurred. This has been acknowledged by Nicholas[8] who divides PM software into three categories:

1. Software that could create Gantt charts or PERT/CPM analysis with little incorporation of labour, resource costs.
2. Software for the cost, labour and control, i.e. comparing actual cost versus planned cost, summary reporting by work breakdown structure, organizational structure or cost-account structure.
3. Software that combines both the above categories and have some project modelling capability.

From the 1994 Project Management Exhibition discussed in section 11.2.1.5, an important distinction was apparent between applications that are specifically for project management and those that encompass management information systems and are more general in their function (typically database management systems). Project Management software is changing rapidly in a competitive environment; therefore it is likely to reflect needs/practice of project management. The rate of change is important because of the competition involved in the project management software market.

11.2.1.4 Reflecting the latest trends in PM?

The role of this part of the research was to identify whether PM software applications addressed any key quality issues in project management, either on existing quality models or on any other models. Articles on PM software have subsequently reflected the areas ‘in vogue’ at the time as shown by an article by Conlin and Retik[9] in 1997 which examines advanced IT tools such as knowledge-based expert systems (KBES’s) and visualisation techniques. No form of quality is mentioned. A valid point made in this article is the attention drawn to the number of software houses that have added to the plethora of PM applications available, not all of which meet every users requirements. Therefore, it has to be recognised that the PM software market used as a guide by this research is itself, going through its own life cycle. This will see attributes of the product change in order to gain market share, but may not reflect the most recent developments in project management. Leavitt and Nunn[10] certainly believe that the offensive of software salesmen promoting PM application has created a ‘myopic view’ of what the role of project management is, creating a perception that it is no more than a sophisticated form of scheduling. An inspection of one current internet based article listing project management software illustrated the overabundance of project IT systems available with the emphasis being on the technical capabilities of the software rather than the functional aspects of the applications[11].

It is apparent that the PM market is a very lucrative one and as such, it has warranted a large degree of attention (and capital) by software developers. This has lead to a situation (epitomised by events like the Project Management Exhibition in Section 11.2.1.5) where PM software has become the most ‘visible’ aspect of project management, creating the perception that project management software encapsulates project management. This observation appears to reduce the validity of this research's initial assessment that has been used to determine the current role of quality in project management. It does reduce the validity and perhaps negates the premise that the software is a 'visible reflection' of what is important in the project management world. Whilst intense competition between software companies has driven them to explore various facets of project management that they can incorporate into their software and to succeed in the marketplace it may not be a valid indicator of the role of quality in project management.

11.2.1.5 Project Management Exhibition

The capabilities of personal computers and the increasing accessibility of project management software have meant that there appears to be a lucrative market in this type of software application. The 1994 Project Management Exhibition illustrated the plethora of PM software available to project teams. Indeed, since that time project management software has been marketed increasingly with mainstream 'business' software applications. Microsoft Project is the highest profile of these applications in part due to the wide-scale use of Microsoft's other software applications and its rating against other PM software. It is debatable that the rise in the popularity of such packages is due to an increased awareness in project management as a whole, or the increasing accessibility and marketing of such packages by software companies expanding their markets. In the context of this research, it was decided that the PM software would sufficiently reflect the current state of the art practice in project management.

11.2.1.6 Finding a quality function in PM software

It was expected that with the advent of industry recognised quality standards like ISO9000 one of the many PM software developers would have incorporated some facet of quality into their product, even at superficial level. In reality, there was almost no mention of quality in any form. At the exhibition, the majority of the company representatives approached admitted that their product did not incorporate any quality related abilities, indeed a number believed that the actual packages were never fully utilised to their full potential. Areas that were being incorporated into the applications included some forms of risk analysis/management.[12] Of the fifteen applications that were examined from the 1994 Project Management Exhibition there was only one package that addressed 'quality' and it emphasised that it was aimed at quality managers. The application, Hoskyns Project Bridge Modeler was part of a modular PMIS.

It was described as a planning and estimating tool which built up a profile of each project to allow a 'combination of facts and assumptions' to be stated 'up front'. The application was presented as being able to allow quality managers to improve planning consistency, encourage the use of standard life cycles and provide a basis for a continuous improvement programme. In essence, it appeared to be a planning software application, which had the facility to map a 'standard life cycle' onto the project plan. As part of the complete system package Hoskyns would supply a number of 'life cycles' to match the 'way in which your organisation develops systems.' In conclusion, it was difficult to ascertain any tangible difference between the functions offered by the Project Bridge Modeler software and other less modular PM applications. It was evident that Hoskyns like many of the other companies were offering a consultancy service in addition to their modular PMIS and this was an integral part of the product.

11.2.1.7 The role of quality in PM software: a summary

In concluding the investigation of the role of quality in PM software, it was felt that none of PM software applications addressed any key quality issues in project management, either in existing quality models or in any other models. Whilst this outcome appears to highlight the lack of importance placed by project management on the role of quality management, the robustness of using PM software as a proxy guide to the presence of quality has been questioned and as such it has to be disregarded as a valid indicator.

11.2.2 The project,quality paradox

Quality texts frequently refer to project management and its techniques when describing the typical implementation of a TQM initiative or an ISO9000 based quality management system. Implementing the quality system is seen as a project with a defined timescale, scope and objectives. It is somewhat of a paradox that the main role of project management in the context of quality is usually as a methodology for implementing an industry-recognised quality system like ISO9000 or a large-scale TQM initiative.

11.2.2.1 Using PM for quality system implementation

There is far more emphasis on the project management of quality systems implementation than the quality management of projects. Beckford's chapter[13] on implementing quality programmes is a typical example of this. He puts forward two methods of implementing the 'quality' project:

1. Bring in consultants to implement generic quality programmes.
2. A self-generated (company generated) quality programme using guidance from consultants.

Beckford[14] identifies the first option is as the most prevalent and is usually implemented by a project team and as a turnkey project, i.e. the quality system/initiative is implemented in its entirety. At Balfour Kilpatrick (Chapter 8), the second approach was used to implement their ISO9001 quality system. It is arguable that there is actually any difference between the two methods of implementation. Consultants in both cases would use the same standards as templates with little difference between the subsequent quality systems implemented. Self-generated quality programmes would be expected to be more accurate, more useable and more accepted by the organizations involved. However, as this research has suggested, if the system is based on a generic template that has its roots in manufacturing the suitability of the system in the first place may be flawed.

11.2.2.2 Using PM for implementing TQM

Leavitt and Nunn[15] extol the virtues of using project management for implementing Total Quality Management (TQM). They identify the beneficial attributes of PM, its increased usage and the limited exposure of PM in the field of quality. One reason given for the limited use of PM in quality is that PM is itself in an 'evolutionary growth phase'[15]. This is an obvious reference to the increased adoption of project management as a working methodology in many industries. It is debatable that PM is going through an 'evolutionary growth phase' or that commercial environments have become more volatile, mimicking the typical project management environment, hence the appropriateness of using PM methods and techniques. The most visible example of this is in the growth and importance of Information Systems (IS) projects as illustrated by the London Ambulance Service case study in Chapter 10.

In conclusion, for the purposes of this research it is worth identifying the quality/project paradox, although it is tangential to the main aims and objectives. It is worth noting that Leavitt and Nunn[15] make some very valid points that are relevant out with the quality/project paradox, in particular on the low acceptance of project management amongst non problem-orientated professions; accountants, production managers, schedulers etc. Different problems and objectives being the basis for their indifference to PM:

> "They are concerned with the speed of repetitive work, or they are groomers of data for reports to higher managers."

The theme of repetition draws parallels with the manufacturing origins of the 'formal quality systems' that were discussed in Chapter 3 Quality Systems in Theory.

11.2.3 Commonality of themes

Laszlo[16] examines the application of quality management as a way of implementing project management based on the quality model defined by the criteria in the Canada Awards for Excellence[17]. Similar to the Baldridge Award discussed in Chapter 4, section 4.3.2.2, the Canada Awards for Excellence promotes a quality model centred on seven key elements; Leadership, Planning, Customer Focus, People Focus, Process Management and Supplier Focus. Laszlo[16] correlates each of the criteria of the quality 'model' to attributes of project management, highlighting where he believes that quality management improves project management.

The first example compares the attributes of 'Leadership' between the quality model and a generic interpretation of project management. Although Laszlo[16] makes some valid points, which can be related to project management there is nothing that is particularly original in respect to current project management theory or practice. It is possible to match most of the attributes described in criteria used from the Canada Awards for Excellence with the Project Management Institute's Guide to the Project Management Body of Knowledge (PMBOK)[18]. Table 11.1 demonstrates the parallels of between the first criteria leadership and extracts from the PMI's guide.

Table 11. 1

Canada Awards for Excellence criteria	**Project Management Institute's guide to the Project Management Body of Knowledge**
Leadership	*Leading* (Listed under 'Key General Management Skills')
Focus on senior management who have primary responsibility and accountability for the performance of the organization	Establishing direction - developing both a vision of the future and strategies for producing the changes needed to achieve that vision.
Stresses the need to avoid power-based or hero-based leadership styles. (As illustrated in the LAS case study in Chapter 10, section 10.2.7)	Aligning people – communicating the vision by words and deeds to all those whose co-operation may be needed to achieve the vision.
Ideological leaders who get their team to want to do what they want by sharing their purpose, vision and values also establish emotional and intellectual ties which result in sustained commitment to a cause. Active involvement of the project manager i.e. 'walk the talk'. (This implies what could be loosely termed 'technical knowledge' i.e. the knowledge to know what the project is trying to achieve and thus being able to circumnavigate any problems created by the 'system' itself.) Believe in people and allow them to develop their own potential.	Motivating and inspiring – helping people energize themselves to overcome political, bureaucratic, and resource barriers to change. Points out that leadership is not just limited to the project manager, it must be demonstrated at many levels throughout the project (as seen in the Balfour Kilpatrick case study where there was definite functional objectives that eventually had to dovetail to create the complete project)

As can be seen from Table 11.1 the meanings, goals and ethos that are expounded by both disciplines despite using different language and phraseology are in effect remarkably similar.

Examples of this type of similarity are also apparent in other articles. Abdul-Rahman[4] states:

> "Quality management in construction involves satisfying the client's requirements in terms of time, cost and quality."

Comparing this to the traditional project management 'time/cost/quality triangle' first discussed in Chapter 1, it is apparent that there is a large amount of absorption takes place between the two disciplines. The emergence of environments where there is rapid change (like information technology) necessitating a project- based approach has perhaps re-awakened the interest in project management as a discipline, leading to an amount of 'cross-pollination' between quality and project management. It could be viewed that there is a certain amount of 'theory plagiarism' evident in many quality management texts, but it is apparent that many management tools and techniques are applicable across the broad spectrum of management theory. Indeed, quality management has perhaps made a wider audience aware of the role that project management can play in the running of their organizations.

11.3 The pertinence of the models implied by existing quality initiatives in a real project environment and their contribution to future project success.

As illustrated from the case studies 'quality systems' can be present in more than one form with the key issue focussing on whether the existing form of quality model implied by existing quality standards are effective, or reflect the needs of project management. It is too simplistic to delineate a quality system using the 'official' definition[19]:

> "**quality system**: The organizational structure, responsibilities, procedures, processes and resources for implementing quality management."

In respect to the two small project organizations CRC and db Houston there was no 'formal' quality system, due to their size and the needs of their project sponsors, but there was evidence of an informal system (Chapters 7 and 9). The medium sized project organization Balfour Kilpatrick (Chapter 8)was an example of a 'formal' quality system, the industry standard ISO9000 quality system. The final case study in Chapter 10 the London Ambulance Service was an analysis of the importance attached to the absence of any quality techniques or systems in the case of a major project failure. The official enquiry[20] into the failure of the project outlined that the LAS failed to follow the PRINCE project management methodology (one of many failures). In its latest incarnation, PRINCE 2 there is even more emphasis on the integration of the methodology with ISO9001[21]:

> "There is a much closer relationship between PRINCE 2 and ISO9001. PRINCE 2 still does not meet all the requirements of the quality standard, because a number of the ISO standards apply to an entire site or company, rather than an individual project."

As discussed in the LAS case study the project was unlikely to succeed for a number of reasons (Chapter 10, section 10.3). Despite this, would the implementation of the latest PRINCE methodology with its emphasis on further integration with ISO9001 have made a tangible difference? In particular with respect to the concerns raised by aspects of the 'formal' quality system investigated in this research.

11.3.1 Defining the Quality Model

When this research has been referring to a quality model, it has been primarily concerned with the implementation of the industry quality standard ISO9000 series. There are other types of quality models as first discussed in Chapter 4 (section 4.3.1.7), the Deming Award, the Malcolm Baldridge Awards and the European Foundation for Quality Model. Despite their rather disingenuous names, these are seen as quality models, which are meant to be templates for implementation of quality systems and initiatives. Although they are well recognized in the USA they are not particularly well established in many U.K industrial sectors. The application of these models is typically carried out in organizations that are often at the forefront of any quality initiative, as previously discussed in Chapter 4.

In contrast, the ISO9000 standards are now a well-established phenomenon in UK industry and as such have a more tangible impact on the commercial operation of project organizations. In 1996 BSI introduced a standard BS 6079 ‘Guide to Project Management’[22]. In an overview of BS 6079, Hughes and Cotterell[23] describe the document more as a general guide to the current best practice in project management than an actual standard. In comparing BS 6079 and the PRINCE 2 methodology they highlight the differences in definition of a project. A project in PRINCE 2 being a ‘temporary organization to deliver a business product’ and in BS6079 it encompasses the ‘whole system lifecycle’. As a standard it appears that BS 6079 is in essence a more technically orientated document in that it covers certain aspects of project management in more depth than PRINCE 2’s general descriptions. In relation to this research the main reference document for general project management theory has been the Project Management Institute’s ‘A Guide to the project management body of knowledge’[24], which is a useful and comprehensive overview of the different areas of the field. The standard BS 6079 is not particularly widely known and it is believed that like PRINCE 2 it is aimed more at creating awareness of the project management field by creating a generic template of how a project should be carried out.

11.3.1.1 Case Study No.1 CRC Gabions Ltd – the ‘informal’ quality system

In Chapter 7 the case study concerned a small project organization CRC Gabions Ltd. that had no formal quality system. The CRC case study demonstrated the full range of attributes of the management of projects, the uncertainty, the uniqueness, and the problems of fulfilling the classic project objectives of time, quality and cost in a competitive, cut-throat, commercial environment. The emphasis on quality at CRC centred on the need to satisfy the customer beyond just the scope and specification of the project (Chapter 7, section 7.6). The justification behind this was straightforward, it led to more business, through new projects and continued work from existing project clients. Creating for the client what appeared to be the best solution for their particular problem was a particular forte of the company. The project personnel appeared to operate best when under pressure, either to create a solution to a problem or to complete a project under arduous conditions. This did create the impression that they were continually fire fighting i.e. being forced to deal with situations and scenarios that were avoidable. Yet, for the majority of the time this was a false impression. CRC were adept at creating opportunities and utilising new ideas and technology to keep being commercially viable, and therefore sometimes became victims of their own success.

With limited human resources, projects could become chaotic. The main criticism of CRC was the autocratic manner in which they ran the company. Their need to have a controlling hand in all aspects of the project created a dependency that would on occasion prove detrimental to the management of the project. In effect the very aspect that made CRC a well respected company, their treatment of the client, the personal effort expended for the client, also worked against them. Having some formalised type of quality system could have allowed effect transfer of project knowledge and responsibilities to take place, releasing CRC’s directors to concentrate on other essential activities.

11.3.1.2 Deriving the 'knowledge-based' quality system

CRC were impressive in their adoption and use of technology to enhance and enable their

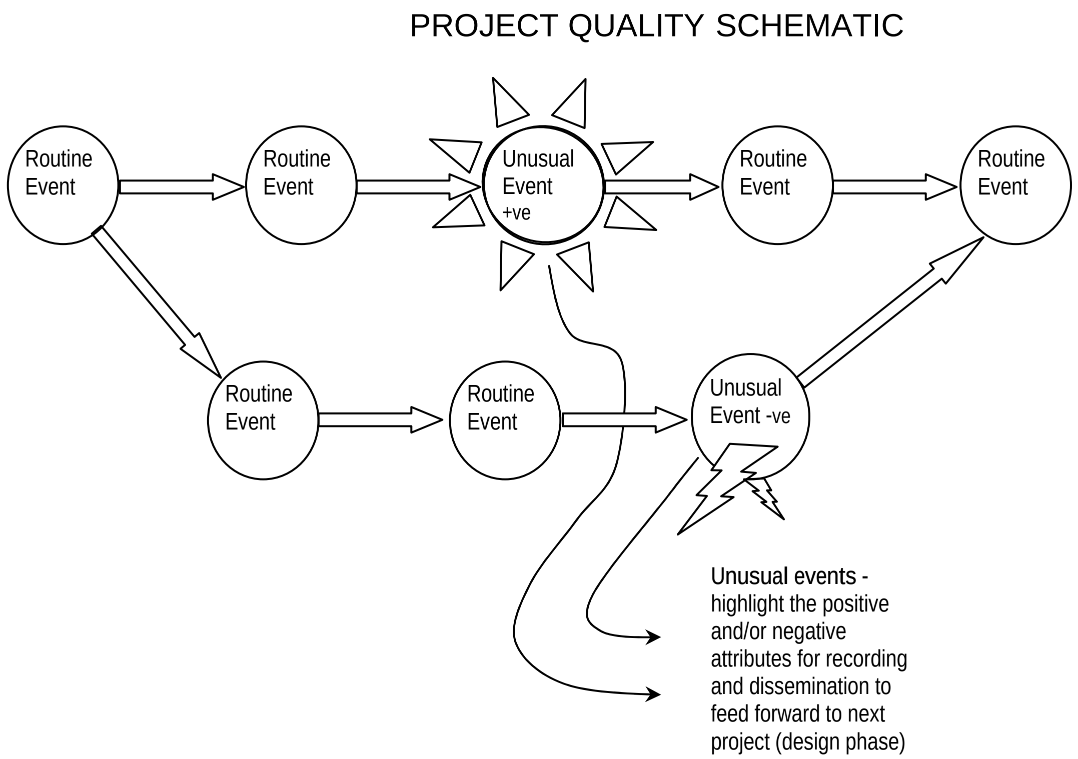

Figure 11.2 Knowledge-based Quality System for Projects

operational capabilities. From this the author developed the concept of alternative ways to capture and distribute knowledge about unusual key activities within a project organization. This subsequently led to the idea of using a 'knowledge-based' quality system as a feedback mechanism to increase organizational learning and to increase future project success. The basis for this system would be the recording of unusual events that occurred at any stage in the project life cycle and feed forward for next project as shown in the schematic diagram in Figure 11.2.

In capturing the events that were significant in the project, there is more likelihood of:

- The project organization retaining the experience and knowledge gained by the project team.
- Having information to feed forward on significant activity failures and successes to increase the chance of future project success.

At a secondary level, the initial recording of the routine events would be a useful process to aid training and to elevate the knowledge of new project members to a functional level. Existing quality systems recognise that there is a need for training although the emphasis is on making sure that the training process is auditable as described by Munro-Faure and Bones[25]. The concept of a knowledge based quality system, how it could be implemented and what it could achieve is examined in detail later in section 11.8.

11.3.1.3 Case Study No.2 Balfour Kilpatrick – the 'formal' quality system

The existing formal quality system at Balfour Kilpatrick was not designed to facilitate continuous improvement in any of the essential functions in their projects. The majority of the data gathered was irrelevant to the technical or financial success of the project. No analysis of the data or the quality system was carried out therefore its only useful function was as a certificate to allow further tenders to be made for continued business. The Balfour Kilpatrick case study was a classic example of what Argyris and Schon refer to as 'cognitive dissonance', which comprises two fundamental concepts 'espoused theory' verses 'theory-in-use'[26]. *Espoused theory*, is the way that someone claims that they think and operate; the second is *theory-in-use*, the way that they actually think and act. With Balfour Kilpatrick, this was the claim that they adhered to a quality standard whilst in operation the project they carried out did not. This was not seen as a tacit deception, the company believed that they provided quality projects; it was just that the quality system with which they operated did not tangibly contribute to this process. On the contrary the quality system restricted the companies abilities.

11.3.1.4 Case Study No. 3 db Houston – the ‘informal’ quality system in a variable environment

db Houston Ltd have created a documented system of the scope of their projects and the subsequent operational support that they will provide. Although the documentation seeks to define the specification and scope of what is provided to the customer in the provision of an information system, it does not create a ‘knowledge database’. A limited attempt has been made to create a ‘knowledge database’ covering technical functions but like CRC, the recording or ‘mapping’ of the processes that take place and what can go wrong is not carried out.

11.3.1.5 Case Study No. 4 The London Ambulance Service, a quality system deficient in accountability

Accountability is a critical element in the feedback inherent in a working quality system. The London Ambulance Case study was the classic example of a project failure due to a deficient in accountability. It is worth pointing out that the LAS case study in Chapter 10 differed from the other three case studies in that it was an example of a non-project based organization carrying out a project i.e. from the client rather than the contractor’s perspective. This classic functional organizational structure can lead to difficulties as pointed out by the Project Management Institute[27].

The LAS’s Computer Aided Despatch project’s very public failure led to a project ‘post-mortem’, which identified a number of serious shortfalls in all aspects of the project lifecycle and in the organization itself. What the public failure created was an accountability that was missing from the original organizational structure. From 1990 the LAS were in the position of having to tender for services. This required a radical altering of the organizational structure, which contributed to large divisions between both the management and the workforce and inside the management as well. Subsequently, with the breakdown in communication there was a lack of devolution of responsibility within the management leading to senior executives taking decisions that were arguably out with their abilities (typically decisions that would have been better carried out by operational managers). This in turn created a lack of accountability leading to what the Report of the Inquiry into the London Ambulance Service[28] described as:

> "q) there is a perceived lack of accountability for LAS actions;
>
> r) while lines of accountability looked secure on paper, in practice the LAS Board was not given, nor did it seek, sufficient information to exercise the responsibilities delegated to it by South West Thames RHA for the day to day management of the LAS;"

The traceability that is now required by the scrutiny of the various bodies representing the stakeholders i.e. the health boards, the hospitals and the general public has meant that the organization has completely changed its way of managing operations in particular the way in which new projects are implemented. As shall be discussed later in the chapter this accountability is an attribute that true project-based organizations appear to have as an inherent attribute, and it is this that some authors believe that determines their success or failure. Traceability is important if there is to be an element of improvement in how projects are carried out. The traceability providing the feedback with which improvement can take place. Stebbing[29] outlines the need for traceability systems in relation to material and component failure, with one of the key points being the 'data and information necessary for generating future design modifications and improvements'. Project management needs this traceability packaged in a form that does not inhibit innovation and teamwork by over demarcation of the project member's roles during the project lifecycle.

11.3.2 Identifying a positive role for existing quality systems

It is not sufficient to cast doubt on existing quality management systems without identifying any possible advantages. Not having an industry recognised standard qualification prevented CRC from working in certain markets, where single-source suppliers are promoted often by ISO9000 registration. With CRC, applying an industry recognised quality system would have generated a cost overhead for the registration process and the internal costs associated with implementing the scheme. The difficult question to answer is would CRC have benefited from certification to an ISO9000 standard. From what has been observed of the thrust of existing quality standards the best implementation that could have been applied, would have been a very loose interpretation of the standards in respect to what constitutes a formal quality system. Formalization of the project administration involved in creating a tender would have allowed the lessons learnt from the first experience with the Railtrack to enhance and shorten the process. This would perhaps increase the chance of winning a contract. In contrast, a poorly implemented quality system could have stifled the unique ability CRC possessed to react quickly to clients needs and their flair for innovation.

11.3.2.1 The Importance of Interpretation

What has become increasingly apparent during the research is the importance of the organization's interpretation of a quality system as opposed to the 'standard' implementation of an existing quality system. Larsen and Haversjo[30] examined the effect of implementing an ISO9000 quality system at a home (called 'Ebo') for the multi-handicapped in Sweden. They found that there was no particular reason for any organization not being able to implement ISO9000 with, 'little or no core effects, but effects are a result of social sense-making processes in an ambiguous situation.' The difference between the ISO standard's manufacturing background and the home's social construct instead of being a problem was seen as a challenge. The home's project group translated the language and meaning of the standard to be more compatible with its culture. This was achieved through carrying out open-minded discussions with the employees to understand and accept the new 'quality' concepts, allowing different interpretations to be suggested and tried:

> "Questions were posed to management, employees and to the consultant: What do they intend by this, what is behind the words? This process led to more creative and more accepted solutions than in many manufacturing companies where the authors through their work as consultants have seen adoptions of ISO9000 where companies copy and implement the standard's text with less independent thought."

This view does highlight positive aspects of ISO9000 and the problem that organizations face is not one of implementation but one of interpretation[29]:

> "They also have little or no core effects, If ISO9000 certification has any non-socially constructed effects, they will be more pronounced when the cultural distance between the standard and the company culture is the largest."

Larsen and Haversjo[30] claim that the distance between the ISO standard and Ebo appears to have been beneficial because compared to an average manufacturing organization, the home had a 'more democratic, egalitarian and organic organization.' Therefore, their thinking was more like Argyris[31] view of double loop learning, the ISO standard system was not accepted unquestioningly, instead they altered it to suit their own environment. The registration authorities accepted this and Ebo received their ISO9000 certification. Whether this flexible interpretation would jeopardise the formal qualification required for some bids in a project management environment is not known. The organizational structure at Ebo showed a marked similarity to a project organization displaying the same attributes that make a successful project team. Indeed, it was described as an organic organization a systemic metaphor (previously discussed in Chapter 5, Table 5.1) that can also be applied to a project-based organization. The success that Ebo has achieved is perhaps due to the co-operation that has occurred between the implementers and users of the system unlike the Balfour Kilpatrick case study where the quality system was enforced with little user consultation. CRC and db Houston could also have benefited from this approach, although at present for db Houston their present market does not require it. It is apparent that the implementation of industry standard quality systems can be achieved with some positive results, depending on the ownership of the system and the manner in which it is implemented.

