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THE APPLICATION OF TQM IN THE CONSTRUCTION INDUSTRY

by

Nicola Emma Thompson, BA (Hons)

A Master's Thesis Submitted in partial fulfilment of the requirements for the award of Master of Philosophy of the Loughborough University November 1999

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ABSTRACT

The UK Construction Industry has traditionally, earned a reputation as a costly, inefficient and confrontational business. In the late 1970's the British Research Establishment highlighted the need for change within the industry. They were followed by amongst others, NEDO in 1988 and then in 1989 by the University of Reading, who recognised the need for change and identified four key areas in which the industry needed to improve, namely: structure; image; education/training and R & D. The message was that to survive and prosper, the industry must change its management and practice.

This research has concentrated on the way that concepts of Total Quality have been introduced within three different companies and industries. The Miller Group primarily known as a Civil Engineering/Construction company; British Telecom selling a service of telecommunications to businesses and the general public; and GKN Sinter Metals providing a service of power metallurgy in the manufacturing sector. This study has determined where there are common objectives and benefits; with the view to recommending the best practice for industries especially to the construction sector where Quality Management and more particularly Total Quality Management does not form a coherent part of their long-term strategy.

The research also assessed and investigated the framework used by each of the companies in their understanding and implementation of Total Quality Management (TQM); the employee attitude and commitment by Senior Management; and the culture change that precipitated the introduction of TQM. The aim of this research was to highlight strengths, weaknesses and similarities between the companies and hence their industries, which is used as the basis for providing a check list of solutions and actions which organisations can consider implementing and building upon in the future.

Lessons that were learnt from undertaking the research was that the construction sector still has limited input from their clients; there is no defined sector scheme and there is little or no understanding of the principles of Quality Management and Total Quality Management.
ACKNOWLEDGEMENTS

I would like to express my thanks and gratitude in the latter stages of the collation and input to this thesis to Professor A Thorpe for his encouragement, support and advise and for the onerous task of reading and the offering of constructive criticism and comment.

My appreciation also goes to Mrs Val Saunders for the typing of numerous drafts and the final article. Also to Miller Civil Engineering for their support in the preparation of this thesis.

The research involved various discussions and interviews with practising executives in industry. The assistance of Mr T Bevin and Mr R Norman of British Telecom plc and Mr D J Forman formerly of British Telecom plc and Mr Mike Kanna formerly of GKN Sinter Metals Limited in addition to numerous other managers and staff of each of the three companies is acknowledged for their time and patience in the provision and collation of information which was of enormous benefit in the validation of my thesis.

Above all, I would like to thank my husband Wayne, for his understanding and sharing my concerns in the preparation and writing up of this thesis.
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Chapter One

Introduction

1.1 Background

1.2 What is Total Quality Management (TQM)

1.3 Project Aims and Objectives

1.4 Research Methodology

1.5 Overview of the Conclusion

1.6 Guide to the Thesis
Chapter 1

Introduction

1.1 BACKGROUND
Companies today are aiming to improve output and reduce costs by reducing work-in-progress, inventory levels, lead-times, stock and increase output with the use of new and sophisticated manufacturing and production techniques [Quality Today 1990].

However, despite all the developments in improving productivity such as Group Technology, Kanban, Gemba Kanri (refer to Chapter 5 Section 5.7.3) this has not, in the past, been matched by similar developments in the technology to monitor and automatically control the production processes. Therefore, the quality of the components and products has not been consistent and, as a consequence, high costs have been incurred due to the scrapping or the reworking of the components. However this can also produce inferior or scrap products at the same rate.

Total Quality Management (TQM) came to the fore within UK Industry in the late 1970's and early 1980's. It was thought to be the panacea to cure the ills of UK industries and put them on a level playing field with other nations, especially the Japanese whose products were successfully flooding the UK home market.

This has led to a number of "Guru's" who have advocated the introduction and furtherance of TQM as the means to compete with the successes of the Japanese industrial might [Oakland 1990].