11.3.3 Inherent flaws in applying generic systems

The Balfour Kilpatrick case study illustrated what can occur when a quality system is applied

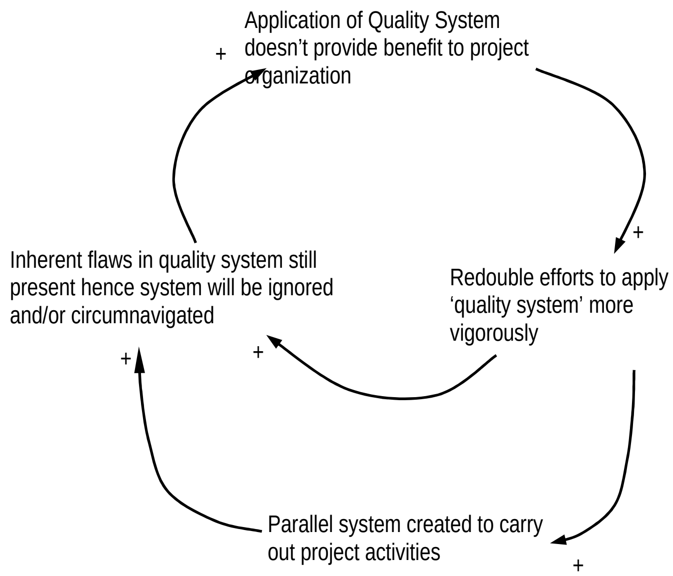

Figure 11.3 Illustrating the likelihood of creating a 'vicious circle' with existing quality systems

to a diverse organization using a generic approach. Time and resources were being diverted to maintain a system that did not increment the organizations learning. The data that the existing quality system collected was:

- Not relevant to improve project operation.
- Not analysed as to its validity or accuracy.
- Appears to be totally inconsequential to the project customer.

At db Houston one director recounted his previous experiences of quality systems where the quantitative analysis carried out involved measuring the number of meetings attended! Critics would argue that organizations like Balfour Kilpatrick are not implementing the industry standard ISO quality system correctly. This is a frequent disclaimer when existing quality systems do not have the desired results. Like Seddon, Wilkinson and Wilmott[32] highlight the ‘prescriptive thrust’ of most quality management literature that ‘largely excludes consideration of ideas and evidence that might challenge or qualify its assumptions and prescriptions.’ Also they point out the blinkered approach taken by advocates of quality management:

> “Where the introduction of quality management is found to be less than fully effective, there is a tendency to interpret such evidence either as an instance of its imperfect application or as symptomatic of an incomplete learning cycle. This implies a need to redouble the efforts to apply it, rather than a stimulus for reflection upon its (problematical) assumptions and prescriptions.”

If this is indicative of the type of approach that is taken by quality practitioners and their organizations then it is going to be very difficult to alter any quality system that is implemented in the auspices of quality management. Indeed it appears that these types of conditions are perfect for creating the ‘vicious circles’ of organizational behaviour described by Senge[33] and first discussed in Chapter 6. The causal loop diagram in Figure 11.4 expands the initial building blocks of the simple feedback loop and feedback showing ‘goal seeking behaviour’ introduced in Chapter 6, Section 6.4. The first causal loop diagram illustrates the generic behaviour of feedback under conditions of simple interdependency. The second diagram illustrates the feedback behaviour in the context of the main case study Balfour Kilpatrick (Chapter 8). This typified the behaviour found at Balfour Kilpatrick when an industry standard quality initiative (ISO9001) was applied to the organization. The target condition of achieving a successful project is unchanged but there are two sides to this 'energy balance.' The *perception* that activities are not executed correctly or more precisely in the manner of the existing quality system and the *reality* which strives to achieve a successful project whilst satisfying the demands of the quality system owners. It is one of the failings of the existing quality system that the main project stakeholders do not see themselves as part of it.

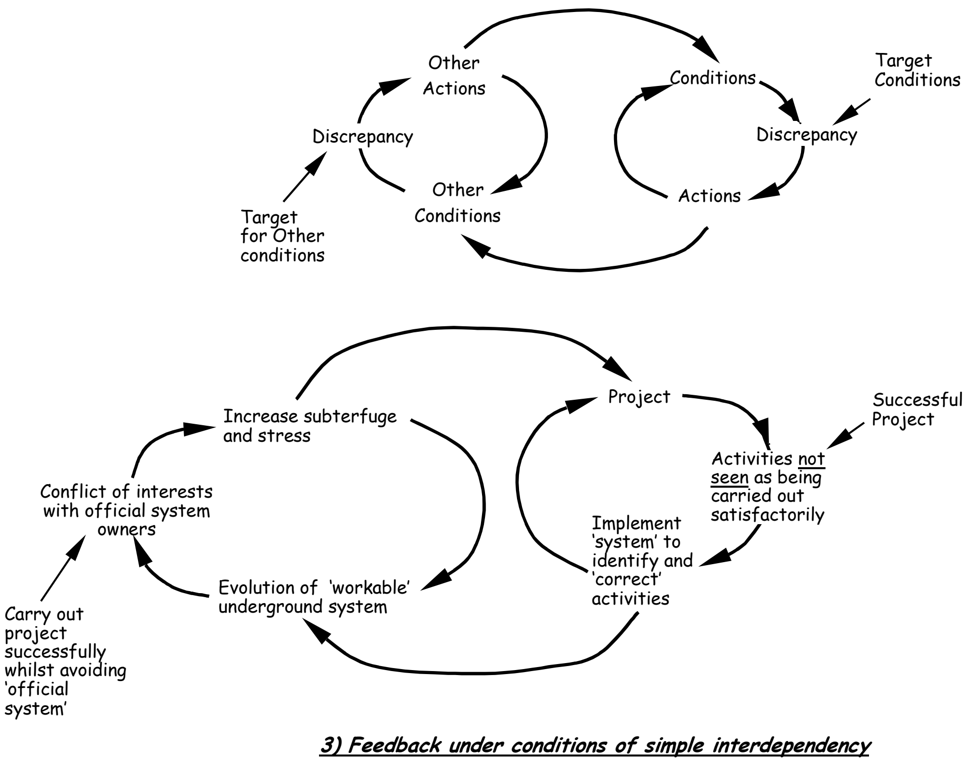

Figure 11.4 Illustrating the likelihood of creating a 'vicious circle' with existing quality systems

11.3.3.1 Ethics in quality certification

With Balfour Kilpatrick, there was a misplaced emphasis on being seen to comply with an industry-wide demand for 'quality certification'. There is also an assumption that the process of certification is free from any impropriety. Whilst there has been no evidence of abuse of the certification process in the case studies carried out concerns are being raised in areas where there is a rapid growth of ISO certification, particularly in the car industry in the United States[i]

11.3.3.2 Market entry

It could be argued that achieving accreditation to a standard would be an entry into an exclusive coterie of businesses where being certified to a standard like ISO9000 is a prerequisite and would provide some form of commercial advantage as discussed in section 11.3.2. Lloyd's Register Quality Assurance Ltd (LRQA) believe this to be the case and in their sales literature[34] use findings from their market research to justify the need for organizations to obtain a certified quality management system (ISO9000). The study was based on interviews carried out with 400 quality managers and senior managers, all of which were existing clients of LRQA. The findings were summarised as follows:

- Internal benefits to the organization much greater than expected, including better management control (a main plank of criticism by Seddon). Improvement in management control was seen as a benefit to 83% of the small businesses studied.
- Certification to ISO9000 sought primarily to prevent exclusion from tenders and to increase market share. 64% of the small businesses stated that there was an increased ability to tender for work.
- 89% of companies of ISO9000 certified companies say the standard has either met or exceeded their expectations.
- 3% of the organizations were quoted as increasing their paperwork and 6% believed that certification to the standard was too expensive.

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[i] These concerns were raised in a management research forum, management-research@mailbase.ac.uk. Further apocryphal evidence on abuse of the certification process in the UK came from a discussion with a quality

It is interesting that the optimistic results obtained in this survey do not appear to correlate with the surveys outlined in Table 11.2. Seddon[35] sceptically refutes the case that ISO9000 registered companies are more likely to have higher sales growth because of being registered to the standard. Instead, he believes that tenders for contracts are increasingly excluding non-registered companies. This in turn forces companies to register.

Evidence of the benefits or otherwise of quality programmes is only now starting to filter through into mainstream literature. Wilkinson et al[36] gives a review of six of the European studies into the effectiveness of TQM. Table 11.2 is a reproduction of the findings.

Table 11. 2

Summary of UK Studies into the effectiveness of TQM Wilkinson et al (1998).

Studies	Approach	Sample	Findings
A.T. Kearney (1992)	Survey	Not specified	80% failed. Either had no information on performance or did not report improvement
London Business School (1992)	Self-assessment against the Baldridge Criteria Survey	42	Most firms in the UK sample would rate poorly against the Baldridge Criteria. This is not sufficient to apply for, let alone win the award.
Durham University Business School (1992)	Survey	235	TQM is still an innovation and there are many uncertainties.
Economist Intelligence Unit	Case studies	50 organisations (European not just	Report massive cynicism TQ initiatives invested

consultant.

Summary of UK Studies into the effectiveness of TQM Wilkinson et al (1998).

(1992)		the UK)	with TQ principles.
Bradford	Externally reported information	29	A high proportion exhibit above average industry performance
Institute of Management	Survey and interviews	880	Only 8% claim that QM was very successful

Comparing the findings of the above surveys and the case studies is difficult due to the previously discussed vagueness in defining quality management/systems. Yet, there can be no doubt that the overall impression given by the summary is one of dissatisfaction and suspicion as to the present form of quality management and the methods used. This resembles the findings of the case studies in this research.

Quality systems are not in their present form meeting the needs of projects or the management of projects. From what has been witnessed it is believed that what would be achieved by staying within the existing framework and conventions of existing quality systems is at best a useable checklist that meets the existing industry criteria and at worst a completely extraneous system that exists in parallel to ‘normal’ project organization operations.

11.4 Incorporating risk in quality systems

In a typical operations environment there is a large degree of repitition and the ability to reduce the amount of variation in process over a period of time. The rationale behind most existing quality systems is the need to capture the details of the process at its optimum, thus reducing the risk of producing a poor or unusable product. The variation encountered in that environment is to a large extent controllable; in contrast project environments whilst

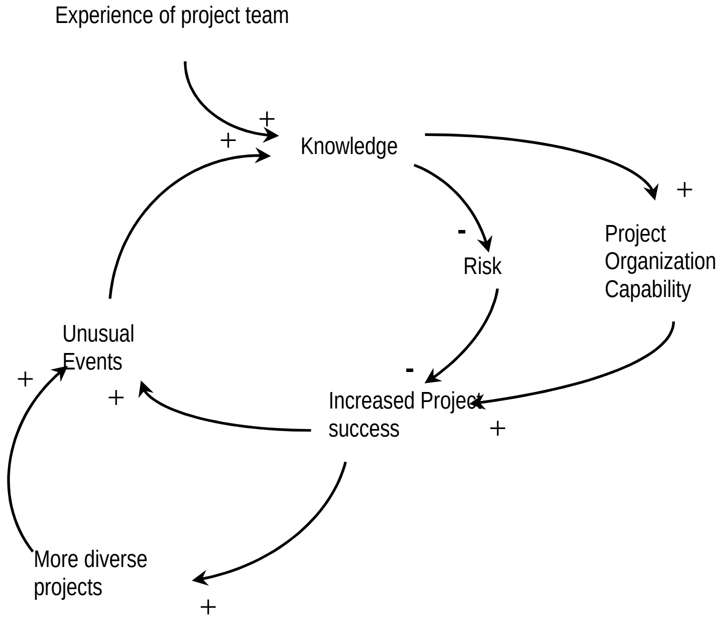

Figure 11.5 Identifying the relationship between risk and a 'knowledge-based' quality system

exhibiting generic traits also have to cope with various levels of uniqueness (as discussed in Chapter 8, Section 8.3.1. Existing quality initiatives do not appear to account for risk being an inherent part of project management (as discussed in Chapter 1, section 1.5, Turner[37] believed that risk was an integral part of all the five dimensions in a project). Without recognising the presence of risk and the need to be prepared to deal with it, existing quality systems are not the dynamic systems they claim to be – they do not allow continuous improvement. An ideal project quality system would lead to the better application of experience, which in turn would reduce uncertainty. The link between risk management and quality systems should be an obvious one, where a 'knowledge-based' quality system captures knowledge for the organization that then leads to the better application of that experience leading to a reduction in uncertainty during the project, or as shall be discussed later increases the opportunity to expand the types of projects carried out. The causal loop diagram shown in Figure 11.5 illustrates this linkage. There is another component to this; the emergence of competition is cited by Oakland[38] as a key reason for the emergence of quality management. However, most project organizations have historically tendered for contracts therefore the element of competition is not a new concept in the project environment.

11.4.1.1 Assessing risk

Assessing risk is like quantifying quality: there is an intangible aspect/perception that is possessed by both the customer and the supplier. Possibly project orientated organizations are more familiar with the process of assessing risk and taking the appropriate management actions, than those organizations that exist in a more sedentary and repetitive environment. The project organization in Chapter 7, CRC exhibited a high degree of risk assessment in their bid for the Railtrack contract – which was attributable to:

- The unique nature of the project that included methods of working out with their normal expertise (creating a purpose-built barge for the repair operation).
- The consequence to the company of project failure. The price loading of the contract reflected that a project of that nature could put the company out of business.
- The level of expert advice that was sought regarding the viability of the project. Including a relatively large amount of research carried out in a short space of time examining scenarios that could lead to project failure or delay. For example the effect on the river levels if there was a large thaw of snow on the surrounding hills, any effect the local hydro electric station could have on the river level, how easily any

craft could be removed from the vicinity of the bridge, the technical and financial viability of constructing a specialised barge.

It is worth remembering that this proposal was the second 'methodology' that CRC had put forward to Railtrack when the first method of carrying out the project by more conventional means was rejected. It was also outside the expertise of Railtrack's consultants at the time, a factor, which may have contributed to the rejection of the proposal.

11.4.1.2 Transferring risk

The way that Railtrack carried out their risk assessments was similar to the role played by National Grid in the Balfour Kilpatrick case study. The onus to assess the risks was transferred onto the contractor carrying out the project. They had to present the way in which they were going to carry out the project (or particular activities in the project) in a method statement, then implement the method statement. This effectively transfers any liability to the contractor. The following extract from Railtrack Major Projects Division's Tender Enquiry Package document, illustrates this point:

> " I have received your final/draft accepted as final Method Statement and accept that the method proposed would appear to be satisfactory from Railtrack's point of view. This acceptance does not constitute acceptance of liability by Railtrack for any accident, incident or breach of statute which may arise from the method adopted."

What both Railtrack and National Grid emphasised was that documented method statements and risk assessments had to be carried out to comply with current legislation and to allow approval of the project or project activities. It is at this point that some interesting questions arise. If the contractor is supplying a method statement[ii] for assessment and approval the customer can only gain the benefit of such an exercise if they possess the requisite knowledge of the subject about which they are making the decision. With the increase in outsourcing and consultancy do large organisations like Railtrack and National Grid have the in-house expertise to assess the risk and viability of projects? Railtrack bought in expertise in the form of consultants for both the civil engineering and quantity surveying functions, which had a significant bearing on which method was chosen. Are the benefits of buying in

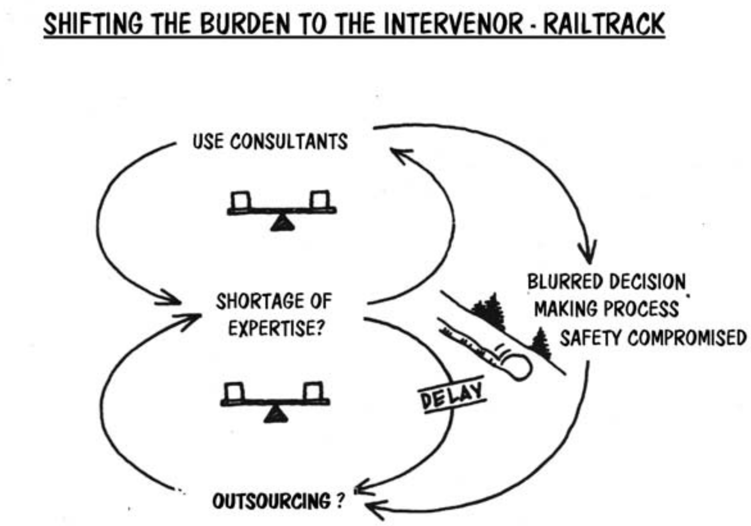

Figure 11.6 Senge's system archetype in relation to consultants at Railtrack

expertise outweighed by the possible loss of knowledge gained through taking a larger part in assessing the projects viability? Quality management stresses getting close to the customer is essential to ensure the customer requirements are met but when the customer may not be aware of any alternatives due to an inability to make a judgement due to the use of third parties (e.g. consultants.) then how do new and possibly innovative techniques get tried? Figure 11.6 is based on one of Senge's[39] systems archetype templates 'Shifting the Burden to the Intervener' and highlights the result of this shortfall in knowledge acquisition. In this

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[ii] Method statements in this context can refer to either the overall project implementation or the implementation

archetype the effect on the capabilities of the 'internal actors' is to delay their ability to solve the actual problem. It is proposed that this could be more than a delay it could be a total loss of the ability to make creditable decisions. Railtrack have been under increasing criticism from the government Commons Transport Select Committee and the rail regulator, especially in respect to safety and use of subcontractors as the following article 'Railtrack hammered on Safety and Profits' from the Herald newspaper[40] describes:

> "Railtrack, which owns Britain's network of lines and stations, was accused of making "excessive" profits and being "weak" on safety. It now faces having its earnings capped and seeing its responsibility for safety handed over to an independent authority. In the first blow to the organisation, an all-party committee of MP's demanded dramatic moves to improve rail safety, including stripping Railtrack of responsibility for safety…In its report, Railway Safety, the Transport Select Committee singled out Railtrack for particular criticism – accusing it of weak management and of not exercising sufficient control over its many sub-contractors, some of whom have posed a direct safety risk."

11.4.1.3 Bureaucracy, risk and learning

The very nature of the existing quality system found in the main case study in Chapter 8 is such that legitimate change becomes impossible due to the apparent stultifying imprisonment of innovation created by the mixture of bureaucracy and limitation imposed in the name of quality. Both Railtrack and Balfour Kilpatrick provided examples of systems, which generated a great deal of unproductive bureaucracy. (Chapters 7 and 8). In contrast CRC the small construction company operated with very few documented procedures or systems due to the increase in work that would involve and because it was not seen as necessary by those running the organization. As illustrated in the case studies the meeting of the two types of organization highlighted the strengths and weaknesses of both organizations as shown in

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of a particular project activity.

Table 11.3.

Table 11. 3

	CRC	Railtrack
Size	Small family run organization	Large multi-faceted organization
Role played by project management	Project management integral to whole business	Separate project management function
Knowledge sources	Experience led, based on the two directors	Hierarchical structure with heavy reliance on outsourced expertise
Reactivity	Fast – dynamic scheduling	Slow – procedure driven
Risk Averse?	No	Yes
Industry recognised quality system?	No, informal quality system, based on reputation, close key client relationships and continued business	No, although place heavy regulatory and contractual demands on subcontractors and suppliers
Layers between management and project	One	Three to four including consultants
Bureaucratic	No	Yes

An organization dominated by bureaucracy as described by Swieringa and Wierdsma[41] is not conducive to learning:

> " A bureaucracy is an organization in which a relatively large amount of education is carried out, and a great deal is learned, even it is one-sided by individuals. At the same time it is an organization which collectively experiences great difficulties in learning, more so than any other type of organization."

If we substitute education for experience the context of this paragraph can be applied to organizations like Balfour Kilpatrick where although there was little formal education there was great emphasis placed on project experience and project ability i.e. the outcomes not the processes. Is it the case as proposed by Swieringa and Wierdsma[42] that the advent of more bureaucracy in an organization will lead to a stifling of learning by the organization? Regardless of whether or not that learning is formal or experience based. More importantly, is this criticism applicable to quality management concepts when applied to a project environment? In a section titled 'They lack the will to learn' Swieringa and Wierdsma[42] pinpoint what the author believes is the paradoxical contrast between quality management and project management:

> "Being prepared to take risks is an essential prerequisite for learning. Situations in which learning is necessary contain risks by definition, because the new circumstances are unknown and could present surprises. Initiative and testing new ideas predictably lead to errors; you learn from doing and the mistakes are experiences, which can increase the effectiveness of learning. In bureaucracies, however, mistakes are often better remembered than successful initiatives. Mistakes are used as a means of fine-tuning the rules to gain better control; they are used as a means of finding a scapegoat to underline the value of the rules and procedures. This makes avoiding mistakes a much more sensible way of obtaining a good appraisal report than showing initiative, Appraisal systems sometimes show mistakes in absolute terms rather than as a percentage of innovative activity. Passivity and thus freedom from error show up better than a spirit of enterprise with the inevitable failures. This results in the lack of the will to learn; you are rewarded for not doing wrong rather than for doing well."

Nowhere is the correlation between learning and risk more apparent than in a true project environment. Situations occur or are presented which require a degree of risk to be taken, whether it is in the design phase, production or termination of the project life cycle. Project organizations have to learn from their experiences or they will cease to exist, therefore any 'system' that enhances their capability to learn between projects should be a useful contribution in this process. It has been unfortunate that existing quality management systems have evolved into systems, which inhibit risk and stifle organizational learning, especially as their primary role is, as a way of promoting continuous improvement.

11.5 Client – Customer relationships: further quality models

An implicit part of existing quality systems is the client customer relationship. Organizations are encouraged to adopt a policy of single source suppliers and subcontractors; project management literature also promotes this viewpoint. Theoretically the supplier will receive a better understanding of what the customer wants, alter their service provision accordingly, in turn the customer receives a better product or service. Manufacturing industry has many examples of this type of integration and as discussed later in section 11.6.3.3 other industries like construction are trying to emulate it. Dilworth[43] also outlines the trend towards having more reliable suppliers, allowing organizations to reduce inventory or reduce the need to have a particular resource. Whilst not being promoted as a model per se, the push to create alternative models of customer-client relationships is a key underpinning of existing quality systems therefore will be addressed in more detail.

Morris[44] theorizes on the impact on project management of what he refers to as *Total Quality*. He believed that the 90's would bring a move away from 'traditional competitive tendering' to more long-term relationships for both contractors and clients creating measurable increases in performance. Certainly, the director of the subcontractor used by Balfour Kilpatrick in the second case study would have agreed with this. He stated unequivocally that the quality of the project activities that his organization offered would be measurably increased if there were a continuity of contract between the two parties. The reality was that the subcontractor had to tender each time with price being the overriding factor.

It can be seen from Deming's fourteen points for management cited in Oakland[45] that ending the awarding of business on cost was an important part of his quality philosophy. Deming advocated awarding business on total cost i.e. all the costs associated with the supplied product or service, what is now often referred to as 'quality costs[iii]'. Total costs also included the life cycle cost of the product and service. It is more difficult to identify these attributes in a supplied service as subcontracting yet there is credence in the rationale behind it. The use of an ability quotient as discussed previously would enhance the recognition of a project organization's capability.

On creating single sources of supply (which is what Morris is effectively referring to) Deming also concurs, believing that it gives the purchaser considerable control over improving the quality and performance of what they receive. The benefits for the sub-contractor are more financial security and continuity of work. Against this, Beckford[46] outlines the disadvantage of creating single sources of supply in that the client is vulnerable to any failure of the supplier 'either financially or in quality'. In project management there is also the additional disadvantage of the location where the project is taking place. Suppliers of materials and specialist sub-contractors may just not be available frequently overlooked by most quality literature. Occasionally these types of problems can lead to novel solutions as the small example obtained from one of the case study companies describes:

> *On one occasion for Balfour Kilpatrick a small refurbishment project necessitated the freezing of an oil pipe using liquid nitrogen. Although not carried out often, this was a common method of carrying out refurbishment work were time was very limited due to the importance of the electrical circuit. The problem arose from poor planning and was due to the location of the site. This was at Cruachan dam above the Cruachan*

[iii] British Standard BS EN ISO9004-1 refers to the 'quality-cost approach' which are costs that arise either directly or indirectly from quality related issues. Often identified and analysed using the Prevention Appraisal Failure (PAF) model.

hydro-electric power station which is a remote location in the hills of Argyll. The work was scheduled for the only time in the year when the main 275kV circuits could be switched off. What was not realised at the time was that there was no ready source of liquid nitrogen near to the Cruachan site. Oban the nearest town did not have any nitrogen suppliers and Glasgow was too far away due to the limited time available to carry out the work. Also there are strict guidelines on the transporting of liquid nitrogen and there was no one available to transport it from Glasgow.

Various solutions were discussed, bypass valves, more pipework, cancelling the work until the following year etc. Finally one of the team came up with the idea of using a domestic central heating pipe freezing kit. This was met with some scepticism but as it was the only reasonable suggestion it was decided to give it a try. A number of kits were bought in Oban and attached to the pipes to be frozen. As oil is harder to freeze than water all the quantities used in the kit were trebled. The waiting time was increased to allow the freeze to take and the valves that had to be fitted were readied, to minimise the time that the freeze had to last. Much to everyone's surprise it worked and the valves were fitted allowing the circuit to be switched back in on time. The postscript to this small example of lateral thinking was that this was probably the first and last time that this method would have been used. And although it was not a groundbreaking activity it may have been of some use in a similar scenario in another part of the company, but outside of the project team there was no apparent conduit for this knowledge.

11.5.1 Case study examples of single source suppliers

Examples of single source suppliers/subcontractors from the case studies are shown in Table 11.4. The relevance of single source suppliers/subcontractors in project management is tempered by the industry and size of the organization involved. In discussing the importance of single source suppliers with Robin Dunlop, the Technical Director of db Houston he stated that for their market the important issue was the operational reliability of the PC's that they incorporated in the IT systems. Although the Siemens PC's they installed did have proprietary components in them (usually the PC motherboards and CPU's) this did not impact on the operational configuration of the PC's, unlike other corporate brand PC's namely Dell and Compaq. Interestingly Mr Dunlop did not believe that PC's required the purchasing power of large establishments to create good supplier relationships. The concept of putting out work to tender in the European Journal is in his opinion 'wholly inappropriate' for purchasing PC's, which he views as 'standard' commodities. This was in relation to large public sector and private organizations that have a statutory obligation to put contracts out to tender Europe-wide.

Table 11. 4

Single source suppliers and sub-contractors used by case study organizations

Case Study	***Supplier or Subcontractor***	***Advantages of using single source***	***Disadvantages of using single source***
CRC Gabions (Railtrack)	Use of consultants for civil engineering and quantity surveying	Skilled practitioners in their particular field. Removes the need to have specialised in-house expertise. Removes onus of responsibility for high risk decision making. (this could also be considered a disadvantage)	Knowledge gained by the organization is gained by the consultants rather than the project organization. Responsibility for decision-making becomes blurred.
Balfour Kilpatrick	Index - Scaffolding Subcontractor	Provided scaffolding to specification including any unique site requirements. Flexible regarding scheduling (very important consideration) Cost although important not believed to be the prime reason for their use.	Limited to a specific geographical location. Small company whose resources can be stretched if contract commitments are high.
Balfour Kilpatrick	Crossmore's – Civil Engineering sub-contractor	Long association with client company. Interaction and	Client totally reliant on sub-contractors

Single source suppliers and sub-contractors used by case study organizations

Case Study	*Supplier or Subcontractor*	*Advantages of using single source*	*Disadvantages of using single source*
		understanding between project personnel of client and sub-contractor good. Sub-contractor flexible to demands of client's projects. Reduced overheads due to contracting in key functional personnel.	personnel and equipment therefore project performance determined by sub-contractor (as for Railtrack example). Degradation of the relationship between the two parties at a senior management level could have jeopardised project success
db Houston	Siemens PC's and technical support	Supplier service and the quality of the product. High reliability of product seen as essential as repairing PC's is not a value added function for the company. Using a large corporate IT manufacturer should reduce risk of supplier leaving market, also pricing tends to be competitive.	Committing to one IT supplier can have a degree of risk due to volatile nature of market. When IT systems have to be supported over a period of time technical support can be very important. Hardware that is assembled from generic components can be seen as preferable.

This emphasis on strategic quality would also permeate other areas of project management including: increasing the use of risk management in projects, contracting becoming a long term relationship between client and customer and increased 'top down' planning, scheduling and simulation.

The qualities 'gurus' discussed in Chapter 4, section 4.2.5, are seen to differ on the topic of single source suppliers and subcontractors. Oakland[47] briefly categorises the quality guru's views with Deming approving of single sources of supply and Juran against. There has been controversy over the construction of a £1000M Korean microchip plant in Fife[48] with accusations that the project sponsors had pre-determined the companies that they were going to subcontract, despite requesting bids from other companies.

11.5.2 Ambivalence to certification of suppliers/subcontractors

Despite the emphasis put on using 'certified' suppliers and contractors it is evident that large organizations are not deterred from using non-ISO9000 registered companies. Railtrack (despite not being certified to ISO9000 themselves) in their initial approach to CRC stated that they were being seen as preferred bidders for the Lochy Bridge and Bridge of Allan projects along with one other contractor. Neither CRC nor the other preferred bidder was registered to a recognised quality standard. Neither of the preferred bidders obtained the Lochy Bridge contract, instead it went to another non-ISO registered contractor. Again, this raises questions on the importance placed by the large organizations on being registered to a recognised quality standard. It is realised that there is the scope in the ISO standards for non-ISO suppliers and sub-contractors, but the alleged benefits of having registered 'downstream' suppliers is an oft quoted mantra in many quality text. Waller, Allen and Burns[49] are a good example of this:

> "ISO9000 is particularly appropriate for the construction industry because of its insistence on the control of subcontractors. Suppose one of the major players in construction adopts the quality management standard. This company can now specify that it will give preference to subcontractors who have also adopted the standard"

Balfour Kilpatrick was registered as an ISO9000 company. National Grid and the other utilities that were Balfour Kilpatrick's customers made it a tender requirement. The vast majority of Balfour Kilpatrick's suppliers were not ISO certified, and in many case's not vetted in the manner outlined in BK's own quality procedure manual due to the lack of time available to the designated quality representatives. Similarly, db Houston despite working almost exclusively for public sector sponsored medical practices do not require to be accredited to any recognised quality scheme. Therefore, it is apparent that the evolution of ISO9000 registered companies has happened more in line with demand from clients and Government agencies than from an implicit demand for a quality system. ISO9000 registration may well be essential for large companies if they are to be involved in projects for government or larger private organizations, but it appears to be less of a prerequisite for small to medium sized companies.

11.5.2.1 Single source suppliers/subcontractors; theory versus practice

This raises a number of essential questions regarding using single sources of supplier/contractor in projects. In manufacturing and projects, the role of the supplier/subcontractor is crucial to the success of the organization. Balfour Kilpatrick subcontracted the civil works on the Walpole project and db Houston depend on Sieman's to supply their PC's, activities crucial to the success of both organizations. The importance placed on this by existing quality systems is high. Yet, from the evidence in the case studies the vetting of project suppliers/subcontractors is not a high priority. This appeared to be due to a number of factors:

- The transient nature of projects not being suited to creating long-term commercial relationships.
- The exploitation of competition within suppliers/subcontractors to increase profit margins has placed the emphasis on using the 'cheapest possible' option regardless of

the overall life-cycle cost. Therefore, the best option, which may not be the cheapest option, is often ignored due to commercial decision-making.

- Project organizations have a higher capability in resolving one-off difficulties during projects hence have created an environment that is tolerant of the consequences of poor quality suppliers/subcontractors.
- The recognition that other smaller project organizations are more likely to carry out the risks which the client organization is less inclined to do (or cannot do due to their existing quality systems).

It is speculative to believe that organizations would employ subcontractors to circumnavigate an existing quality system, yet the present commercial thrust of many large-scale organizations (like Railtrack) does seem to favour risk transference to either increase financial gain or to prevent liability for project failure. Therefore it is not unreasonable to assume that project organizations who are certified to an industry recognised quality standard will use suppliers/subcontractors who are not similarly certified.

Putting forward reasons for this does not provide a clear answer but does highlight the need for further investigation. Is the role of a quality system negated by the very transient nature of a project? Or is it the case that organizations, which rely on small/medium suppliers and subcontractors, do not believe that creating a prerequisite for an industry recognised quality standard will improve their own operations? Despite the criticism levelled at existing quality management systems there was enough evidence to suggest from the CRC and db Houston case studies that some form of ‘system’ could have benefited the organizations in producing a form of homogeneity for the more routine activities.

11.5.3 Current developments in creating project partnerships

A major theme in quality management is the need to nurture constructive, long-term relationships with customers and suppliers. The benefits of this are apparent from the case material in this research. CRC's successful relationship with British Waterways was built up over a period of years. Balfour Kilpatrick has had a successful partnership with most of the major electricity utilities in the UK for over 50 years. A key to db Houston's success is their customers personally know whom they are dealing with, allowing discussion of the clients particular needs and objectives.

In contrast, poor relationships can have a detrimental effect on project success, and the likelihood of reduced future business. The subsequent breakdown between Balfour Kilpatrick and their subcontractor Crossmore's did not affect the Walpole project but it did create problems in other BK projects. Railtrack's declaration of total risk transference at the preliminary meetings of the Lochy Viaduct project left CRC in no doubt as to the level of co-operation that they were going to receive from Railtrack in achieving a favourable project outcome. It is therefore not suprising that the quality of many project activities is compromised even before project execution takes place. The following three sections examines; the problems of relationships between project client and contractor highlighted in the Latham Report, a new form of contract which attempts to prevent adversarial relationships the New Engineering Contract (NEC) and recent attempts to create more productive project environments by using an initiative called 'partnering'.

11.5.3.1 The Latham Report

Projects and construction projects in particular have always had a history of adversarial relationships between the main stakeholders. In 1994, the Latham report[50] highlighted the problems created by the existing contract types used in the construction industry. In its executive summary, the report made thirty recommendations aimed at 'helping clients to obtain the high quality projects to which they aspire.' These recommendations included, the evaluation of tenders by clients on quality as well as price, the need for more evidence on the specific effects of the quality standard BS5750 and the need for a set of basic principles upon which modern contracts could be based. These principles (13 in total) are summarized in Table 11.5.

Table 11. 5

	Summary of the Latham Reports 13 Principles (adapted from Thomas Telford 1999)
Specific Duty	All parties to deal fairly with each other, their subcontractors, specialists and suppliers in an atmosphere of mutual co-operation.
Firm duties of teamwork	Shared financial motivation to be fair and co-operate. Create a general presumption to achieve win-win solutions to problems that arise.
Interrelated contracts	Clarify the roles and duties of all those involved. This is suitable for all types of projects, any procurement and all disciplines
The Contract	To be written in easily comprehensive language supported by complete guidance notes
Role Clarity	Clarify and separate the key roles of those in the contract, the Supervisor, Designer Project Manager and Adjudicator.
Risk Allocation	A choice of allocation of risks appropriate to each project and allocated to the party best able to manage, estimate and carry the risk
Control of change	Avoid changes to pre-planned project information. Where variations do occur they should be priced in advance with provision for independent adjudication
Payment Methods	Express provision for assessing interim payments by methods

	Summary of the Latham Reports 13 Principles (adapted from Thomas Telford 1999)
	other than the monthly valuation, by using milestones, activity schedules or payment schedules. Repeat measurement based on work progress.
Payment Time	A clear period set out within which interim payments must be made to all participants in the process, failing which they have the automatic right to compensation. Late payment will be deterred by the imposition of sufficiently heavy rates of interest.
Trust Funds	The provision of secure trust fund routes of payment
Dispute Resolution	Take all possible steps to avoid conflict on site, but provide for speedy dispute resolution by predetermined adjudicator/referee/expert if required.
Performance	Provide incentives for exceptional performance and penalties for poor performance.
Advance Payments	Make provision where appropriate for advance mobilisation payments. Advanced mobilisation payments to contractors and sub-contractors including for off-site fabricated materials provided by part of the construction team.

Defining intangible attributes like ‘fairness’ is never going to be easy, especially in an adversarial environment. Despite this, the New Engineering Contract (NEC) was recommended as being able to meet some of these aims and was promoted as a basis for altering the contractual arrangements between project stakeholders.

11.5.3.2 The New Engineering Contract (NEC)

In 1993 the Institute of Civil Engineers, developed the New Engineering Contract (NEC) in an attempt to ameliorate the fundamental problems with existing contracts. Most work in the construction industry takes place under contracts produced by the Joint Contracts Tribunal (JCT) while most contracts for civil engineering projects are produced by the Conditions of

Contract Standing Joint Committee (CCSJC). Latham criticised these contracts for being unclear, encouraging conflict and/or litigation and creating high levels of mistrust. The Latham report recommended the use of the NEC to address the above issues and suggested that it should be implemented as a national standard throughout the construction industry. According to the Institution of Civil Engineers,[51] the New Engineering Contract 'has now been used on over 6000 projects worldwide including more than £2.0bn worth of work in the UK'. The NEC is based on two principles[52]:

> "…foresight applied collaboratively mitigates problems and shrinks risk, and clear division of function and responsibility helps accountability and motivates people to play their part."

The second part of this statement matches existing quality systems where demarcation of function and responsibility are seen as key attributes.

The NEC attempts to create a contract that is in an understandable form and clearly defines the responsibilities of all the key parties involved. What it strives to do is create a partnership between both *Employer* and *Contractor* to achieve the aims and objectives of both parties. This is demonstrated in the opening core clause of the second edition of the NEC Engineering and Construction Contract[52]:

> "10.1 The *Employer*, the *Contractor*, the *Project Manager* and the *Supervisor* shall act as stated in this contract and in a spirit of mutual trust and co-operation. The *Adjudicator* shall act as stated in this contract and in a spirit of independence."

The role of the adjudicator is to provide unbiased and independent judgement in the event that there is a dispute arising under or in connection with the contract. The adjudicator decision is enforceable as a 'matter of contractual obligation' between the parties involved which may also include the payment of compensation if additional cost has been incurred.

This is in an attempt to prevent the damaging and costly consequences of litigation plus dealing with the dispute in a period that lessens ongoing damage to the overall project. This conscious effort to move away from the litigious confrontational attitudes so prevalent in the construction industry is an important step in moving towards achieving projects that achieve the goals of both the supplier and the customer.

The strength of the NEC is that it is a contract, which has tangible consequences for both of the parties not adhering to it. In comparison the quality system is demanded yet is often only required by the supplier (as in Balfour Kilpatrick case study). The enforcement of this system involves a third external party, the auditors whose only vested interest is in ensuring that the quality system meets predefined requirement that can be far removed from the actual lifecycle of the project. The NEC is based on the customer and the supplier sharing any profit or loss. There is a proactive early warning system built into the contract to compel either party to warn of a problem, which will affect the time, cost or performance of the project. Arguably, the strategic role of a quality system is to create the mechanisms inside an organization that lead to continuous improvement but therein lies the problem. To achieve continuous improvement the organization has to be able to interact with the customer and have tangible feedback mechanisms to channel the learning gained during the project duration. Existing quality systems as witnessed in the main case study do not involve the customer in a key role, which creates further doubts on the abilities of these systems as useful quality indicators. The creation of a contract that embodies many of the goals of a quality system in particular the symbiosis needed between customer and supplier plus the added incentive of shared financial motivation is perhaps a more valid model for quality in project management than existing systems.

Although the NEC appears to be quite widely used, according to Hughes[53] it does not appear to have significantly improved the situation. Nevertheless, the search for ways to improve co-operation between the main project stakeholders has continued. Balfour Kilpatrick's overhead line division in Scotland has utilised the NEC in conjunction with one of their main clients Scottish Hydro Electric. How well this contract has been received is not known although given the existing good relationship between the two parties it would not be a particularly rigorous test of the NEC's ability. Perhaps the NEC can document existing good relationships but it cannot create harmony from discord.

11.5.3.3 Partnering

Partnering is the latest academic/industry methodology for project companies creating mutually beneficial relationships between the main project stakeholders. This is relatively new to the UK construction and engineering industry having first appeared in the mid 90's in the United States. The extent to which it is used is not entirely apparent, although a senior project manager who works extensively in the facilities management sector brought its existence to the attention of the author. According to Barlow[54] et al.:

> "…partnering is simply a generic term for a range of practices to promote greater co-operation between organizations"

It encourages all of the groups involved in a project to work together by adopting shared interests and goals and by open dialogue. Like the NEC, it is hoped that by understanding each other's expectations and values, the parties involved will be able to trust each other and to work together to solve any problems. Partnering can be used alongside any method of contracting. Often the participants draw up a 'partnering charter'. This is separate from the legal contract and outlines the goals of team members and a framework to resolve any disputes should they arise. Barlow[51] et al. examined five case studies in which partnering arrangements had been used and concluded that 'in each case the… partnering processes helped to build mutual trust and achieve dramatic improvements in performance'. However, according to Watson[55] contractors and clients often enter into partnering agreements half-heartedly:

> "…contractors desperate to win repeat business are taking on the tough task of cutting costs for clients with no net reward other than the wink and promise of additional work. Many on both sides of the contractual fence are failing to get to grips with key aspects of partnering – which means that rewards are likely to be disappointing"

She also reported that there was concern in the industry that subcontractors were being excluded from partnering arrangements and that consultants tended not to be committed to working in partnership with contractors and that they were often critical of them to demonstrate their expertise and worth to clients. This was demonstrated at preliminary meetings between Railtrack and CRC concerning the Lochy Viaduct project (Chapter 7). Railtrack's consultant had the key role in deciding the merits of the original conventional method that CRC were going to use to repair the viaduct. The consultant was critical of the method that CRC were going to use, yet did not appear to offer a valid alternative, leaving the impression that his role was to evaluate the project as a product which was going to be bought 'off the shelf' with as little interaction from the buyer as possible. Whilst it is recognised that the consultant was commissioned to look after their client's interests, it is perhaps valid to recall that Railtrack first contacted CRC as experts in this type of work. In addition to the other concerns on the role of consultants in regards to organizational learning, using a consultant as an arbitrator may also not be in the best interests of either client or contractor.

An article in Contract Journal[56] highlighted a survey of clients conducted in 1999 by the Construction Clients' Forum (CCF) providing further evidence of the continuing poor performance of the UK construction industry. It found 58 per cent of clients reported that their projects were late, 32 per cent said that they were over budget and 90 percent reported defects of varying seriousness. According to the Contract Journal (1999) a government report due out later in 1999 will show more than half of all projects are indeed completed late. It appears that the recommendations of the Latham report have not yet had a significant impact on British management.

This does raise the question can any of these contracts and initiatives work, if there is not the sufficient will to make them work? The problem is also perhaps one of implementation. Material on the NEC and partnering concentrates on large organizations that are the main project sponsors with the subcontractor being in the subservient role. It is unlikely that any subcontractor involved with these contracts and initiatives are in the position to disagree. The true worth of the NEC and partnering needs to be studied in projects were the stakeholders are on an equal footing. With CRC, partnering was based on its reputation and its ability to create a long-term relationship with the client. This was CRC's definition of quality. Despite this, reputation does not appear to be a formal enough endorsement for many organizations. The formalisation of other types of contract based on the past project performance maybe a more appropriate measure of contractor appraisal.

11.5.3.4 Formalising a project organization's reputation – an ability quotient

The evaluation of contractors for projects can still be an ad hoc process and as shown in Chapter 10, the London Ambulance Service case study, the main criterion is often cost. What defines a project organizations reputation is its ability to carry out a project successfully. The client ultimately determines if the project is a success, and thus endorses and enhances the project organizations reputation. It is for this reason that Peters[57] calls projects the 'ultimate accountability models' (this is discussed in more detail in Chapter 12, section 12.3.3). Therefore, evaluation of project contractors could be based on some form of 'ability quotient'. This could be achieved by recording the attributes of a contractor during previous projects, ratified by the client at that time and then presented as a portfolio to the contractor's future clients. Even if a project has not met its objectives, there are often activities that have been carried out well which highlight the contractor's abilities. The onus would be on the contractor to make prove their ability to the client, which in turn would feed forward into their own (the contractors) project portfolio.

11.6 Alternative insights from systems thinking and systems dynamics

Chapter 5 and 6 detailed an examination of the alternative models and techniques provided by Systems Thinking (ST) and System Dynamics (SD). The conclusions of that examination are revisited and discussed in the following three sections.

11.6.1 Systems Thinking

ST is a useful way of identifying and conceptualising problems in project organizations, hindered by the disparate number of opinions and techniques on offer. It also demands a high level of candour and resource that could be an obstacle to implementation in some industries. The use of 'influence diagrams' was found to be particularly useful in visualising the conceptual relationships that contribute to the outcomes of particular actions and policies. The other significant part of system thinking was system's archetypes, a form of template for identifying key patterns of behaviour often exhibited by organizations. Attributed to Senge[58] the archetypes provided a template with which to analyse patterns of behaviour witnessed in the case studies, e.g. the perceived effect of the existing quality system at Balfour Kilpatrick (illustrated in Figure 8.7). In conclusion, ST does provide ways of identifying and conceptualising existing quality systems, which provides a basis for creating an alternative quality system. The limitations of system thinking appear to be centred on the lack of adoption by mainstream management theorists and its relative obscurity in the field of project management.

11.6.2 System Dynamics

As outlined in Chapter 6 System Dynamics is promoted as a methodology that enables its users to model the dynamics of the processes in their organizations. By simulating various scenarios, SD is believed to encapsulate the knowledge that individuals gain analysing the business processes using mental models and integrating this knowledge into the fabric of the organization. What this research identified was that SD could be used in limited manner to emphasis the flaws in existing project quality systems and to promote the original process based quality philosophy of continuous improvement. The limitations of SD revolve around its specialist nature and unless SD practitioners empower their clients to embrace and make more accessible the thinking and philosophy behind both systems thinking and system dynamics, it will still be seen as a methodology only available to a limited number of academics and organisations. This would be unfortunate because the way of thinking that SD promotes and its attempt to model qualitative and the quantitative entities and relationships could lead to the much needed change in the way that attributes like quality are measured at present.

11.6.3 The contribution made by ST and SD

In conclusion, there is enough evidence to show that systems thinking and system dynamics can make a valid contribution to creating a viable practical quality system. Transferring the tools and techniques from ST and SD into the project domains of the case studies would be the most difficult part. It would require a radical shift in quality strategy by a project organization to implement some of the concepts that ST and SD promote. Yet, perhaps by approaching the topic of project quality from a new and challenging perspective there would be a better chance of continuous learning in projects taking place. This would create a similar scenario to that which faced the staff at Ebo[59], having to implement what was to them the new and alien concept of ISO9000. What is clear from the case studies carried out is that there is a need for organizations to re-evaluate what people's perception of traditional quality management is, and how they see it in relation to the success or otherwise of the projects in which they participate. Using ST and SD could start to address these issues.

11.7 Identifying valuable attributes from the case studies

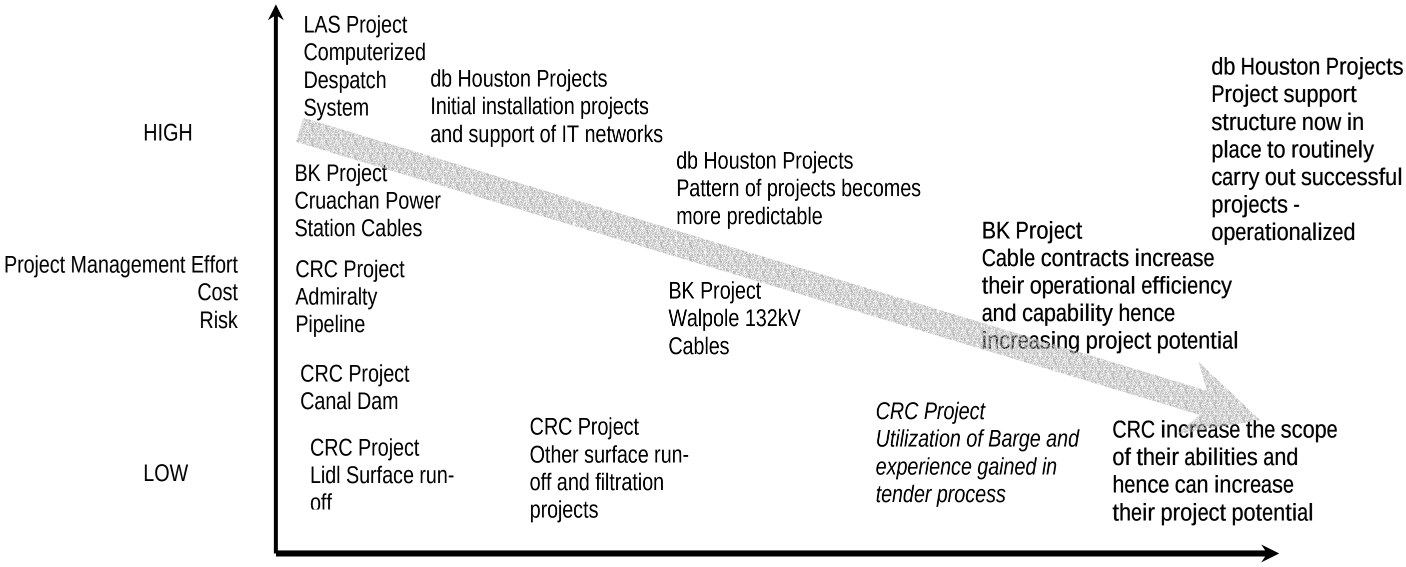
A key hypothesis that emerged during the course of the research was that if quality systems were to make a positive contribution to future project success they should be capable of producing a conduit for the flows of information needed to provide project organizational learning. By increasing project organizational learning, the probability of future project success should be increased from the feedback gathered, disseminated and distributed by the 'knowledge-based' quality system. The evidence to support the need for this type of quality system became apparent during the collation of the case studies.

11.7.1 The importance of identifying non-unique tasks, turning repetition into routine whilst retaining creative anarchy

Treating a task in a project as unique ignores the valuable experience from past projects on the design, planning, scheduling and execution of the task. Unique tasks are associated with higher risk and cost implications. For example, the method proposed to solve the erosion of the bridge foundations at Lochy Bridge had clear risk implications hence the elaborate method designed and proposed in CRC's bid and its attendant higher cost. Projects also consist of non-unique repetitive tasks. These are the antitheses of the activities that create the uniqueness of projects; they are the generic tasks that are essential to the effect management of all projects. These tasks were seen to be the most suitable for existing quality systems. Most non-unique repetitive tasks within CRC were administrative in nature: wages, accounts, transport issues etc. The Lochy Bridge case study highlighted the absence of any generic method for the 'tender process' at CRC. Methods to be used and costing of the project were principally attributable to the experience of the directors and the other essential personnel. The key project personnel typically determine how a project is carried out, but constructing the tender to bid for the particular contract can be a particularly long and labour intensive process in itself. For CRC, the construction of the tender for Railtrack was a major activity which, although unsuccessful should have been replicated (i.e. become a routine task) to allow bids for further contracts. In relation to cost estimation and budgeting Nicholas[60] believes that employing 'standardized technology and procedures helps improve the accuracy of estimates'.

11.7.2 The relevance to small project organizations of transforming the unique into the routine

With limited personnel having to carry out a number of roles and tasks a simple system based on checklist type, approach may have been beneficial without imposing a surfeit of procedures. The ultimate goal would be to transform unique to repetition into routine to reduce the load on the existing personnel and to prevent activity and project failures, without losing what Seddon[61] refers to as *creative anarchy* that is of great value in innovative organizations operating in a changing environment.



UNIQUE REPEATED ROUTINE

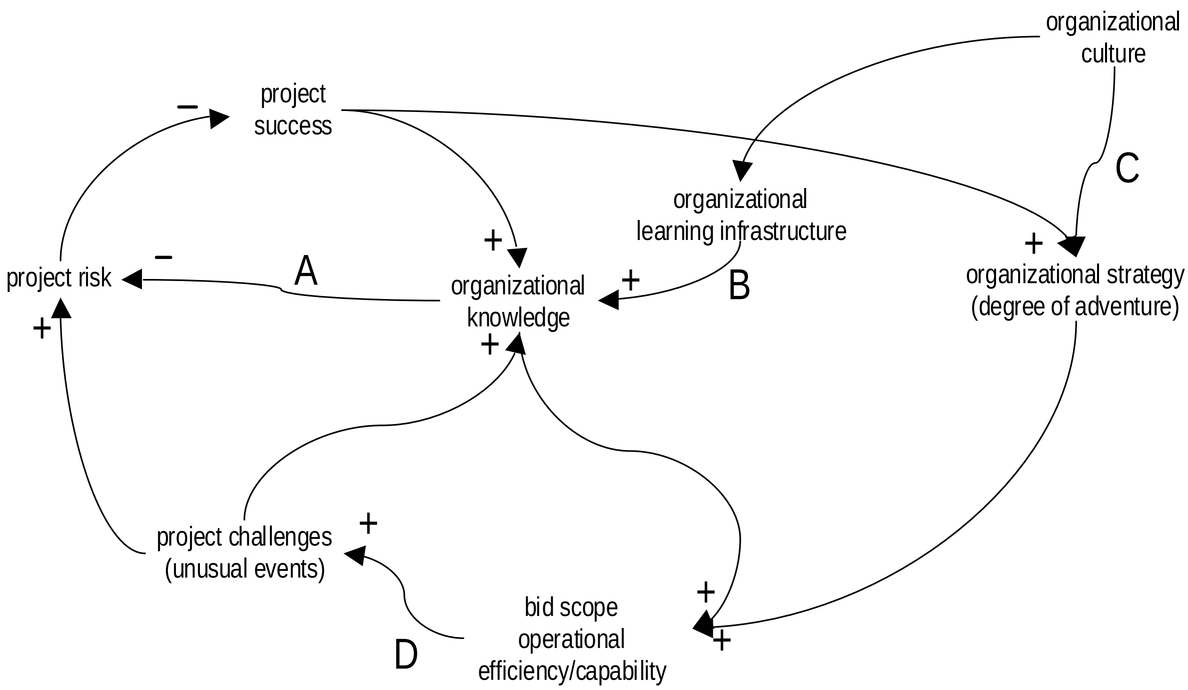
Note:
For CRC potential repeated and routine projects are in italics to denote what was expected happened if the Railtrack project had gone ahead

Figure 11.7 Transforming unique project attributes into routine

By partitioning the case study examples into three stages unique, repetitive and routine, the identification of traits that allow creativity to be retained without compromise may be possible. Figure 11.7 illustrates the reasoning behind this by using the case studies from this research. As the project moves from unique to the routine, ideally the project management cost and risk should also decrease. In turn, this would allow the expansion of the abilities of the project organization or a consolidation of their existing business. Combining the concepts of decreasing risk with routine, increasing knowledge by feedback to increase capability, provides the basis for the alternative project quality model illustrated in Figure 11.3.

11.8 Developing the Alternative Project Quality Model

The alternative project quality model attempts to synthesize the areas of the project management environment, encountered throughout this research, culminating in the need for



A If the organization has much relevant experience this can be used to solve the project challenges and reduce risk
B The ability of the organization to learn from past projects (successes and unusual events) depends upon having the appropriate mechanism for the transfer of those experiences
C Some organizations are more willing to take on new types of projects (e.g. CRC)
D Depending on the size, commercial environment and organizational strategy of the project organization either of these attributes can be valid. (e.g. CRC more likely to increase bid scope, BK more likely to increase efficiency/capability)

Figure 11.8 Causal loop diagram – the foundation for the alternative project quality model

better organizational knowledge, achieved by more feedback. This reinforces the need to create a practical learning infrastructure based on information, knowledge and experience of previous projects. Figure 11.8 represents the foundation for the model using a causal loop diagram. In accordance with other causal loop diagrams, the link from one key variable to another can either denote a similar change (positive symbol[iv]) or an opposite change (negative symbol). The translation of the causal loop diagram (what Shibley[62] describes as the 'story') is as follows:

> The project *organization culture* either encourages or discourages the *organizational strategy*, described in the model as the 'degree of adventure', which the organization is willing to take on, i.e. the risk and diversity of the project in comparison to the capabilities of the organization. In addition, the organizational strategy also describes the organization's willingness to use alternative methods and technologies to achieve their project objectives.

The *organizational learning infrastructure* describes the ability to promote and capture what has been learnt through using a diversity of approaches to tackle project activities and objectives. From this *organizational knowledge* is increased or reduced. A high degree of adventure promotes a high degree of scope in the projects that the organization can bid for (assuming they successfully carry out their preceding projects) This can also be translated into an increase in *operational efficiency/capability* if like Balfour Kilpatrick and db Houston increasing the bid scope is not an imperative strategic goal. Increasing the *bid scope* also increases the challenges that will be faced by the project organization, which in turn increases the *project risk* encountered. Higher *project risk* lowers the chance of success of an individual *project* though *organizational knowledge* increases to the long-term benefit of the company. *Organizational knowledge* feeds back to both reduce *project risk* and increase *bid scope operational efficiency/ capability.*

Note for the purposes of the diagram the definition of culture is that provided in Chapter 4 by Clutterbuck and Crainer and cited by Beckford.[63].

[iv] In some literature the positive and negative symbols can be denoted by 'S' for same and 'O' for opposite.

11.8.1.1 Degree of adventure

The culture at CRC exhibited a high degree of willingness to accept diverse, high-risk projects, therefore their organizational strategy exhibited a high 'degree of adventure'. This also drove their ability to learn in the respect that they embraced new technologies and challenges; their organizational learning infrastructure was enhanced although there was no formal learning infrastructure. CRC's design and bid for Lochy Viaduct project was unique. The projected cost and risk was substantial in respect to the size of CRC. The tender bid was high due to the technique proposed, using the specialised barge. CRC determined that the barge was the best option with which to overcome the technical difficulties involved in working close to the railway bridge. The client defined health and safety, as paramount therefore using the barge was the only way in which CRC believed that the work could be carried out, within the criteria outlined by the client. The lengthy and complicated tender process that CRC had to engage in exposed the company's lack of experience in that process. Like the project as a whole, the tender process was unique for CRC. In other aspects of their work, CRC exhibited a flair for what is described in Figure 11.7 under organizational strategy as a 'degree of adventure'. The Admiralty pipeline project underlined this. From a tenuous piece of information, CRC created a project, locating and reclaiming 50-year-old pipes that allowed British Waterways to reinstate a canal towpath.

Since writing the CRC case study, CRC as a company has gone into voluntary liquidation. Changing laws in the construction industry and a downward turn in future projects contributed to Mr Clements decision. Perhaps CRC exhibited too great a degree of adventure; or perhaps the translation of individual project experience into *organizational knowledge* was not successful. Certainly there was no learning infrastructure to allow the transfer of knowledge to others in the company, which combined with the vagaries of running a small business obviously took its toll. Having had a high degree of adventure it was perhaps the lack of consolidation of the project experience that contributed to the demise of CRC. Despite having discovered and introduced gabion baskets to the construction industry in Scotland, other companies utilized the technology and became more commercially successful.

11.8.1.2 Operational efficiency, capability and bid scope

The project described in the Balfour Kilpatrick case study (Chapter 8) was an example of a larger commercial project carried out by an organization, which specialised in installing high voltage cables for large utility companies. Therefore, the types of projects that were implemented did exhibit a large degree of functional commonality. (The 275kV cables installed in the vertical shaft at Cruachan Power Station briefly described in Chapter 8, section 8.3.1 was a rare example of a truly unique cable project) Typical projects would consist of excavation, cable installation, backfilling the excavation and jointing then testing. The majority of the unique activities/aspects found in these projects centred on the project location, any unusual technical criteria and the mix of personnel that created the project team. Therefore, the drivers for Balfour Kilpatrick would not be to increase their ‘bid scope’ like CRC but to increase their operational efficiency or capability through some form of mechanism as described in Figure 11.8 (notes **B** and **D**)

11.8.1.3 Organizational learning infrastructure

The Balfour Kilpatrick cable contract was a typical cable project, the number of incidents that were outwith of the normal range of problems were relatively few. Despite the project, being relatively ‘generic’ there was lessons to be learned. These included the rework needed at the pylon (attributable to National Grid’s own design, fabrication and installation), the subsequent accident at the pylon, the security incident, and a narrowly avoided dispute with the sub-contractor (precipitated by decisions taken out with the immediate sphere of influence of the project). The project team learned from these incidents but the organization itself did not. It had no infrastructure with which to capture record and disseminate this knowledge. The ISO9002 quality system that was in place did not provide any tangible means of recording or distributing the events that happened. This was compounded by the prevailing attitude of the quality personnel who viewed the quality process as one of document tracability with no regard to the outcome of the project. No feedback was available to future projects that would have contributed to continuous improvement.

CRC failed in their bid to win the Lochy Viaduct contract, yet plans were in hand to utilise the plant and expertise gained on the Lochy Bridge project. If CRC pursued further contracts with large organizations like Railtrack it would likely that a tender procedure would have enhanced the process. The barge that was to be specifically designed and built for the Lochy Viaduct project was to be incorporated into future projects. (Development costs for the barge were incorporated into the contract for the Lochy Viaduct which was partially offset by the barge reducing the amount of temporary works that would have had to carried out using an alternative method) The barge was to be utilised on the same type of project or on work connected with major canal refurbishment. CRC were investigating the possibilities of further projects with British Waterways even before a completed tender had been submitted to Railtrack. The use of the barge and the experience gained would have increased the scope of projects that CRC could have considered. In Figure 11.8 this can be seen as increasing the ‘bid scope’, something that the CRC organizational culture facilitated and was adept at achieving in the majority of cases. The Balfour Kilpatrick project was a routine project, with generic activities. Even with this type of project there will be members of the project team whose expertise and knowledge is not complete, trainees or others who have been working on different types of project. The author was returning to managing a cable project after a 6-year absence therefore getting up to speed on new developments was important especially at the beginning of the project where decisions had to be taken regarding the project execution and programme.

The problems faced by small project organisations were also evident in the other small company used in the course of this research db Houston Ltd (Chapter 9). db Houston Ltd installs and maintains small computer networks and has a growing workload which has meant increasingly that projects are more at risk of being inadequately implemented due to a shortage of personnel which created a lack of continuity. The introduction of procedures for example could help clarify some of the project objectives and perhaps stabilise the current fire-fighting situation. This is a short-term solution; eventually a longer-term strategy will have to be implemented. Whilst advocating the need for some form of 'system' in these small project organizations, it is still questionable whether or not existing quality systems can be diluted or modified enough to be useful. When the environment is changing rapidly the concept that a procedure-based approach will prevent project failure can appear naive.

11.9 Conclusions

From the findings of this research it can be concluded that the pertinence of the models implied by existing quality initiatives in a real project environment is not high. Formal quality systems are in evidence; yet do not provide the necessary feedback to create a positive effect on future project success. The strengths of existing quality systems lie in how they can create a routine for repetitive activities, providing a framework for future improvement. Project organizations can benefit from such systems if they can interpret them to suit their environment. Unfortunately, the underlying idealism behind quality management can been lost under a blanket of inappropriate implementation, amplified by a lack of flexible interpretation. Hence, the positive attributes of existing quality systems are eroded to the point that they exert a negative influence on the organizations in which they are used. It was believed that in the case studies organizations where projects were closer to operations there would be some benefit from existing quality systems, yet this was clearly not the case. If ‘routine projects’ do not benefit then it is unlikely that any type of project organization would benefit.

The use of alternative ways of analysing and defining quality using methodologies such as systems thinking and system dynamics are at present too remote for widespread application, but they can provide general insights, for example the alternative project quality model. Their strengths lie in their ability to visualize, conceptualise and model the project as a ‘system’. Achieving this could pinpoint the critical factors needed to create a quality project i.e. a successful project, which has a framework to feedback information into the organization to contribute to future project success. The alternative quality project model (Figure 11.8) is an illustration of the general concepts that it is believed should be encompassed by such a framework. The case studies constructed in this research have exhibited various attributes which contributed to the success or failure of the projects carried out. The case studies have attempted to focus on the topic of quality in project management, which in the case of CRC, Balfour Kilpatrick and db Houston were inherent in the organizations. This is commensurate with traditional project management literature, which as discussed previously sees quality as integral to the project. Simply adopting quality systems developed for a manufacturing environment is not appropriate for project management. The nature of the case studies tended to lie toward the routine rather than the unique end of the project spectrum, but even here existing quality systems do not seem appropriate. The feedback routes and timescales are significantly different and require a re-evaluation of quality systems. A key element of a quality system for project management is an effective method of managing knowledge to encourage the feedback vital to future project success. To achieve this knowledge-based systems that have a more explicit method of managing knowledge are required. Project management is all about the feedback of knowledge to improve project ability, the mechanisms to achieve this need to be redefined and put in place. Quality systems in the context of project management need to be re-defined as learning mechanisms to further the knowledge of the organization and its project personnel. What this research is proposing, is that the role of the quality system should become an aid to creating more learning between projects, i.e. a 'neurocybernetic' knowledge-based quality system based on the theories developed in this chapter, in particular the alternative project quality model in section 11.8.

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[63] Beckford, J., p.22.

Chapter 12

An Alternative Perspective on Quality in Projects

12.1 Chapter Synopsis

This chapter proposes an alternative perspective on quality in projects, based on the findings of the four case studies created. Like Chapter 11 it synthesises the various elements that have been examined, observed and investigated throughout this research. This chapter will strive to provide a response to the second primary aim of the research stated in Chapter 1, which was,

2. *To develop an alternative model as a basis for the management of quality in projects; this model will aim to rectify any deficiencies, identified in (1).*

In drawing together the findings of this research, it will become apparent that there is a growing need for organizations to harness the knowledge that is inherent within their own personnel. Flourishing project organizations have managed to capture knowledge from past projects to feed forward and improve their chances of future project success. However, this is seldom an explicit process. Quality management, with the systems it promotes, should be able to make a considerable contribution to this feed forward process. But quality management is not always seen as an integral part of the strategy of success for project organizations: some appear to view it as an extraneous system that appears not to have the backing of the vast majority of its users. This chapter also draws on parts of a preliminary joint paper 'The Mechanisms of Projects Learning' in Appendix No.7 that demonstrates where elements of the proposed model have been derived.

12.2 Devising a more appropriate Quality Management System

To achieve an alternative quality system appropriate for project management the emphasis must move from what Seddon[1] described as the 'command and control' type mentality to one in which any new system contributes or 'adds value' to the project organization in a positive and worthwhile manner. The predominate trait of the quality systems examined was the need to 'be seen' to be doing the 'right thing' rather than doing the 'right thing' as a matter of course (assuming that the activities carried out were indeed valid to begin with.) In the Balfour Kilpatrick case study the quality system contained procedures that were neither technically useful or a particularly good record of the work carried out. Pro formas that typically had to be filled in by the project engineer on site were often erroneous, not through any desire by the engineer to lie, but by the vast amount of documentation that had to be filled in, which in turn had a demoralising effect. This was compounded by the apparent lack of analysis of the records once a project had been completed, therefore procedures and quality inspection plans were in effect in place to offer some perceived form of guarantee to the customer, something that in the case of the Balfour Kilpatrick case study the direct customer was not interested in anyway.

At a more fundamental level, Wilkinson and Wilmott[2] asks whether the use of quality management (of which quality systems are a key part) is there to improve the quality of life for the majority of human beings 'or is the primary effect of quality initiatives to remove many people from productive activity and to intensify the pressures upon those who have the privilege of continuing employment.' Although this is perhaps outwith the scope of this research it is worth noting that the use of quality management experienced in the case study projects did not appear to be influential enough to determine project operations, an ironic situation given its alleged prominence in the organizational hierarchy.

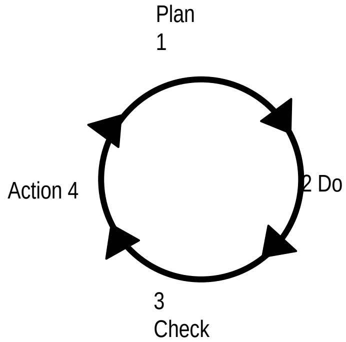

Figure 12.1 Deming's Plan-Do-Check-Action cycle

12.2.1 The Deming Cycle, knowledge accumulation and self control

Deming's well known cyclical exhortation plan, do, check, action, shown in figure 12.1 is still widely quoted[3] as the form that any quality based problem solving system should take, and it is as valid today as it was when it was first written in 1986. (Shewart, is cited in Deming's Out of the Crisis[4] as the originator of this 'perception of the cycle'.) Figure 12.1 is the common depiction of the PDCA cycle although it debatably loses the critical message shown in the original, i.e. the concept of learning or 'knowledge accumulation'. The iterative

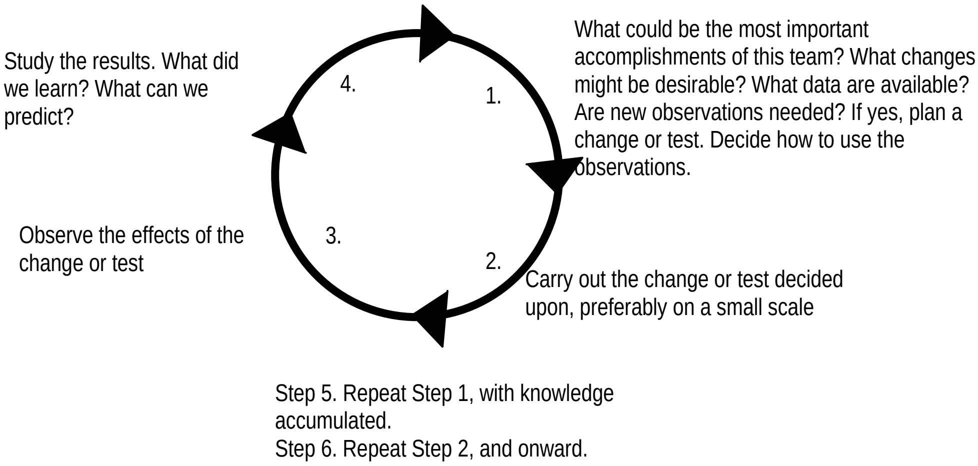

Figure 12.2 The Shewart cycle

process that the cycle describes is often seen as the way to continuous improvement. Figure 12.2 illustrates the original 'Shewart' cycle[5] from Deming. The 'do' part of the cycle is seen by Kondo[6] as consisting of a further plan-do-check- action cycle which he believes is a reflection of the self-control of the people performing the activity. Figure 12.3 illustrates this

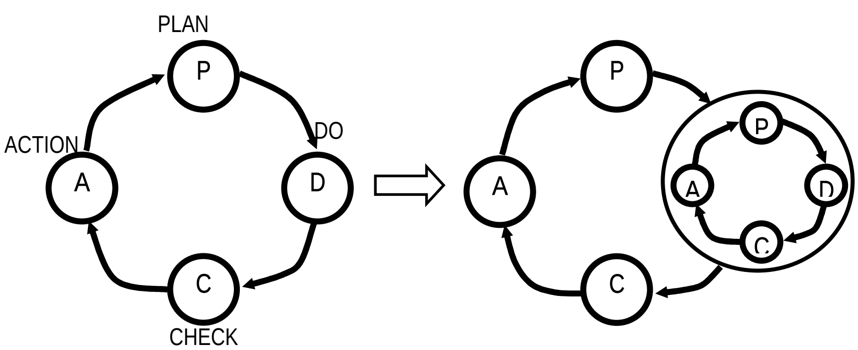

Figure 12.3 The Deming Cycle including the 'performance of the individual' as described by Kondo

concept. Juran and Gyrna[7] link this PDCA cycle to the main elements of a feedback loop. Their description of the ‘universal sequence of steps’ that makes up a control process are shown below:

1. Choosing the control subject: i.e., choosing what we intend to regulate.
2. Choosing a unit of measure.
3. Setting a goal for the control subject.
4. Creating a sensor which can measure the control subject in terms of the unit of measure.
5. Measuring actual performance.
6. Interpreting the difference between actual performance and the goal.
7. Taking action (if any) on the difference.

The manufacturing origins of these steps is quite apparent and indeed Juran’s approach to quality improvement cited in Beckford[8] is often seen as heavily relient on quantitative

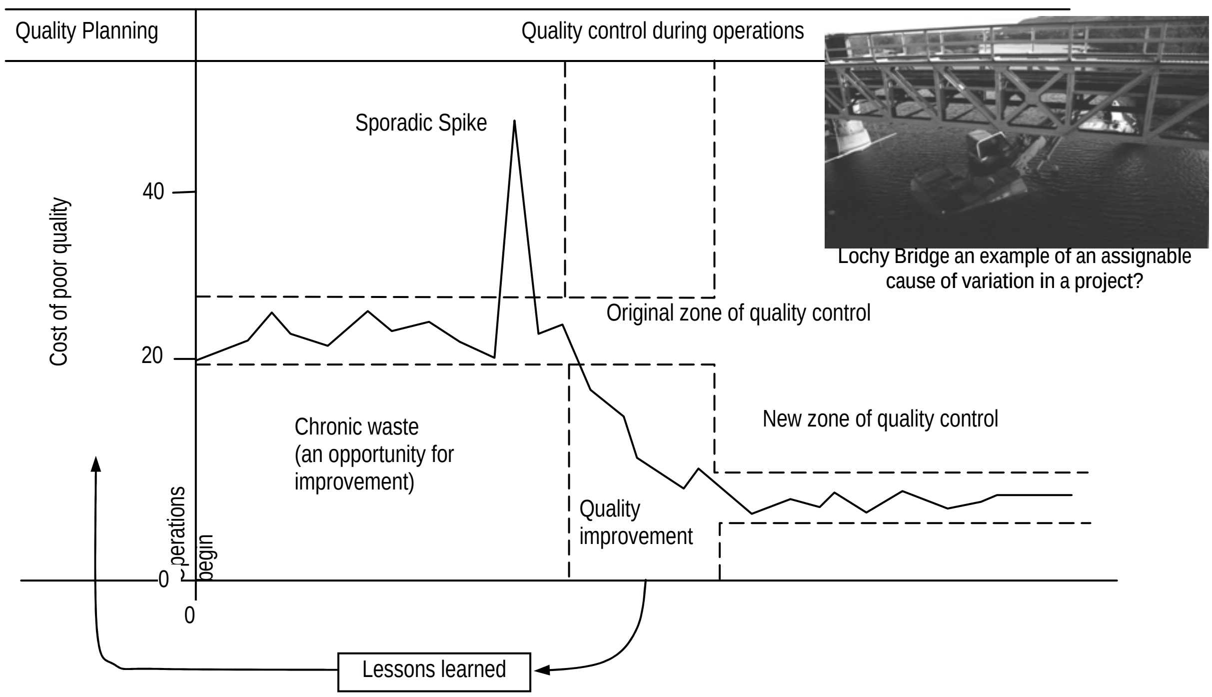

Figure 12.4 Juran’s trilogy diagram

approachs, establishing specific plans, goals and targets to identify what needs to be done to achieve 'fitness for purpose[i]'. Juran does believe that despite the dominance of traditional quality activities (what he refers to as "little Q") based on manufacturing, modern quality activities do encapsulate all activities (" big Q")[9]. There are a number of similarities between Jurans teachings on quality and traditional project management approaches. Emphasis on planning, goal setting and assigning clear responsibility for achieving goals are part of the Juran's philosophy. What is important in Jurans methodology is the role of feedback or 'lessons learned' as shown in Figure 12.4 Juran's Trilogy diagram[10]. This illustrates a generic type of statistical process control chart where the efforts of quality improvement reduce the cost of poor quality. There is the same level of variation but at a far lower cost of poor quality. Sporadic spikes that appear at any part of the process are dealt with by quality control during operations. Maylor[11] reproduces the Deming cycle (shown in Figure 12.5) and applies it to project management in a manner that does not appreciate that the check phase can rarely be carried out after the completion of all phases, indeed the early detection of errors is essential to prevent the problems illustrated by Rodrigues and Williams[12] in Chapter 6, section 6.8.5.

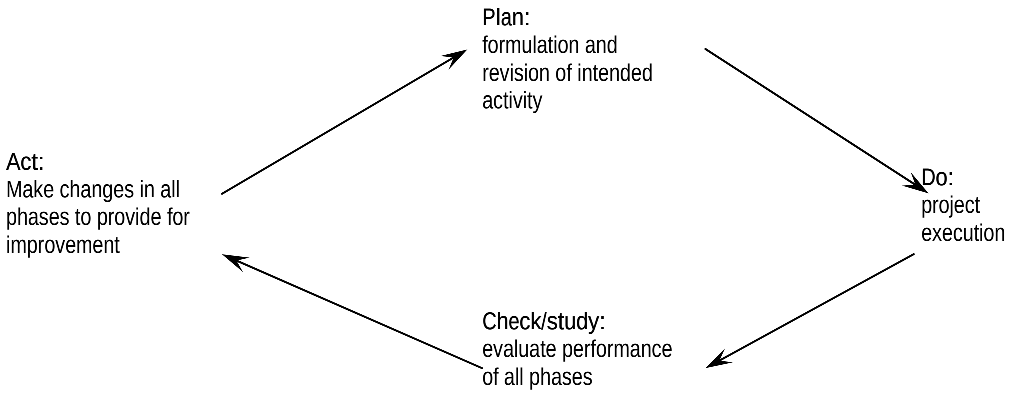

Figure 12.5 Deming cycle for project management

[i] Juran defines quality as 'fitness for use or purpose'. In the context of projects, this is comparable to the 2nd level of quality 'meeting the real requirements' illustrated in Chapter 1, section1.3.

Reducing the ‘chronic waste’ is achieved by what Juran refers to as ‘quality improvement’. Juran attributes the chronic waste to inadequate quality planning. Again there appears similarities with project management. The sporadic spikes which represent assignable (special) causes are similar to an unexpected event that occurs in a project, for example the excavator in the Lochy bridge case study sinking into the river (Chapter 7, Plate 7.4). Juran describes ‘special’ causes as events that cause a large amount of variation in the process with examples being operater error, faulty preparation, or defective incoming raw material. Special causes such as these are determined by Juran as detectable and it is economical to eliminate the causes. Certainly the sinking of the machinery at the Lochy Bridge could have been prevented with more preparation, therefore it is a ‘special cause’.

12.2.2 Applicability of random variation in PM

Random (or common cause) variation is the term that Juran uses for the slight variation that is created in a typically manufacturing process by for example wear of equipment over time, human variation in the settings of controls, differences in supplied material, style of working etc. Applying this to the project environment does not appear straightforward yet random variation is present in a number of forms. For example climate can have a marked effect on the activities of a project in the construction industry, yet there is many situations that projects have to carried out regardless of this. Random variation in a project could be defined as the common causes of variation that are outwith the control of the project team. The contrast between the two environments (although Juran espouses the applicability of modern quality activities to all types of organization in reality it is still aimed or perceived to be manufacturing based) is the nature and magnitude of the random causes. In project management the scope of the project determines the boundaries of what it is the environment which will directly effect the project. For example the stakeholders,the project objectives, the timescales, the specifications, the availability of resources etc. A random noise that effects a project could be defined as an incident that effects the project from outside its scope boundaries.

In Chapter 8 (section 8.7.1) the Balfour Kilpatrick case study the decision was taken by senior management to terminate the companies association with the sub-contractor being used on the site, despite the fact that the project had not been completed and it could have had serious consequences both in security and in completing the contract on time for the customer National Grid. For the Walpole project this was an example of random variation, the project team could not determine that this was going to happen. Yet examining Balfour Kilpatrick as a whole project organization this was plainly an assignable cause of variation. There is also an important distinction in the nature of the variation that effects the project. The example just cited was clearly a management/contract issue rather than a technically based issue. The full facts of what occurred to precipitate the decision to terminate the sub-contractors contract is unlikely to be recorded, therefore any lessons learned will not contribute to any 'quality improvement'. It is more likely that the recognition of assignable variation will occur with more tangible technical based problems that occur during the project life cycle.

12.2.3 Self accountability a key facet in Project Management

The concept of self-accountability is one that Peters[13] highlights as the difference between the classic functional models of organization and the models of project organizations. His descriptions of organizations that use project based models are that they are the 'ultimate accountability models'. Project teams are seen as having both internal and external customers (a parallel with textbook quality teachings) that creates accountability. The organizations Peter's uses in his case studies are large corporations. None the less, the comparison between those case studies and the ones in this research is strikingly similar, particularly in the roles played by the organizations and their personnel produces some important points for discussion:

- Project models are the ultimate accountability models.
- Real internal and external customers breed high accountability.
- Project teams are held responsible for results (and always understaffed by design).
- Characterises the differences between project teams and committees.
- Having a designated project leader – with the commensurate skills that go with it.

Peters[14] believes that 'Project management turns out mostly to be about mastering paradox' and project managers usually possess the following key qualities:

- Responsibility for the project from start to finish.
- Responsible for coordination and 'concept' championing.
- Responsibility for costing, technical details and design.
- Have direct contact with the client and be a project champion in there own right.
- Prefer personal communication as opposed to 'paperwork and convening meetings.

In all the case studies carried out in this research there was individuals who possessed the

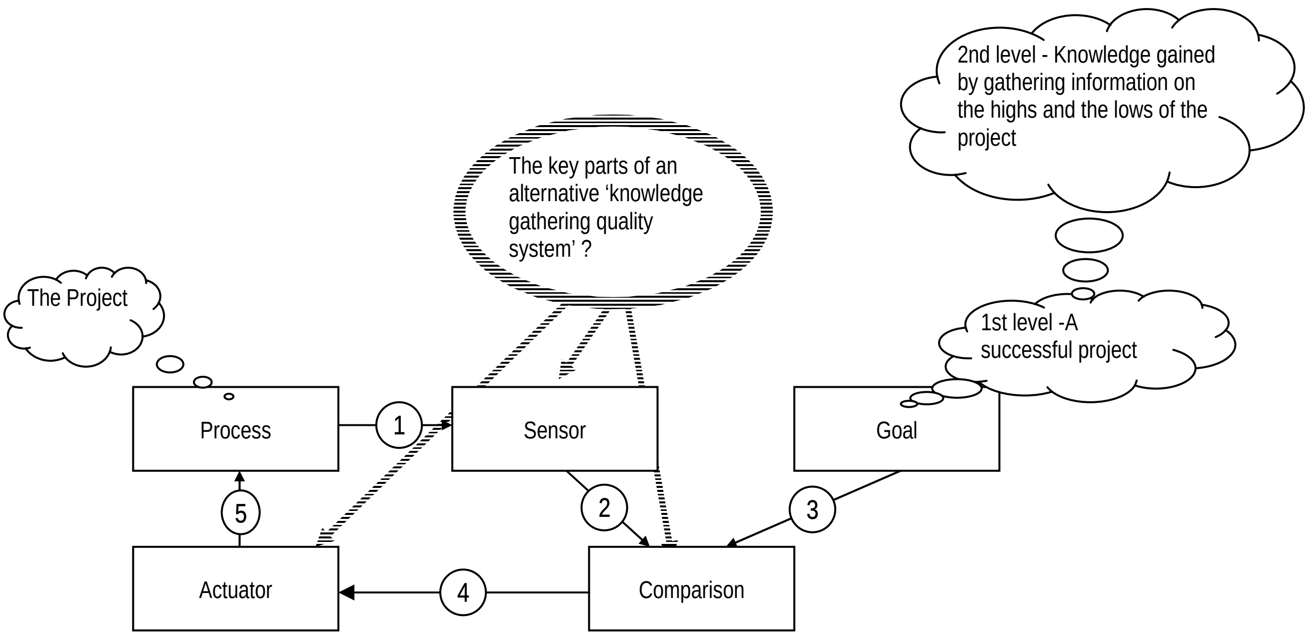

Figure 12.6 The Feedback loop based on Juran and Gryna adapted with key parts of a knowledge-based quality system shown

traits described by Peters (who goes into greater detail with an astute synopsis of what a project manager has to deal with) except for the London Ambulance Service case study (Chapter 10). It is noticeable that there was little or no accountability exhibited throughout the whole project process. Superimposed on Figure 12.6 are the key parts, which would be used in the alternative quality system. Difficulty arises in defining the areas of what the system is going to regulate and what units are to be used to affect a measure. With the concept of a knowledge-based quality system the emphasis would be expected to be on the regulation or more correctly the deregulation of inputs and outputs of information into the project both during and after the project. Revising the simple feedback diagram shows what attributes the knowledge-based system would need as shown in Figure 12.7. The practicalities of a knowledge based quality system are based on its ability to gather useful and disseminate useful data.

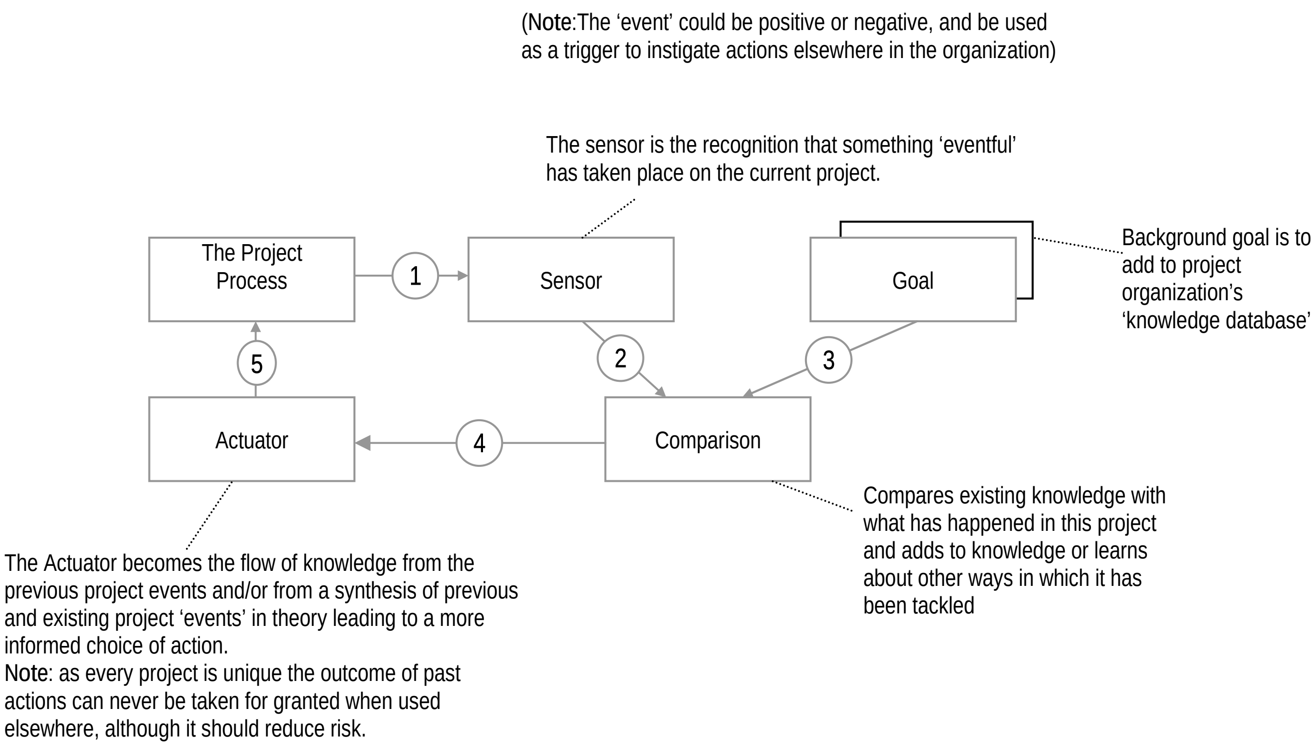

Figure 12.7 Defining the components needed to create the knowledge-based quality system

Existing quality systems are still dominated by the need to segregate, quantify and approve tasks, which initially may appear to be advantageous, by introducing what is in effect the concept of operational repetition but in the long term does it reduce the innovation and creativity that projects can produce?

To prove that an organization can carry out a successful project cannot be dependent on a process, which audits the viability of a system. The audit process as described in the Balfour Kilpatrick case study does not account for what Senge[15] refers to as processes of change, instead they rely totally on snapshots to determine the well being of a system that may or may not be contributing to the success of the project. It is hardly suprising that there is general disillusionment with the form and the requirements that existing quality systems and quality practitioners impose on project organizations. Feedback exists in the quality systems of present not due to the need for improvement but as reinforcement of the need to have some form of recognised quasi-official quality system. Leading to what has already been described and illustrated in Chapter 5 as a positive reinforcing loop i.e. a 'vicious circle'.

In implementing a quality system at the execution phase of the project existing quality systems tend to live up to the reputation that they are no more than glorified quality control programmes. It is perhaps unfortunate that many quality initiatives are seen as this.

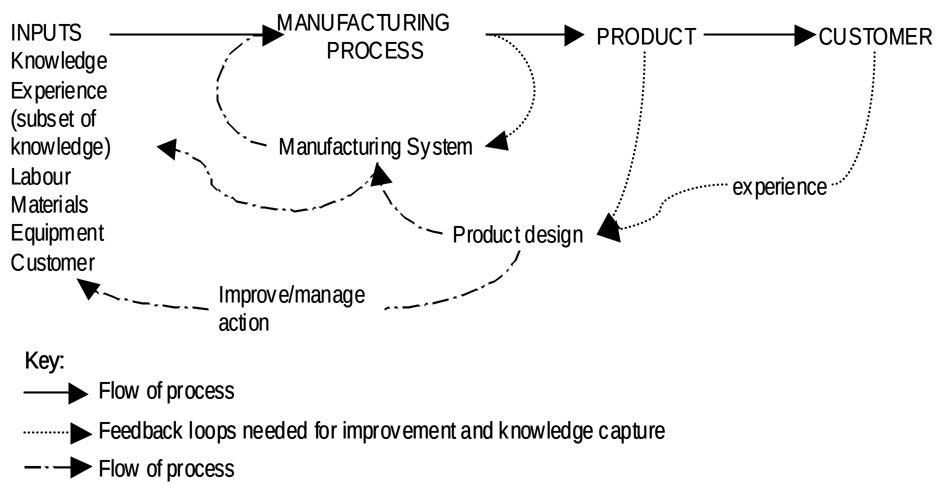

Figure 12.8a) Generic Manufacturing Diagram

Stebbing[16] describes the misnomer that quality control is often seen as the remit of the quality department in an organization when in fact it should be seen as a function of whatever department needs the checking to take place. Therefore by this definition practicing quality control in a project is an operational function carried out by the project team which returns to the historic concepts of inspection and control.

The evolutionary background of quality management is an ideal vehicle to promote the quality (capture of knowledge) in a project environment. The case studies carried out have outlined the manufacturing bias still present in existing quality systems. A gap[ii] exists between the existing manufacturing based quality systems and the requirements of a project-based organization. A generic depiction of a manufacturing process is illustrated in Figure 12.8a). There is clearly parallels with this and Swieringa and Weirdsma's theory of 'collective learning' which consists of three learning loops as shown in Chapter 1, Figure 1.5. This is a representation of a generic manufacturing process, the type that many quality management systems are derived from. The attributes shown in the diagram are either

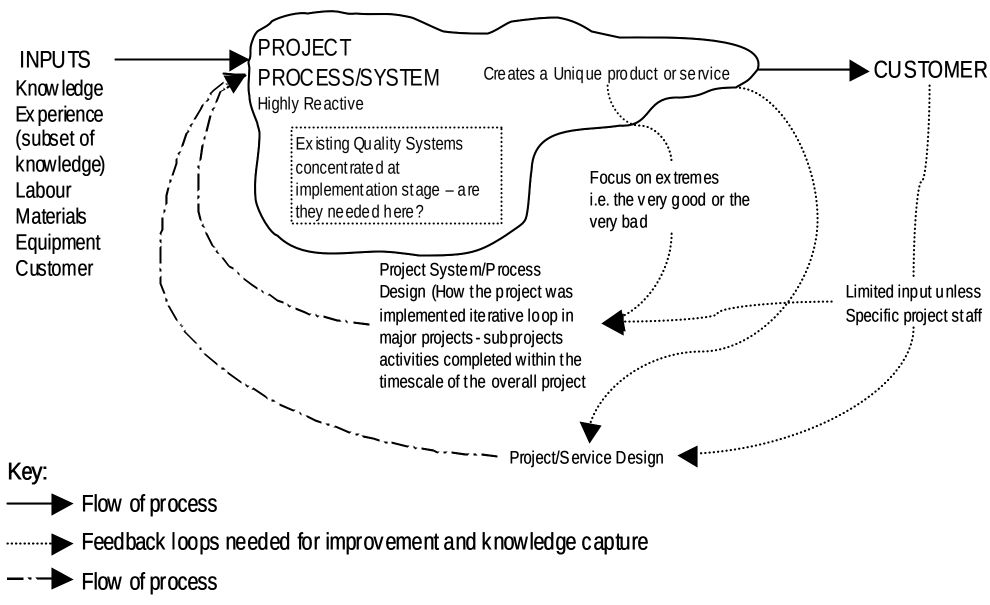

Figure 12.8b) Generic Project Diagram

tangible physical processes like the manufacturing process or the products produced or they possess a mixture of both the tangible and intangible like the Manufacturing System (figure 12.8a).

Progressing to Figure 12.8b) the diagram attempts to highlight the differences between the manufacturing process and the project process. With the manufacturing process whether it is jobbing, batch, mass, continuous etc. the emphasis is on repetition, iterative loops are an inherent parts of the process. Feedback routes are obvious and contribute not just to the operational optimisation of the process but also to the knowledge database of the organization. Part of this knowledge database includes the experience gained by the personnel on-site and who drive the system. This does not ignore that variation is part of the process of manufacture, as was illustrated earlier quality improvement is aimed at directing the process to perform to its optimum capabilities. Despite this there is a relatively high degree of continuity, conformity and stability in comparison to the project process[iii]. The product or service that is the outcome of the project process is shown as an integral feature of the process. The rationale behind this is to emphasise the relative immediacy of a project once it is in its implementation stage. It is at this stage that traditional quality systems are concentrated due to the ease at which they can be implemented.

Trying to generalise what facet of quality is most prevalent at the implementation stage is difficult due to the wide range of interpretation of quality systems available from quality management literature. From the case studies, it appears that quality control is the most likely manifestation of quality to be present at the implementation stage in the project lifecycle.

[ii] No parallels should be drawn between this use of the term 'gap' and the 'gaps' outlined by the SERQUAL model by Parasuraman et.al.

[iii] In this research the case studies 1 to 3 were of project organizations, case study 4 the LAS was an organization that carried out a project.

Therefore is the 'gap' between existing quality management systems and projects variable depending on the amount of 'uniqueness' in of the project as shown in Figure 12.9? From the findings of this research as discussed in Chapter 11, even if the projects tend to be routine

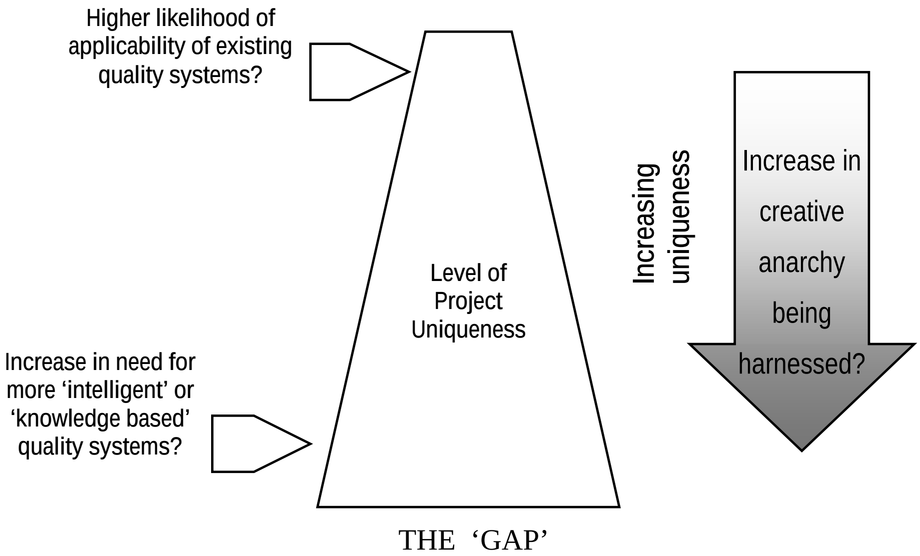

Figure 12.9 The premise on which the GAP between existing Quality practice and the type of project involved is based

rather than unique existing quality systems do not seem appropriate, therefore a completely new framework would be necessary. The generic project diagram in figure 12.8b) also shows the general feedback loops that take place during the project process. An important difference with the manufacturing diagram is that some of the major feedback loops, like the project system/ process design may only be applicable in the lifetime of the project. If the project life is short then any alteration to the project process will only take affect on the next project. Again this is the uniqueness of projects that creates a possible barrier for the ongoing transfer of knowledge in the organization. For any useful transfer of knowledge to take place any 'knowledge capturing system' must be robust enough or practical enough to be able to cascade down to subsequent projects.

Likewise with a major project it would be expected that the project process would be dynamic enough to be able to be modified to take advantage of any freshly acquired knowledge. For example subprojects would benefit from previous subprojects carried out in the course of a major project. Obvious obstacles to this are the traditional barriers that exist between contractors and between customers in many industries. As discussed in chapter 11, section 11.5.3.3 areas of the construction industry are currently examining the concept of 'partnering' which seeks to break down these traditional barriers. Barlow[17] beliefs this requires a move away from 'single-loop learning' to 'double loop learning' the point where the organization are questioning the viability of their established norms. This will in turn

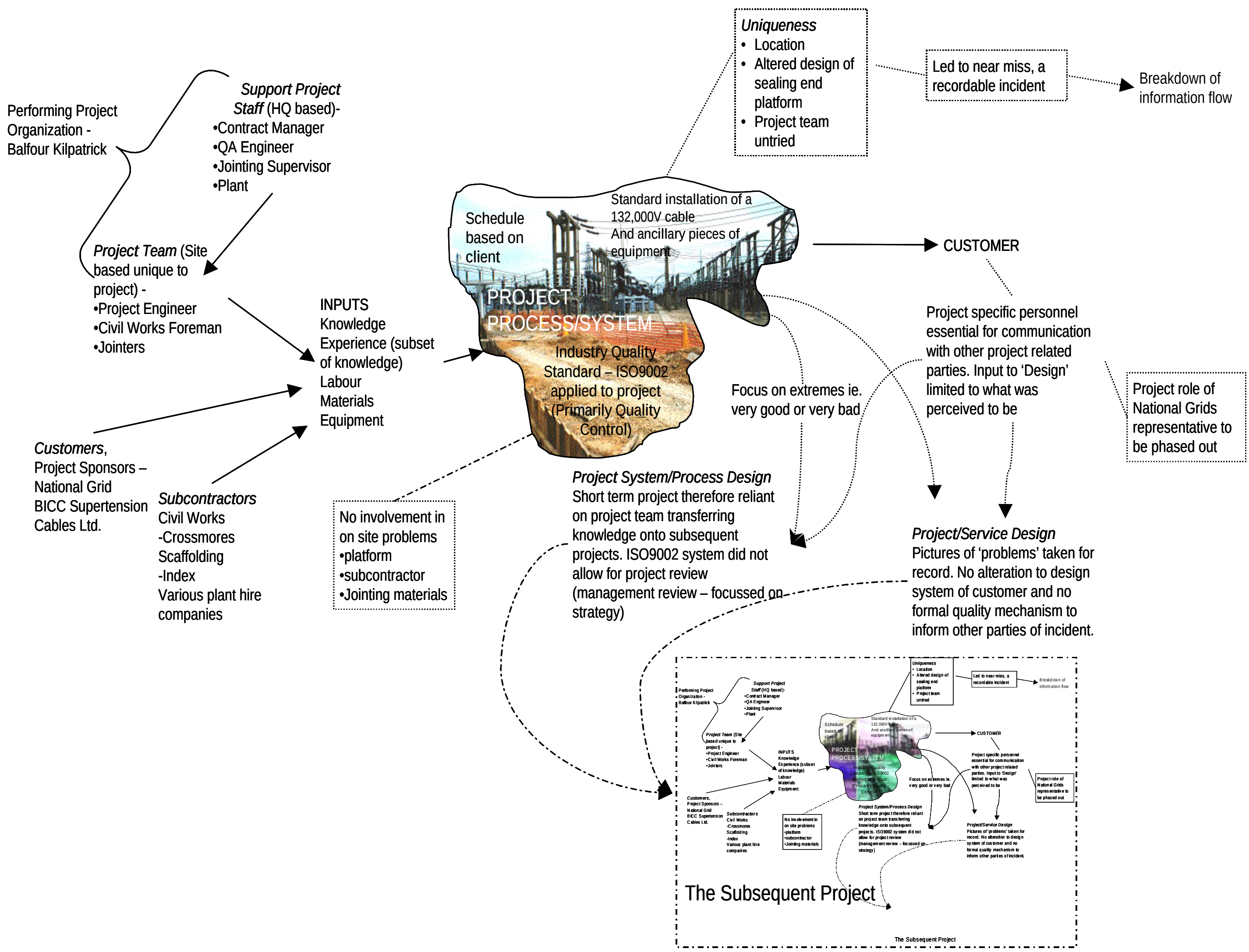

Figure 12.10 The Cable Project

develop a 'more questionings and learning environment'.

12.2.4 Comparing the projects diagramatically

By recreating the flows and components of the types of projects found at two of the organizations used in this research, a tentative decision can be made on the validity of the gap concept, thus leading to a proposal on the form that future project quality systems should take. In Figure 12.10 the existence of a quality system did not contribute to increasing the organizational learning of Balfour Kilpatrick. Any significant activities that occurred during

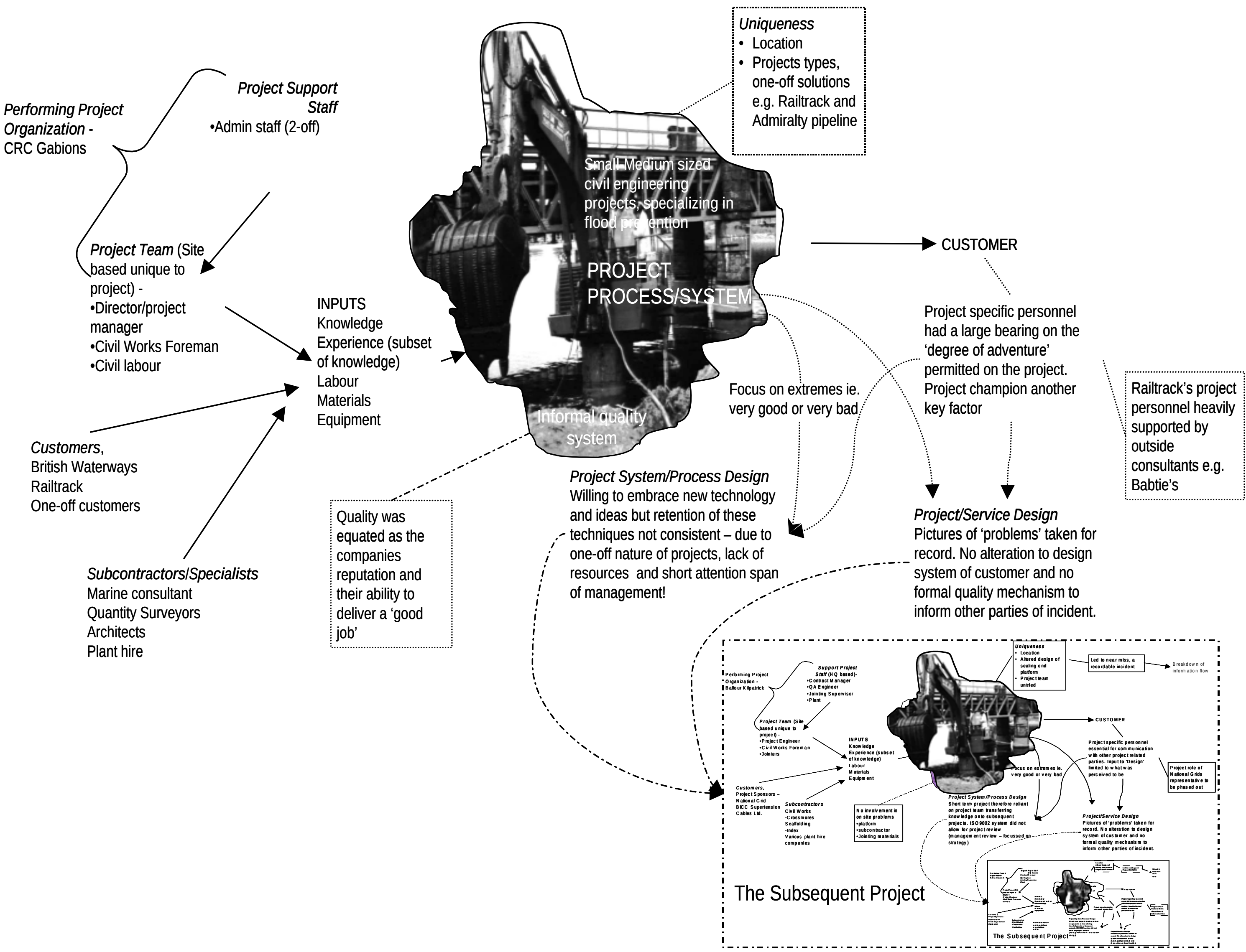

Figure 12.11 CRC Gabions

the project were not officially recorded, and it would only be down to the personal interest of the project staff if any record was taken. The near-miss incident at the platform where someone almost fell through was eventually noted in the customer's safety records but as discussed in Chapter 8, section 8.7.2 no remedial action was taken therefore allowing the possibility of a similar incident happening again. As shown in Figure 12.11, CRC exhibited a 'high degree of adventure' being willing to take on new technology and increasing their bid scope to enhance their success. Unfortunately they did not retain their positive experiences and had no system in place, which would have aided them in this goal. Negative and positive events that take place during a project are the basis for project learning (as discussed in Chapter 11, Section 11.4.1.3) and unless there is a mechanism in place to capture these events then the learning opportunity shall be lost. The following sections will now propose the framework for the 'Learning Project' a mechanism to assist in understanding the project learning process, such that an organization might develop an approach to exploit the knowledge gained from their projects.

12.2.5 The Learning Project

12.2.5.1 Determining the existing information flows in the project organization

Examining existing project organizations and discovering the inputs and outputs of information that already exists requires a holistic view of how the projects are carried out. By mapping the project process using tools and methods like systems thinking and system dynamics the shortfalls and restrictions on information flow could be recognised. Encouraging project personnel to identify their mental models and map their own paths of data flow would also enable a framework to be created for the alternative quality system. The next step in progressing the concept of the learning project model is to create a system dynamics model using the SD software application. The model is attempts to recreate all the possible stocks and flows that contribute to the project organizations learning process. The model has been created in four key stages: the existing learning process of the project organization, the organization corporate learning, the transference of knowledge and the learning process that occurs on the project. The preliminary joint working paper by J. Bowers (University of Stirling) and the author in Appendix No.7 provides more detail on the creation of the model, the criteria used, and the assumptions that have been made.

12.2.5.2 The Project Learning Process

As previously discussed (Chapter 1, section 1.4 and Chapter 3, section 3.3.7), although every attempt may be made to increase the effective knowledge of the organization and the project, knowledge can also be lost typically by key staff leaving or, in the case of long projects the knowledge may become outdated. This basic framework is illustrated in Figure 12.12 and the sections below explore the process in more detail. The graphical capabilities of the

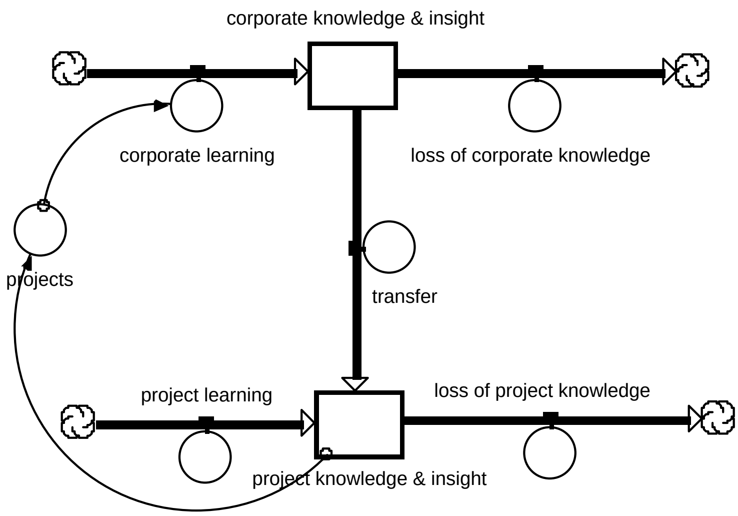

Figure 12.12 The basic project learning process

system dynamics application Stella was used to develop an understanding of the relationship between the different entities in the learning process. The different components used in creating the model could be detailed in addition to allowing a 'whole system' view to be taken of the complete process,

12.2.5.3 Data Capture

A limitation of the commonly adopted definition of a Project Management Information System (as discussed in Chapter 11, Section 11.2.1.2) is that it considers just the needs of the immediate project and not the whole organization. Typically the only data routinely transmitted across the project boundary are the high-level progress reports for the organization's senior management. This attitude is perhaps justified when project teams are under pressure to deliver a product within a restricted timescale and budget but this can be to the long-term detriment of the whole organization. The experience of each project is potentially valuable and feedback is essential if the organization and future projects are to benefit. As when considering the information flows within the project, this experience can take many forms. Some of the feedback may be quantitative, e.g. comparisons between the estimated and actual costs, but other feedback may be qualitative, such as descriptions of solutions to engineering problems. Learning from past project experiences does occur at present but all too often in an unsystematic manner; it is claimed that more effective learning could deliver 'a drastic increase in the effectiveness and efficiency of project management'[18].

In Chapter 7, the Balfour Kilpatrick case study data capture was a personal process, where individual project team members were involved in a project, gained experiences, both positive and negative, then moved onto the next project. The organization's 'picture' of a project is limited to a financial outcome, a set of drawings of the installation and the memories of the personnel that carried out the project. Recording the incidents that occurred, were outwith the remit of the existing quality system. Abdul-Rahman[19] highlights the lack of records kept on failure in construction projects, which leads to similar failures re-occurring, even on the same project. Yet, providing a medium that could rapidly convey the important 'learning issues' seems to be a real obstacle. In the authors experience the use of photographs was common practice by many of the project staff at Balfour Kilpatrick, yet there is no accessible library of project images, except for the few occasions a 'prestige contract' would be filmed. Even now, a collation of the existing photographic and video material that the organization possesses could provide a very useful tool. Data capture also involves harnessing the views and opinions of those carrying out the project. Interviews, forums, away-days all can contribute to the understanding of what makes a project a success, but consequently there must be resources available to capturing that knowledge, a type of project historian/archivist.

12.2.5.4 Assimilating Data

In a project organization the body of corporate knowledge may include various forms of information and reside in different types of memory: some of the knowledge will be quantitative data stored in computer based databases accessible across the organization, other knowledge will be anecdotes exchanged informally by word of mouth. Figure 12.13 illustrates the generic sources of corporate knowledge and the mechanisms for absorbing, and

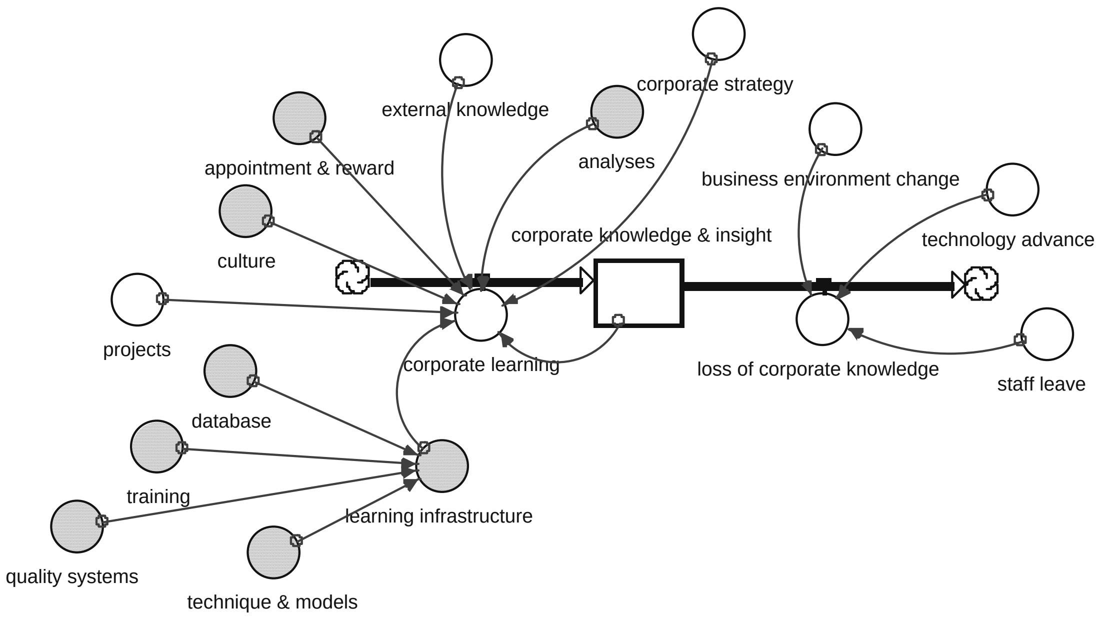

Figure 12.13 Corporate learning

losing, that knowledge. The shaded circles indicate an influence on the process while the unshaded circles are associated with the data themselves.

12.2.5.5 Disseminating Data

The only justification for corporate learning is if that knowledge is transferred to the decision makers. This transfer may be affected in many ways: e.g. accessing computerised databases, attending seminars or informal discussions. Whatever the means of transfer, some effective infrastructure is needed to encourage this communication. However, a major route to delivering the necessary knowledge to the new project is by selecting the appropriate team. There are many factors determining the team selection: the availability and compatibility of staff are important but the learning process can be enhanced by choosing a team members from different project backgrounds, each contributing different sets of project knowledge. Figure 12.14 illustrates the dissemination process.

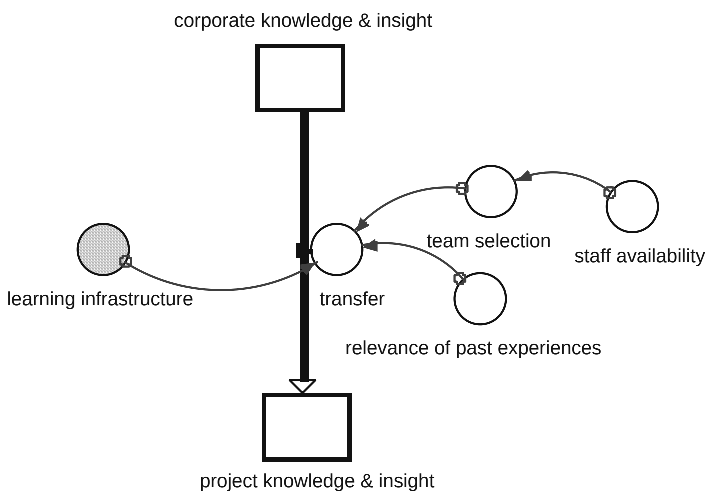

Figure 12.14 Transferring knowledge

The simple mechanism of the 'engineering letters' at Balfour Kilpatrick described in Chapter 8, section 8.9.7 as a way of imparting important information was very successful. By sending out 'letters' detailing recent events and problems a 'database' of knowledge was created that formed a reference of practice that the project members could use. The advent of computing in the workplace also lends itself to this type of distribution. Information systems that provide email and intranets are ways in which information dissemination can be achieved. These have an overhead in getting to a stage where they are useable but as a high-end method of information distribution, the possibilities are undoubtedly there. For the author returning to manage a project, the most noticeable change in communication was the advent of mobile phones. Having the ability to contact virtually anyone in the organization whilst taking part in the project activities was a revolution. Decisions were taken on route, advice sought, information passed on, without the physical limitations of a land-based line.

12.2.5.6 Learning during the project

Occasionally organizations embark upon projects that are well beyond their experience. It

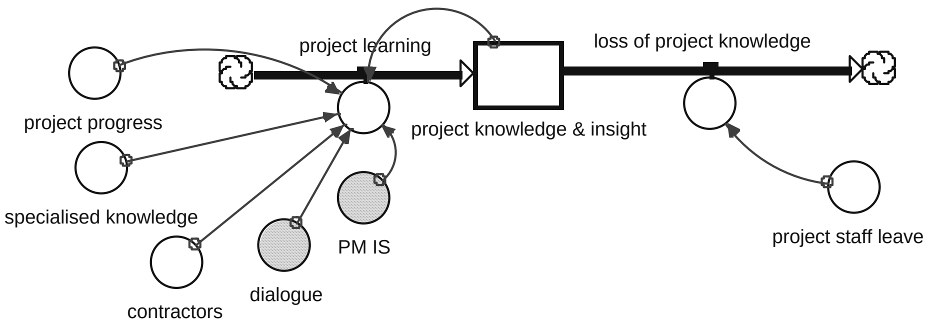

Figure 12.15 Learning during the project

may be thought essential for the long-term health of the organization that a new product is explored even though it involves implementing unproven technologies. The relevant corporate knowledge may be limited to no more than the generic skills such as basic project planning and control. While such a project will inevitably be a high risk, it should still be possible to learn from sources other than the corporate body of knowledge, as summarised in Figure 12.15. CRC were a typical example of an organization that looked outside the boundaries of their own industry to find innovative ways to deal with the problems that they encountered as illustrated with the portable dam (Chapter 7, Plate 7.11).

12.2.5.7 Feedback between projects

The knowledge gained in individual projects feeds back into the body of company knowledge. The number, size and diversity of the past projects all influence the potential company knowledge. Rather than waiting for a project to be completed before its lessons are promulgated, key experiences should be publicised as early as possible. However, in many instances, events and their consequences may only be fully appreciated at the end of the project. The feedback might take many forms. Quantitative data may describe the variations between the estimated and actual activity durations and costs. Problems and their solutions may be documented on paper, or other media such as video may be more appropriate. Contractors capabilities may be noted and the performances of resources (staff and hardware) recorded. In addition to reporting specific experiences, the project should also relate insights, which were developed during the project such as why events occurred, or why the management actions worked.

12.2.6 The 'whole system' view

Assembling the components of assimilating and disseminating corporate learning together

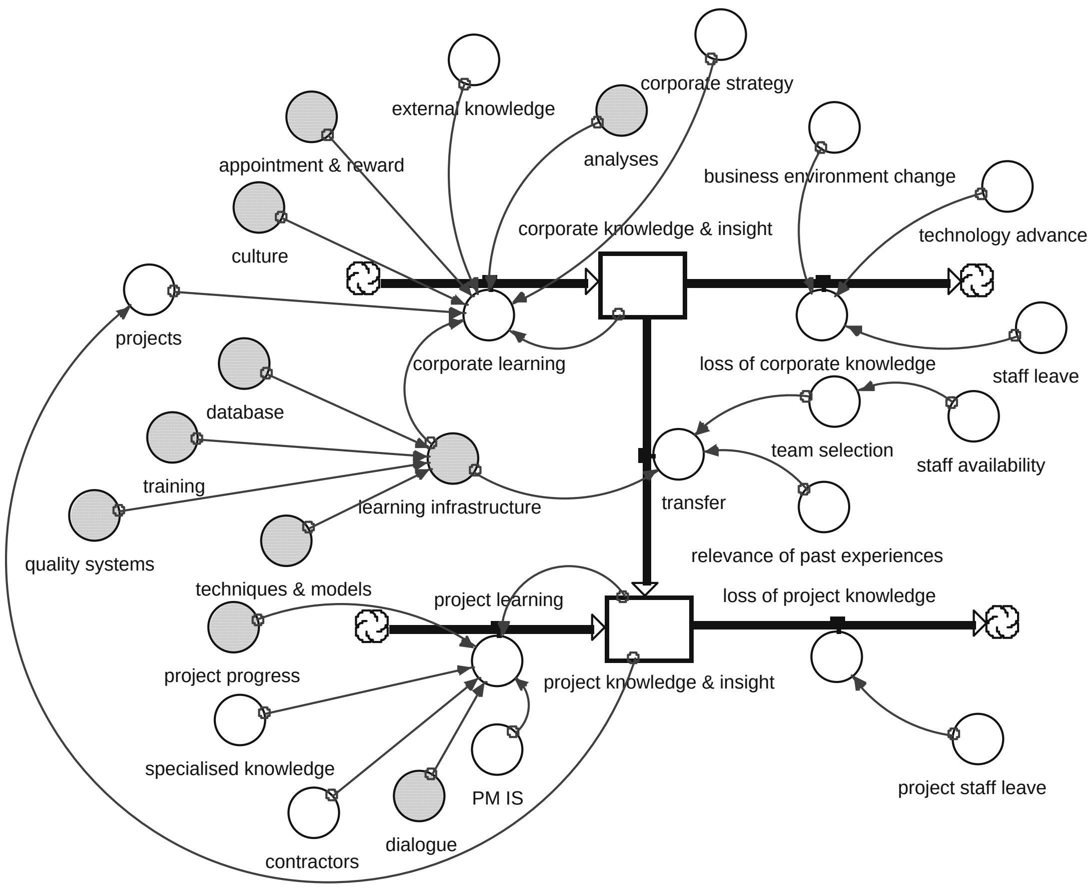

Figure 12.16 The project organizations learning process

with the possibilities for learning on the project, a complete framework for the project learning processes is produced in Figure 12.16. The framework reflects experiences in a range of projects but all of the forms of data and the influences on the learning process can be found in most projects. The framework is intended for use in analysing the learning processes in project-based organizations.

12.3 The practical application of the model

The next stage is to propose feasible and practical ways of implementing such a model in organizations such as those used in the case studies. To recap the important attributes of the alternative quality system were:

1) To capture data from project activities. There would be two streams to this. The first recording a 'routine' project to provide a baseline of what is the typical lifecycle of the projects that the organization carries out. Once recorded this would used for

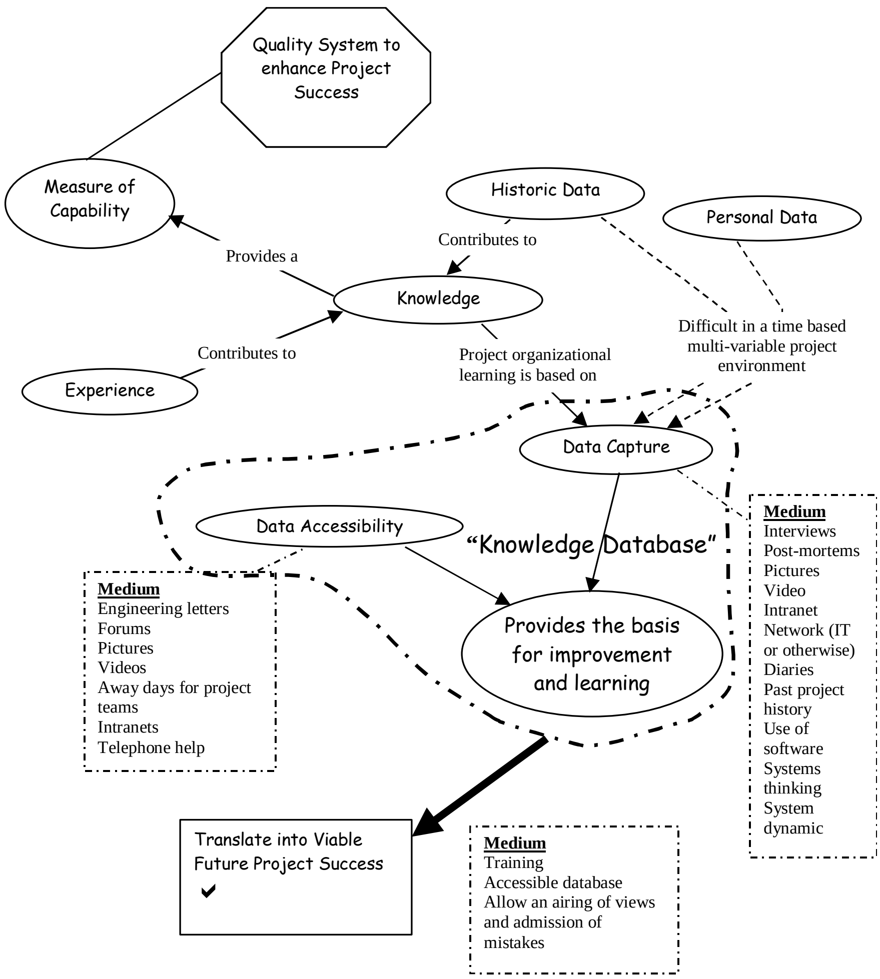

Figure 12.17 Attributes needed to form a practical 'knowledge-based' quality system

training and induction for new project members/employees. The second stream would be the recording of atypical incidents either good or bad to provide data for the organizational knowledge database.

2) The knowledge database would collate and process the data into information, then disseminate it to other project teams. The grading of information would allow potential serious problems (especially health and safety issues) to be given priority. Historic project information would also be available to the organization's personnel to facilitate better decision-making in both existing projects and in future projects.

What is being proposed is an Information System (IS), which is aimed at providing a source of information/knowledge to increase the success of a project. The promotion of quality would be the promotion of interchanging project knowledge. On a pragmatic level, the areas that have to be combined to produce a useful quality methodology/system are proposed in Figure 12.17. This basic diagram illustrates at a high level the inputs and outputs that are required from a 'knowledge based' quality system. The next step is applying this to organizations at a practical level. In particular the capture of knowledge, the medium it takes and the feeding forward of this knowledge to future projects (which overlaps with access to the data).

To implement a system that gathers and distribute information throughout an organization requires the construction of a practical information system. Options include utilising any existing systems, creating a completely new system or a hybrid of new and old. The medium on which the alternative quality system could be based depends on what resources the organization has available. The alternative quality system could be entirely paper-based (as per existing quality systems) although as discussed previously as a medium on its own there are occasions when it does not always have the immediacy and impact of pictures or video. CRC demonstrated the usefulness of video images and at Balfour Kilpatrick, photographs were often more appropriate that text.

Other avenues of data collection and dissemination should also be incorporated, especially from less formal venues where many views and ideas are discussed and aired e.g. at coffee breaks or informal functions. Many important and interesting topics are discussed and decided in an informal environment leading to an important cross flow of ideas and knowledge. Getting a record of individual's memories and ideas can stimulate others to try different techniques and ways of problem-solving in addition to adding to the organizations knowledge database. Interviewing older members of the project organization also can provide very useful information. This was demonstrated at Balfour Kilpatrick, when discussions were taking place on whether it was possible to replace the cables at the Pump Storage Power Station at Cruachan (mentioned in Chapter 8). The original project had taken place in the 1950's and 60's. Information on how the cables were installed was very limited. Balfour Kilpatrick's chief engineer convened a meeting with the project staff that had most recently been working on the cables and two members of staff that had worked on the original project, one nearing retirement and the other retired. The other key bit of information was some old cine footage of the original project. This footage combined with a number of meetings allowed a decision to be taken. It also highlighted how much key knowledge can be lost to an organization through the passage of time.

CRC utilized video, mobile phones and computers to assist in their projects. Using this equipment for training and to exploit existing knowledge would not be difficult, in addition to providing the project organization with a portfolio of projects to demonstrate to prospective clients their skills and abilities. The main obstacle at CRC was the autocracy of the two directors, which limited the potential for disseminating information despite their openness to new ideas and techniques. As illustrated in Figure 12.12 it was an inability to exploit the new techniques they used and capitalize on their new knowledge that contributed to the demise of CRC. Of the all the case study organizations, Balfour Kilpatrick is the one that has the resource to create a practical knowledge-based quality system. The gathering of data is at present dependant on the site personnel and it is frequently for their own records not the organizations. Site diary's are kept daily but are more a record for administration purposes rather that a record for knowledge distribution. Mobile phones have been one technological innovation that has had a significant impact on the management of Balfour Kilpatrick's projects. The increased flexibility they allow has contributed to resources being more efficiently distributed and the ability to act quickly in the event of problem. Combining a mobile phone, laptop and digital camera could allow text and images to be captured, distributed through email to other projects or transferred to a central database. The role of

Project: **Server Install**

Practice ....

Date ....

Notes ....

Hardware	
BIOS Settings	
LPT1 COM1 COM2 to manual settings	
Make sure not pnp OS	
Set Admin BIOS password to ***********	
SCSI Symbios settings	
Disks should be 16 bit data bus able to do sync 40MB/s	
Tape should be on 8 bit and not Sync	
Check you have N440BX Ethernet disk	
Mega Raid – You have to do other things – will be filled in later	
Do not connect an UPS to the line during install – no likey	

Check Boot.ini	
As below for mirror	

Character based install	
Create bootable DOS partition of about 2GB.	
Boot n BOS disk 1 – let system detect MASS storage unless Mega RAID installed	
First setup screen change language	
For install – select the bootable 2GB partition and convert to ntfs	
Reboot 1 or 2 then gioes to GUI screen	

Final Checks	
D: drive exists	
SQL Installed	
Event Log No Problems – clear log files	
login as dbh admin	
Test UPS Shutdown	
Test Backup - Backup D:\I386	
Check Mirror Sets {HEALTHY}	

GUI based install	
Name – Organisation	
N440BX – Network – have disk	
Confirm Selections No to Firewall - No to DNS	
Set Graphics to 800 x 600 75Hz reboot	
Reboot and login.	
Run Disk Admin. Move CD letter to R: and create a D: drive using NTFS with balance of free space on primary disk. Don't mirror yet – do that last.	
Restart BOS setup or install BO CD1	
Agree T&Cs	
CD Key	
Service Pack 3 install - restart	
Login Setup proceeds and applies HOT FIX reboots	
Login setup proceeds – select Intanet Pub Server	
No to firewall / no to AS400	
CDs 2 and 3….	
FOR INSTALL SQL SERVER OPTIONS SET EVERYTHING TO POINT TO D: DRIVE AND LEAVE NOTE FOR GPASS ON THE DESKTOP. "GPASS READ ME".	
MS Personalisation install screen – cancel yes to quit	
Let install proceed to reboot	

Service Pack 4 install	
Install SP4 from Tech Net CD Dec 1998 (current)	
Message to update for Y2000	
Install Y2K files from SP4 disk	

Copy NT Files	
Copy i386 from BO CD1 to D:\i386	

Users Admin	
Create dbh administrator P – +++++++++	
Clear all log events	
Create 10 users (user1 - password password – change at next logon	
Install UPS software Version 5 at least	
Restart	

Disk Administration	
If using NT Fault Tolerance – Establish Mirror.	

Tape Driver	
Control Panel – Tape Devices – Automatic	

Emergency Floppy	
Run C:\WINNT\SYSTEM32\Rdisk	
Update Repair Info	
Create Emergency Repair Disk	

Figure 12.18 Example of a db Houston procedure

quality personnel would be that of data gatherers and 'project librarians' rather than auditors of systems. Creating forums for project staff to meet and discuss although intangible in terms of quantifying its effectiveness is another method of knowledge transfer, which can be effective. db Houston like CRC did not devote extra resource to a bespoke quality system instead it was seen as an integral facet of their projects. The difficulty of implementing a knowledge based system in a small project is the demands that this places on the existing personnel. Since the case study was written, db Houston has taken on more personnel and there has been some attempt to start creating a system, which captures the knowledge that exists in the company. As discussed in Chapter 6, section 6.3.4 this is primarily based on technical issues, but that alone can contribute to making a project successful. Figure 12.18 illustrates one of db Houston's procedures, in this case for installing a network server. The use of a document like this for learning is finite; once the person using it has learned the sequence, it becomes a checklist. Arguably, this is comparable to existing quality systems that rely heavily on bureaucratic documentation. The difference is in the ultimate use of the document; in existing formal quality systems procedure documents become the quality system, as part of a knowledge database they would be used when required. The emphasis being on knowledge acquisition not on the policing of documentation.

12.4 Conclusions

For a project organization to share and develop insights from its personnel there must be a culture that promotes that type of learning and provide the resource to achieve it. What this research is proposing is that having a quality system that creates continuous improvement is possible by diverting resources used in maintaining existing quality management systems to provide the learning infrastructure that would be a greater long-term benefit. In smaller organizations the use of technology could partially assist in this process but it is recognized that there is an overhead to creating a learning infrastructure, which has to balance with the day to day running of the business. In the context of small companies, the creation of a learning infrastructure may provide the framework that is needed to expand the business or at least allow delegation to take place with more consistent results. An important concept that is being proposed by this research and is incorporated into the model is the level of knowledge accrued, is dependant on the diversity of the projects attempted, coupled with the corresponding level of risk (degree of adventure). Hence the high-risk activities create more knowledge. Therefore a project organization willing to accept more diverse work to extend their knowledge by accepting some increase in short-term risk may in the long term reduce their risk due to their increased capability. Further research needs to be carried out to validate this theory but from the evidence gathered there does appear to be a balance. It is possible that the project organization in Chapter 8, CRC overreached this balance by trying to continually increasing their 'bid scope' as opposed to consolidating their existing project work.

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Chapter 13

Conclusions and Further Research

13.1 Chapter Synopsis

This chapter describes the main achievements and how the research could be carried forward. The thinking and ideas behind this research grew from an initial perception that existing forms of quality management and quality systems may not be particularly suited to a project environment. The research tended to confirm this view; in particular the feedback of information was often inadequate, hampering organizations in learning from previous project mistakes. The thesis contributes to the debate into the validity of existing quality systems in project management and proposes an alternative methodology to promote quality in the project environment.

13.2 Conclusions

13.2.1 Existing quality systems in project management

From the findings of this research, it is apparent that existing quality systems need considerable refinement for project organizations. Existing quality systems do not provide the necessary mechanisms by which project organizations can:

- Capture the experiences, activities and information that take place on the projects that they carry out.
- Analyse, retain or disseminate any information acquired during the project lifecycle.
- Distribute the information/knowledge gained through the histories of past projects to allow any sort of learning process to take place.

It appears in that in certain circumstances existing quality systems have become an objective in themselves; areas of the process have overshadowed their role in creating continuous improvement. It is perhaps a telling indictment of quality standards like ISO9000 that they are not easily implemented in small project organizations, and do not provide a much needed framework to facilitate organizational learning. It became apparent during the research that quality as a key attribute to project success needed to be redefined; the definitions developed in manufacturing environments were not appropriate to PM.

This research has identified the discrepancies in these systems. Systems derived from the ISO series of standards are prone to inflexibility and are still modelled around the principles of manufacturing based industries where there is generically more cyclical routine rather than the uniqueness found in many projects. The drive for quality initiated by government bodies, and adopted by the public and private sector has created an approach to implementing quality that whilst commendable is not readily transferable between different industrial environments. Whilst this is often attributable to the poor interpretation of quality standards to different industries, it is compounded by implementation techniques that reinforce the inadequacy of the concept. The underlying assumption upon which these standards is based originates from organizations being unable to provide a quality service or product, which has prevented them from being competitive in both home and international markets. Whilst undoubtedly this is has been one of a number of variables contributing to the lack of competitiveness of many industries it ignores the nature of the project management environment where self-accountability is an implicit factor. Project organizations cannot survive many failed projects. Therefore as witnessed in the case studies of the two small organizations without industry recognised quality systems, both organizations recognized the importance of quality, it was their key to commercial survival.

13.2.2 Existing quality systems as feedback systems

The role of the ISO9000 standard as a feedback system was closely examined in the case study of the medium sized construction company. The system was bureaucratically administered to prevent its failure in the context of requirements that were defined by the quality standard. Paradoxically these were not based on the knowledge of the project environment in which the quality system was implemented, and ultimately led to the creation of an alternative ‘underground’ system. This was a system used by project personnel, which circumnavigated the existing quality system allowing the work to be achieved. It should be noted that this was not to the detriment of project quality rather it was the outcome of having an inappropriate system in place to begin with.

As discussed in Chapter 11 and 12 and illustrated in Figure 12.9 it was expected that existing quality systems like ISO9000 would be more suited to project organizations whose projects were more routine and had fewer unique characteristics. This did not appear to be borne out in practice, even though the projects carried by the case study organizations could be classes as routine. The difference in timescales between project and manufacturing organizations has also been identified as a contributing factor in the breakdown of existing systems. Altering a process in a manufacturing environment is relatively straightforward in respect to the variables present and the feedback of information is ‘onsite’ i.e. it has not been dissipated by other influences. This contrasts with the project environment where the change between projects (i.e. the project process) can consist of a complete change of personnel, resources and location, dissipating valuable information (knowledge) that could improve the organizations project process.

13.2.3 Alternative quality systems

The apparent inadequacies of existing quality systems suggested that there was a need to radically overhaul existing quality systems and to investigate alternative ways of identifying key quality attributes in projects. In all three of the field-based case studies, there was recognition of a need for a system, which captured the knowledge gained by the project personnel during the project process. This knowledge is frequently lost to the project organization through personnel leaving, information not appearing relevant outwith the boundaries of that particular project, a reluctance to exhibit failed activities and the lack of any mechanism to capture and disseminate such knowledge. In addition, the ability to capture and disseminate knowledge in the case of smaller project organizations could allow (where the culture allows it) easier delegation of responsibility, hence better use of limited resource.

The next stage of the research was the development of the *learning project model.* Using principles and techniques from systems thinking and system dynamics, the outline of a model has been created, giving rise to a prototype systems archetype for a learning project organization.

13.3 Further research

13.3.1 Additional Case Studies

The number of case studies used in this research was limited due to the scope of the research and the importance placed on the depth of data. To consolidate the findings of this research further case studies in the same industries would be necessary. For example construction/civil engineering companies like Balfour Kilpatrick, CRC and information technology companies like db Houston. Applying the ‘alternative project quality model/learning projects model’ to other similar companies would allow comparative studies to be made. Also using project organizations from different industries and of different sizes would enable more robust analysis of the validity of the ‘learning projects’ model.

13.3.2 Future research methodologies

The methodology of ‘participant observation’ and in part ‘action research’ was in the author’s view the most valid form of data gathering. Despite this, it is unlikely the resources and time would be available to carry out similar types of study on a wider scale. The main strength of action research is that it allows the researcher unparalleled access to data, but the researcher must also have a skill that can be utilized by the host organization. This restriction on the concept of action research is difficult to avoid, unless the researcher possesses a skill or attribute that not industry specific, i.e. a support or service role.

13.3.3 Prototyping the ‘learning projects’ model

A key objective of any further research would be to ‘prototype’ the ideas and theories proposed by the ‘learning project’ model. The implementation of the learning project model would require the complete co-operation of the host organization (or an area in the host organization) and would require a thorough examination of the existing mental models of the participants in respect to traditional quality management. The initial sequence and plan for a pilot scheme would be as follows:

- Examine and identify any existing mental models and systems archetypes that are obvious.
- Identify and map existing routes of feedback.
- Use rich pictures, causal loop diagrams and Stella to conceptually represent the feedback routes.
- Examine existing mechanisms used for the actual capturing and dissemination of information.
- Implement an information system using (where possible) existing resources that replicates the learning project model. The system would not be expected to run in parallel with any other ‘quality system’ therefore if one exists there could be a transfer of resource.
- Chart progress over finite period of time in particular whether there is a noticeable increase or decrease in quality related problems. It is conceivable that there would be an increase in quality related incidents if the system is implemented in such a manner

that doesn't apportion blame. Being able to learn from real quality incidents would allow actual continuous improvement.

13.3.4 SERVQUAL

During the research of the Information Systems project organization; the use of the SERVQUAL model was discussed in the context of information systems. It was highlighted that the quality of service that the company provided post-project, was an integral part of the physical system that they had created in the clients organization, and displayed similar traits to models that portray maintenance and support as a series of minor projects. As previously discussed the inclusion of maintenance and support in the project life-cycle allows this case study to examine the relevance of the service quality model SERQUAL developed by Parasuraman, Zeithaml and Berry[1] and whether it is appropriate in the context of a project environment.

Applying the SERVQUAL model to projects would also address another issue highlighted by the research; that clients were frequently unaware of the quality of the service that they were receiving. Like service quality the perception of project quality is often different from the actual project quality received by the customer. Therefore as part of the implementation of the 'learning project' model a part of it could be devoted to examining the gap between perceived project quality and actual project quality, contrasting the views and reality of the customer's and the contractor's standpoints.

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Appendix No. 1

Chronology of Major Events

1987	First computerization project commences with £3 million budget.
	Only voice transmission to ambulances included in original specification
1899	Specification amended to include transmission of data as well as voice
1990	Project abandoned at recommendation of consultants Arthur Anderson. Cost of abandonment put at £7.5 million
	Long running dispute over pay ends
1990-91	New senior management team appointed
Feb. 1991	System Requirements Specification for new Computer Aided Despatch system completed
April 1991	Major management restructuuring completed
	Management slimmed by 20%
	LAS reduced from four to three Divisions
May 1991	Contractors to build system selected
June/July 1991	System Design Specification prepared
Oct. 1991	New System Manager joins LAS
Dec. 1991	Project team recognizes that original January 1992 deadline would not be met
Jan 1992	Partial system goes live
Jan-Sep. 1992	Despatch system imp[lemented piecemeal across LAS Divisions
April 1992	LAS board presented with a formal vote of no confidence in system by LAS staff in NE Division
Oct 1992	Central Ambulance Control reorganized
	26 Oct. – System goes live
	27 Oct. – System closed down
	28 Oct. – Reverts to semi-manual operation

	Chief Executive of LAS resigns
	External Enquiry announced by the Health Secretary
Nov. 1992	System crashes, fallback routines fail to operate
	System closed down
	Revert to entirely manual operation
Feb. 1993	Inquiry Report published
	Chairman of LAS resigns

Case Study No.4 London Ambulance Service

Chronology of Major Events[1]

1987 First computerization project commences with £3 million budget.

Only voice transmission to ambulances included in original specification

1899 Specification amended to include transmission of data as well as voice

1990 Project abandoned at recommendation of consultants Arthur Anderson. Cost of abandonment put at £7.5 million

Long running dispute over pay ends

1990-91 New senior management team appointed

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Jan-Sep. 1992 Despatch system implemented piecemeal across LAS Divisions

April 1992 LAS board presented with a formal vote of no confidence in system by LAS staff in

[1]Flowers, S., (1996), Software failure: management failure, , John Wiley & Sons Chichester pp.48.

	NE Division
Oct 1992	Central Ambulance Control reorganized
	26 Oct. – System goes live
	27 Oct. – System closed down
	28 Oct. – Reverts to semi-manual operation
	Chief Executive of LAS resigns
	External Enquiry announced by the Health Secretary
Nov. 1992	System crashes, fallback routines fail to operate
	System closed down
	Revert to entirely manual operation
Feb. 1993	Inquiry Report published
	Chairman of LAS resigns

BALFOUR KILPATRICK LIMITED
TRANSMISSION & CABLING DIVISION

QUALITY MANUAL

SECTION 2

Quality Policy

Balfour Kilpatrick Transmission and Cabling Division are committed to providing Clients with projects which are completed safely, to programme and to the required standard of quality.

This shall be achieved by:-

- Ensuring all employees understand the importance of quality in their work and employ only those working practices which ensure that all quality objectives are met.
- Nominating certain staff and charging them with the continuous examination of the Quality System.
- Reviewing the effectiveness of the Quality System by means of Management Review to ensure the continuous improvement of the Quality System thereby confirming and enhancing the Company's known reputation for quality.
- Operating a Quality System which fully meets the requirements of

  either BS EN ISO 9001 : 1994

  or BS EN ISO 9002 : 1994

  as appropriate.

....

Mark Andrews
General Manager
Transmission and Cabling Division

JULY 1997

SECTION 2
ISSUE NO. A
PAGE 1 OF 1

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BALFOUR KILPATRICK LIMITED
TRANSMISSION & CABLING DIVISION

QUALITY MANUAL

CONTENTS

JULY 1997

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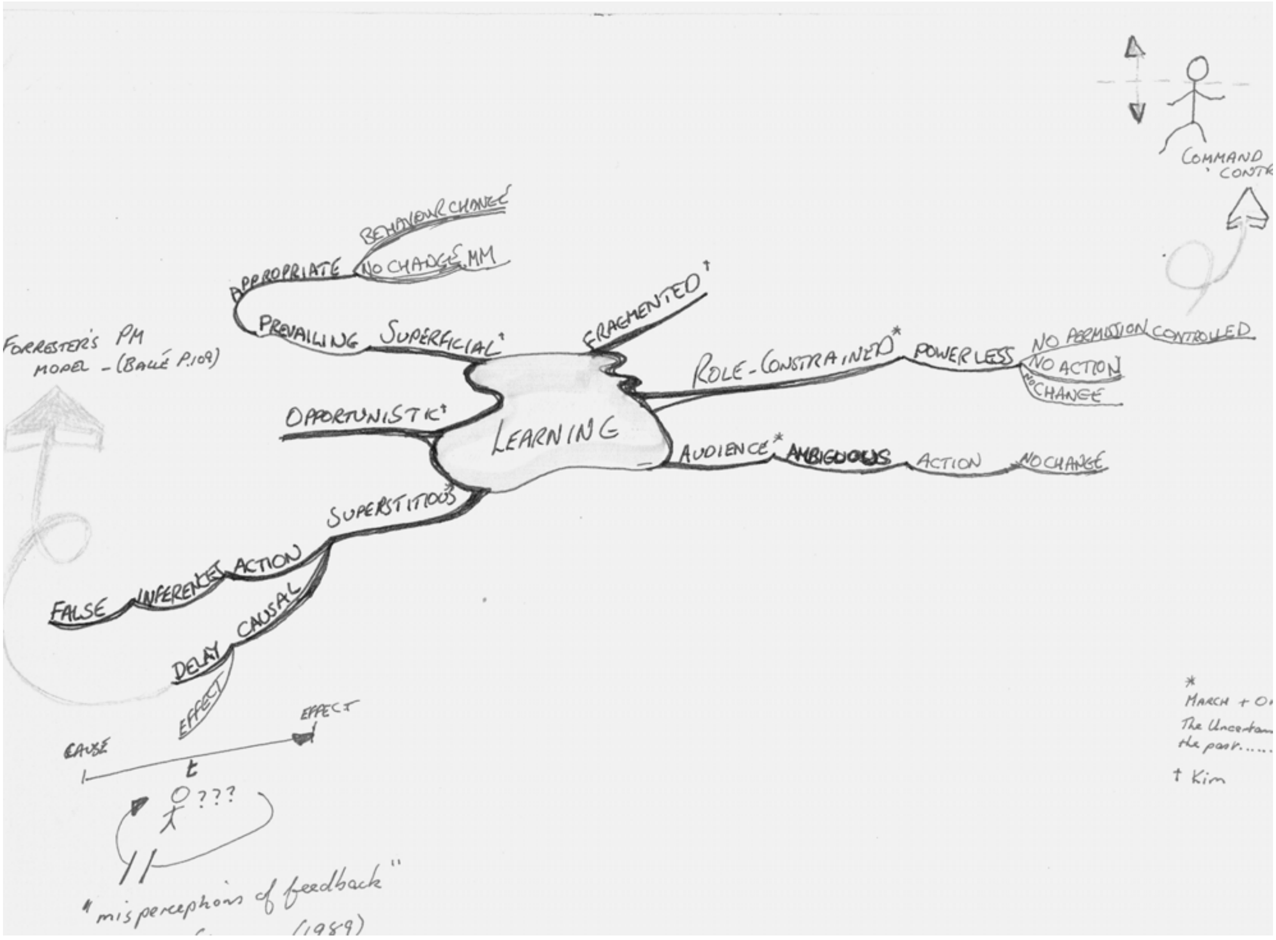
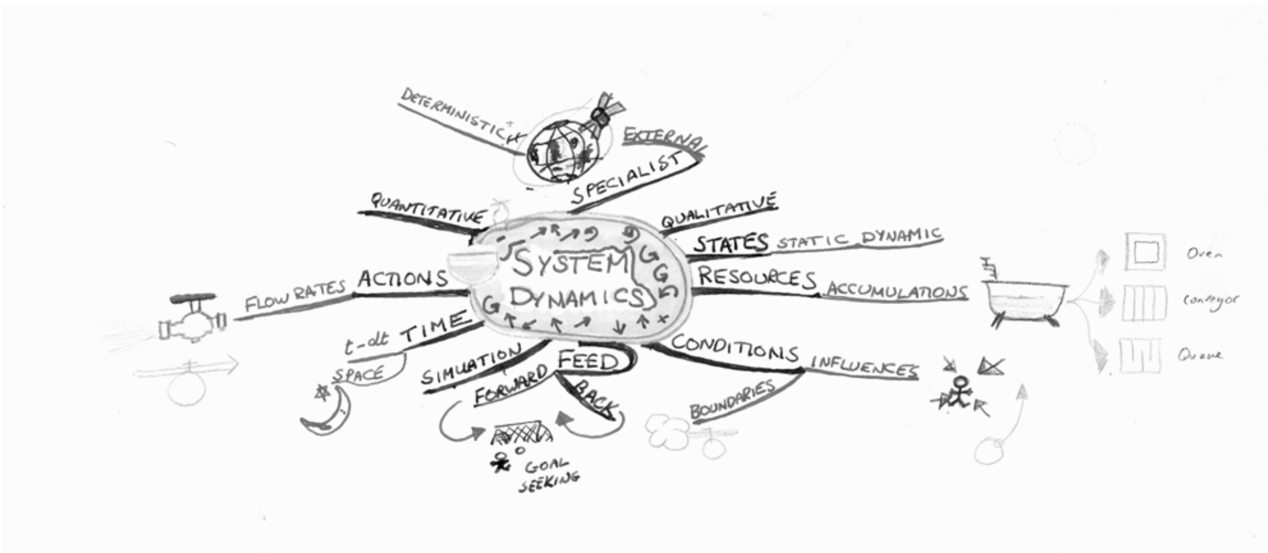
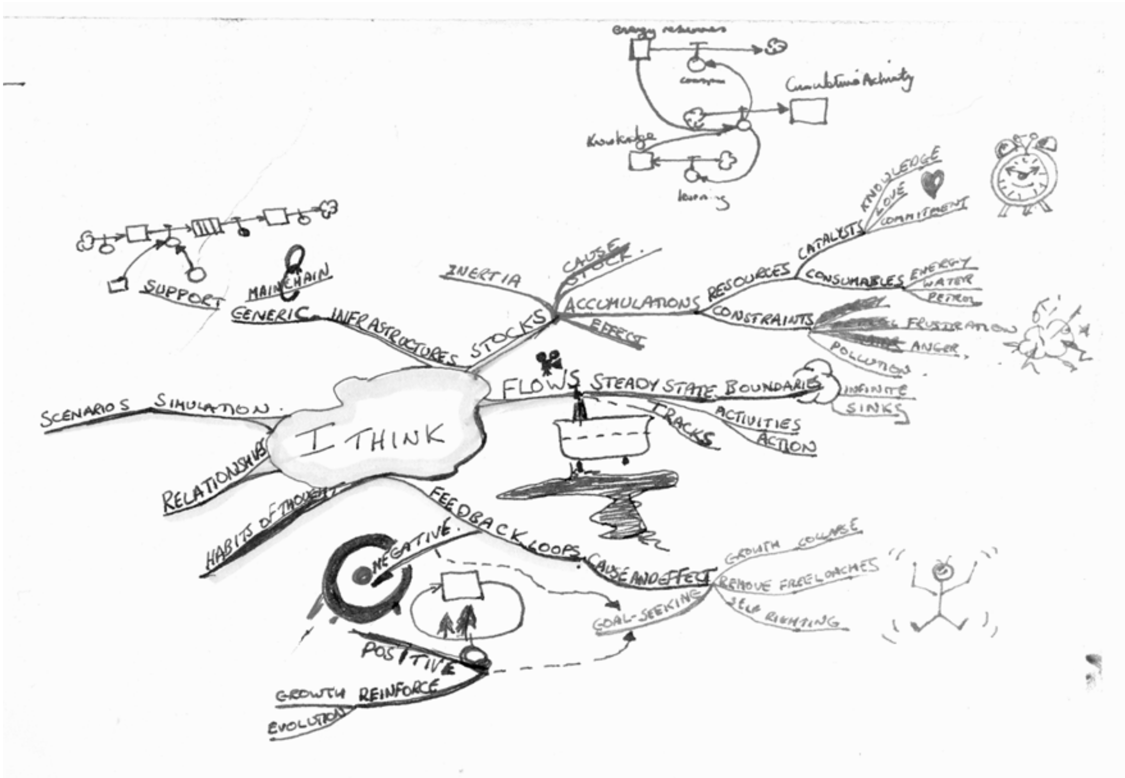
Mind Maps

These mind maps are created using coloured pens and pencils and extend over an A3 area. They were created when the author was examining learning issues, system dynamics and the modelling package ithink.






I THINK
STOCKS
INFRASTRUCTURES
GENERIC
SUPPORT
MAINCHAIN
INERTIA
CAUSE
STOCK
ACCUMULATIONS
EFFECT
RESOURCES
CATALYSTS
KNOWLEDGE
LOVE
COMMITMENT
CONSUMABLES
ENERGY
WATER
PETROL
CONSTRAINTS
FRUSTRATION
ANGER
POLLUTION
FLOWS
STEADY STATE
BOUNDARIES
INFINITE
SINKS
TRACKS
ACTIVITIES
ACTION
SCENARIOS
SIMULATION
RELATIONSHIPS
HABITS OF THOUGHT
FEEDBACK LOOPS
CAUSE AND EFFECT
GROWTH
COLLAPSE
REMOVE FREELOADERS
SELF RIGHTING
GOAL-SEEKING
NEGATIVE
POSITIVE
GROWTH
REINFORCE
EVOLUTION
Cumulative Activity
Knowledge
learning

The Mechanisms of Projects Learning

John Bowers and Peter Flett

Department of Management and Organization

University of Stirling

Introduction

"A project is a unique venture with a beginning and an end, conducted by people to meet established goals within parameters of cost, schedule and quality" (Buchanan and Boddy, 1992)

Uniqueness is a defining characteristic of a project and is the cause of many of the problems in project management. However, uniqueness can be reduced by searching out relevant experience and applying the lessons from past projects: the Learning Project takes full advantage of past successes, and failures. This learning process is claimed to be essential to the future of project management. This paper examines some of the methods organisations employ to assimilate and disseminate knowledge. Although some of this knowledge may take the form of quantitative data recorded in computerised databases, other valuable information may be more subjective advice conveyed by less structured means such as seminars, internal newsletter or impromptu discussion.

Beyond the project management information system

All projects depend on an information system to enable management to monitor progress and exert effective control. Some systems may also provide databases to assist in project planning, such as when estimating costs. Analyses[i,ii] of the Project Management Information System (PMIS) usually consider just the quantitative data needs and the design of computer-based systems; standard texts also employ a similarly narrow definition[iii,iv]. However, the complete information system should be viewed as more than computer software and records of quantitative data. Alternative definitions of an "information system" recognise the importance of other sources of knowledge and the role of the human in transforming data into meaningful information[vvi]. Essential information may take many forms, such as the experience team members bring to the project and the expert advice provided by consultants. Incorporating softer data in the analysis of the PMIS does not imply an attempt to enforce a bureaucracy upon all forms of communications; the object is to recognise the importance of the different types of information and the variety of means of transferring knowledge.

A further limitation of the commonly adopted definition of a PMIS is that it considers just the needs of the immediate project and not the whole organisation. Typically the only data routinely transmitted across the project boundary are the high level progress reports for the organisation's senior management. This attitude is perhaps justified when project teams are under pressure to deliver a product within a restricted timescale and budget but this can be to the long term detriment of the whole organisation. The experience of each project is potentially valuable and feedback is essential if the organisation and future projects are to benefit. As when considering the information flows within the project, this experience can take many forms. Some of the feedback may be quantitative, e.g. comparisons between the estimated and actual costs, but other feedback may be qualitative, such as descriptions of solutions to engineering problems. Learning from past project experiences does occur at present but all too often in an unsystematic manner; it is claimed that more effective learning could deliver "a drastic increase in the effectiveness and efficiency of project management"[vii].

The Learning Project

The Learning Organisation has been advocated as essential to a thriving business in a rapidly changing environment. The aim is to exploit knowledge more fully and specifically to develop and disseminate insights derived from experiences throughout the organisation. The notion of the Learning Organisation has been described and refined by many authors, for example Senge et al[viii], Swieringa J and Wierdsma[ix]. A great emphasis is placed on developing and sharing insights. Many organisations may have an effective information system which ensures that decision makers have the necessary data but a Learning Organisation encourages the development of insights into how, and why, those decisions are made. The insights may be gained by an individual or through sharing experiences with others and are disseminated throughout the organisation. Senge et al[viii] describe mechanisms that have been employed in various organisations to facilitate this learning process. This paper incorporates some of the concepts of the Learning Organisation in the development of a framework for a Learning Project. The framework is an amalgam of practices adopted in a number of organisations in varying degrees. The perspective is that of an organisation which undertakes frequent developments such as the replacing or updating facilities using contractors. Although the learning processes described in this paper relate directly to a client organisation, many similar processes may well be relevant to contracting companies. It is intended that the framework should assist in understanding the project learning process, such that a company might develop its approach to exploiting knowledge. Some of the activities essential to better learning may be regarded as marginal at present but deserve recognition and encouragement: what might appear to be a chat over coffee could really be a vital part of the Learning Project's feedback mechanism.

The project learning process

A project can be a great success, delivering a radical new product on time and within budget; much may be learnt by the team engaged on the project but unless these lessons are promulgated throughout the organisation, the experience must be written down as a missed opportunity. Kim and Senge[x] describe the case IBM's development of the Personal Computer: a dedicated, independent team was created operating outside the company's usual bureaucratic structure. The PC was developed in record time but there was no significant attempt to learn any lessons from this experience. Anecdotes about similar missed opportunities are to be found in many other organisations. The project learning process should encourage the exploitation of the learning opportunities, while avoiding over elaborate prescriptive systems. The elements of this process are:

- assimilating knowledge across the organisation;
- the transfer of relevant knowledge to the new project;
- learning on the new project;
- feedback to the body of corporate knowledge.

Although every attempt may be made to increase the effective knowledge of the organisation and the project, knowledge can also be lost typically by key staff leaving or, in the case of long projects the knowledge may become outdated. The basic framework is illustrated in Figure 1 and the sections below explore the process in more detail. The diagram was created using Stella, an example of systems dynamics software. The graphical capabilities of Stella were used to develop an understanding of the learning framework and the various influences on the process.

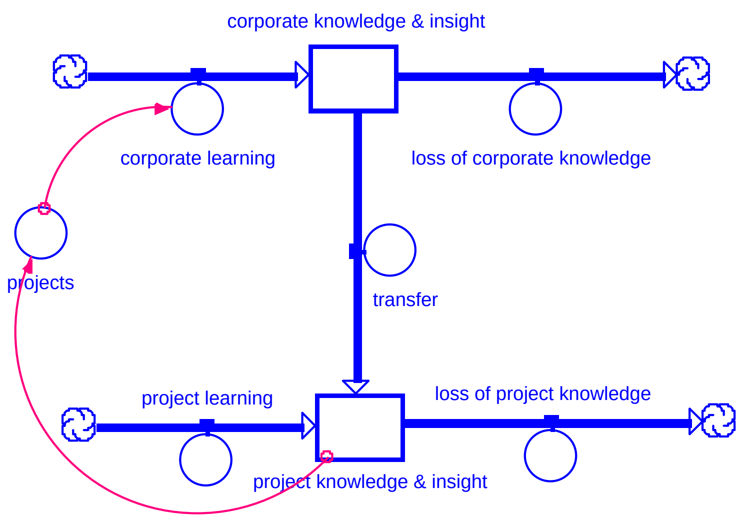


Figure 1 The Basic Learning Process

Assimilating knowledge across the organisation

The body of corporate knowledge may include various forms of information and reside in different types of memory: some of the knowledge will be quantitative data stored in computer based databases accessible across the organisation, other knowledge will be anecdotes exchanged informally by word of mouth. Figure 2 illustrates the generic sources of corporate knowledge and the mechanisms for absorbing, and losing, that knowledge. A description of each element of the process is included as an appendix. The shaded circles indicate an influence on the process while the unshaded circles are associated with the data themselves.

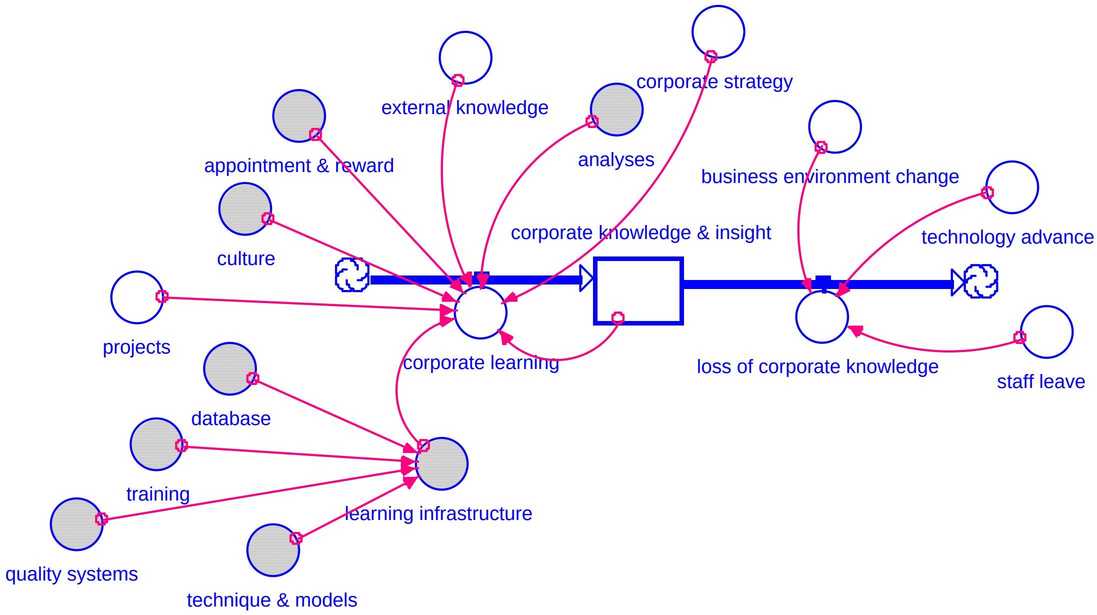


Figure 2 Corporate learning

The dissemination of knowledge to the new project

The only justification for corporate learning is if that knowledge is transferred to the decision makers. This transfer may be effected in many ways: e.g. accessing computerised databases, attending seminars or informal discussions. Whatever the means of transfer, some effective infrastructure is needed to encourage this communication. However, a major route to delivering the necessary knowledge to the new project is by selecting the appropriate team. There are many factors determining the team selection: the availability and compatibility of staff are important but the learning process can be enhanced by choosing a team members from different project backgrounds, each contributing different sets of project knowledge. Figure 3 illustrates the dissemination process.

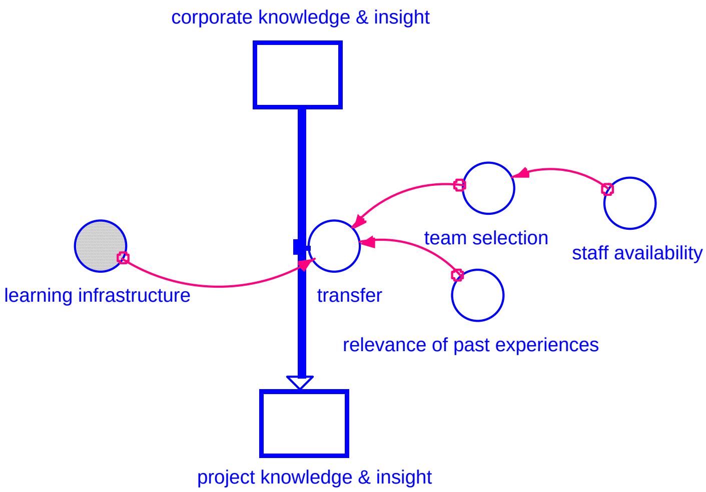


Figure 3 Transferring knowledge

Learning on the project

Occasionally organisations embark upon projects that are well beyond their experience. It may be thought essential for the long term health of the organisation that a new product is explored even though it involves implementing unproven technologies. The relevant corporate knowledge may be limited to no more than the generic skills such as basic project planning and control. While such a project will inevitably be a high risk, it should still be possible to learn from sources other than the corporate body of knowledge, as summarised in Figure 4

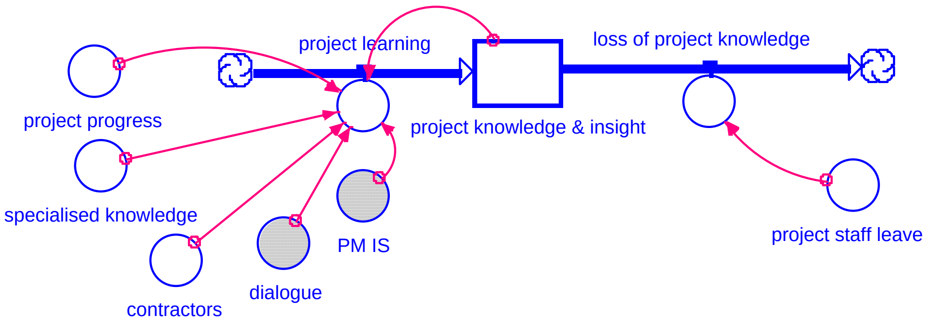


Figure 4 Learning on the project

Feedback

The knowledge gained in individual projects feeds back into the body of company knowledge. The number, size and diversity of the past projects all influence the potential company knowledge. Rather than waiting for a project to be completed before its lessons are promulgated, key experiences should be publicised as early as possible. However, in many instances, events and their consequences may only be fully appreciated at the end of the project.

The feedback might take many forms. Quantitative data may describe the variations between the estimated and actual activity durations and costs. Problems and their solutions may be documented on paper, or other media such as video may be more appropriate. Contractors capabilities may be noted and the performances of resources (staff and hardware) recorded. In addition to reporting specific experiences, the project should also relate insights which were developed during the project such as why events occurred, or why the management actions worked.

The complete picture?

Assembling the components of assimilating and disseminating corporate together with the possibilities for learning on the project, a complete framework for the project learning processes is produced in Figure 5. The framework reflects experiences in a range of projects but all of the forms of data and the influences on the learning process can be found in most projects. The framework is intended for use in analysing the learning processes in project based organisations.

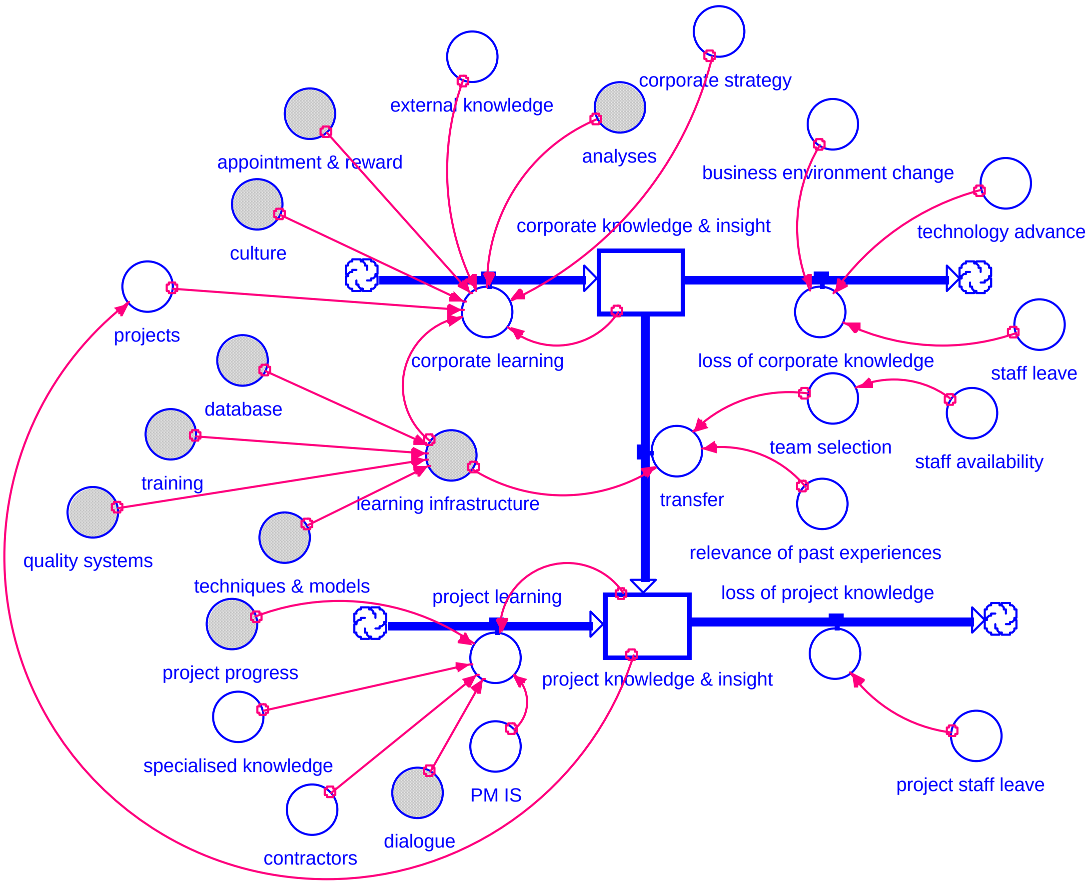


Figure 5 The project organisation's learning processes

Appendix: Notes on the elements of the project learning process

One of the advantages of using Stella to develop the framework of the project learning process is that text can be attached to each element. This text is hidden from view until invoked by the click of a mouse when a description of the element selected is displayed. Thus when discussing the framework with project managers the overall logic can be debated and then the detail revealed only when focusing in on a particular issue. It was found that this approach enabled a wealth of material to be developed without the becoming unwieldy. The notes accompanying each element are documented below. The name of each element is highlighted using italics to help relate the text to the Figures 2-5.

The project learning process

Corporate knowledge & insights may take many forms, e.g:
i) capabilities of contractors
ii) appreciation of user's needs
iii) details of existing (& future) systems with which the new project must be compatible
iv) experience of past project implementations
v) general insights derived from analyses of specific project experiences (+ knowledge from other sources)
The knowledge may be stored in different ways, e.g:
i) personal memories
ii) written reports
iii) quantitative databases

As time passes so there will be a *loss of corporate knowledge*. The knowledge may become outdated, or it might be lost as key personnel leave.

Establishing a pool of company knowledge is only useful if the relevant material can be identified and its effective *transfer* to the new project encouraged.

The relevant company knowledge may be transferred but this will be supplemented by *specific project knowledge & insight*. In the case of a "unique" project there is minimal relevant company knowledge but it can still be possible to gain sufficient knowledge from other sources. However, such projects will tend to be costly and high risk. The knowledge gained in the new project should form a contribution to the pool of company knowledge. Where the project is "unique" it may well provide a sizeable addition to the company knowledge. Even though the new project may not in itself be a success it can be a valuable "learning experience" establishing knowledge in a new area which is vital for the development of the company.

Knowledge may be obtained from sources specific to the new project. The effectiveness of this *project learning* process depends on having a suitable infrastructure within the project to store and disseminate the project knowledge to the rest of the team. Where the project team is small and the timescale is relatively short there may not be any need for a too formal infrastructure, otherwise it may be necessary to adopt the company learning infrastructure for the new project.

Assuming that no dramatic change occurs in the business environment or the technologies which could make some of the project knowledge outdated, the *loss of project knowledge* during the lifetime of the project should be limited.

Assimilating knowledge across the organisation

The *learning infrastructure* should:
i) encourage the process of collecting company-wide knowledge (qualitative & quantitative)
ii) store the knowledge in a "database"
iii) provide ready access to relevant knowledge for the new project team.

The *database* may include various forms of data, e.g.:
i) formal reports (e.g. post mortems of past projects, performance of contrators) and quantitative data (e.g. comparsions of estimated and actual costs and durations of activities)
ii) more informal media, e.g. videos, photos, anecdotes

The data might held in various forms, e.g.
i) categorised comments using keywords and readily accessed via a standard database search
ii) an "expert system"
iii) articles in newsletters

The accessibility of the database is critical, both for the assimilation and dissemination of knowledge. In some cases, a sophisticated computer based database can act as a barrier to learning when a more informal database relying upon individuals' memories and a free exchange of views may be a more appropriate form (even then some record of individuals' expertise can be valuable in facilitating this process)
i) a library of written materials
ii) a library of videos, photos
iii) individuals' memories

Training can encourage both the transfer of specific knowledge and also develop the learning process. E.g. staff may be made aware of the available knowledge resources and the means of accessing them (ranging from "who to speak to" to training in use of computer based databases). More fundamentally, staff may be encouraged to exploit collective knowledge rather than relying on their own experience. (Swieringa and Wierdsma, p.89-90).

Techniques and models such as cost estimation and risk analysis demand that the new project is compared with the past. When undertaken rigorously this requires access to a database of relevant past experience, though tempered by expert judgement about the particular circumstances of the present project. Other models may also be employed, such as those of systems thinking and dynamics, in order to make mental models more explicit, assisting in the process of developing insights and communicating knowledge.

The organisational *culture* will affect the quantity & quality of the information provided:
i) people have to appreciate the value of their input to future projects
ii) project staff must be given the time and encouragement to provide feedback on their experiences (all too often the only concern is the success of the present project)
iii) a "blame culture" will tend to discourage staff from providing honest feedback

Staff may be appointed from outside the organisation, bringing new knowledge. The *internal appointment & reward system* can ensure that successful staff (those with more relevant knowledge/ insights) achieve

influential positions, spreading their knowledge/ insights more effectively. The reward system can also encourage the dissemination of good practice: it may encourage individuals to seek out good practice and others may identify role models, striving after the rewards by adopting the knowledge/ insights of the officially recognised successful staff. (ref 1,p.50)
External knowledge may be acquired from various sources, e.g:
i) consultants
ii) training
iii) studies of other organisations & their projects
iv) studies of the external environment (e.g. new technologies and markets)
v) partnering with other organisations (e.g. joint ventures)
vi) project management body-of-knowledge

Analyses of individual projects (successes and failures) can provide valuable data, if the studies are sufficiently detailed & objective. Analyses of the body of company knowledge may provide more general insights into project management ("double loop learning"). The analyses may include both commissioned studies and also discussions, both formal (e.g. committees, structured internal seminars) and informal (e.g. chance meetings). Various techniques and models may be employed to support this process.

Corporate strategy should influence the whole organisation. Examples of the strategic knwolwegde include:
i) financial objectives (e.g. desired IRR)
ii) policy on risk
iii) contract procedures

Business environment change could arise from various sources, e.g.:
i) the market
ii) competition
iii) government (e.g. health & safety)

The dissemination of knowledge to the new project

Team selection is critical to a project's success. The ideal team will pull together experiences from a number of projects (and also staff with company-wide insights) relevant to the new project. However, this has to be balanced against the need to ensure a compatible team (ref1,p75)

An organisation with a large pool of transferable staff with a range of experiences offers great potential for the ideal team to be selected. However, in most companies the choice of possible is likely to be severely limited with *staff availability* being limited and a number of projects competing for scarce resources.

If the *relevance of past experiences* is minimal to the new project, the company knowledge will not be a great help. The project may have to learn from other sources. However, even in such cases, experience about this project learning process itself should be a useful contribution. There may well be general insights about managing such a unique project which are valuable.

Learning on the project

If the project has any significant degree of uniqueness, *project progress* will be accompanied by the realisation of problems. These might arise from various sources, e.g: an incomplete specification or an incompatibility with existing systems. While these problems are not welcome, they are inevitable where the project has any unique elements. Once overcome, these problems may be viewed as learning experiences.

Specialised knowledge of value to the new project may be acquired from external sources, e.g:
i) consultants
ii) studies of similar projects undertaken by other orgnisations
iii) partnering with other organisations (e.g. joint ventures)
iv) project management body-of-knowledge

If there is little that is novel in the new project, all the knowledge may be provided by the company. However, if the new project is "unique" (as far as the company is concerned) it is desirable to select *contractors* with the relevant experience, if possible. Some contractors may be unwilling to divulge much information, or use it to their advantage, e.g. in agreeing terms for change orders. If the working relationship is good, there may be an exchange of knowledge to the benefit of both the project (and company) and the contractors.

Effective *dialogue* is essential if the the project team is to be more than a collection of individuals. the PMIS should encourage the transmission of the basic control data but the project team should be able to develop their understanding of the project further. For example a critical delay may not be the fault of the contractors but the result of an ambiguous requirement which needs to be resolved quickly before the problem amplifies into a major item of rework. (Senge et al (1994) p 351-381)

Typically the project management information system (*PMIS*) focuses on the provision of the data needed for the monitoring and control of the project. Such data can also contribute to developing insights during the project's life, e.g. by providing a comparison between the project plan and actual progress which might help develop an understanding of why the project has been delayed.

If the project knowledge is not adequately recorded in some database or shared amongst a number of people, there is the risk that *project staff leave* and take vital knowledge with them.

Feedback

The knowledge gained in individual *projects* feeds back into the body of company knowledge. The number, size and diversity of the past projects all influence the potential company knowledge. Rather than waiting for a project to be completed before its lessons are promulgated, key experiences should be publicised as early as possible. However, in many instances, events and their consequences may only be fully appreciated at the end of the project. The feedback might take many forms. Quantitative data may describe the variations between the estimated and actual activity durations and costs. Problems and their solutions may be documented on paper, or other media such as video may be more appropriate. Contractors capabilities may be noted and the performances of resources (staff and hardware) recorded. In addition to reporting specific experiences, the project should also relate insights which were developed during the project such as why events occurred, or why the management actions worked.

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