The theoretical conception of the "Guru's" could not be faulted, no one, when listening to, or watching their visual presentations could fail to be swayed.

However, many were simplistic in their presentations and no real account was taken of how the person on the shop floor would apply the principles of TQM which might be easy, in a small two or three man company, but very difficult in a large company employing thousands of people. The principles initiated by the introduction of BS 5750 in 1979 which set out how to establish, document and maintain an effective quality system. Its aim to demonstrate to your customers that you are committed to quality and are able to supply their quality needs [DTI 1993], provided the necessary basic discipline whether you were a company that employed 10 people or 10,000.
1.2 WHAT IS TOTAL QUALITY MANAGEMENT?
TQM is a way of managing to improve the effectiveness, flexibility and competitiveness of a business as a whole. It applies as much to service industries as it does to manufacturing industries. It involves whole companies being organised, in every department, every activity and every single person at all levels. For an organisation to be truly effective, all elements must interact together, because every person and every activity affects and, in turn, is affected by others [Oakland 1990].

TQM is far more complex than other change strategies and requires a great deal of commitment, planning and leadership. Commitment is the foundation of any effective TQM initiative [Oakland 1991]. Without it, even the most carefully designed programme will fail [Oakland 1991]. The key issue in promoting commitment is, leadership. As Atkinson [1989] stated, leadership and commitment go hand in hand. If there is doubt about these issues, TQM is unlikely to be focussed. Those organisations that are successful and have achieved excellence, are those that have promoted TQM, and have developed core values by which they manage. These values are transmitted to all and, more importantly, are understood by all.

TQM is a fundamental shift from what has gone before. The systematic analysis, preplanning and blue-printing of operations remains essential but the focus switches from a process driven by external control through procedure compliance and enhancement to a process of habitual improvement, where control is embedded within and driven by the culture of the organisation. TQM demands a clear focus on the customer and total commitment throughout the organisation. It means defining quality in customer terms; it means making each employee responsible for quality; it means management commitment to supporting that responsibility; and it means a continuous quest for quality improvement. There should never be a point at which people say, "Well, we have achieved quality - now we can get on with something else" [Oakland 1990]. To achieve TQM requires nothing less than a culture change for most organisations with the total backing of the senior management team.

TQM is a method of removing waste, by involving everyone in improving the way things are done. The techniques of TQM can be applied throughout a company so that people from different departments, with different priorities and abilities; communicate with and help each other. TQM helps companies to [Oakland 1990]:
• focus clearly on the needs of their markets;
• achieve a top quality performance in all areas, not just in product or service quality;
• operate the simple procedures necessary for the achievement of a quality performance;
• critically and continually examine all processes to remove non-productive activities and waste;
• see the improvement required and develop measures of performance;
• understand fully, and in detail, its competition and develop an effective competitive strategy;
• develop the team approach to problem solving;
• develop good procedures for communication and acknowledgement of good work; and
• review continually the processes to develop the strategy of never-ending improvement.

Figures 1.1, 1.2 and 1.3, shows graphically the TQM model and the steps to TQM as advocated by the Guru's and more recently developed as part of BS EN ISO 9000 series of standards (refer to Chapter 4) implemented by many organisations world wide.

**Figure 1.1:** The TQM Model

Figure 1.2: Continuous Improvement
In addition to the management commitment required to achieve TQM, there are three other major components of TQM:

- a documented quality management system;
- statistical tools; and
- teamwork.

These will now be discussed in greater detail.

1.2.1 A documented quality management system

The cornerstone of company-wide quality management is the concept of customer and supplier working together, to their mutual advantage. For any organisation, this becomes "total" quality management if the supplier/customer interfaces extend beyond the immediate customers, back inside the organisation and beyond the immediate suppliers. In order to achieve this, a company must organise itself in such a way that the human administrative and technical factors, affecting quality, will be under control and produce consistency. Consistency can only be achieved if for every product or each time a service is performed, the same materials, the same equipment and the same methods of procedures are used in...
exactly the same way. The process will then be "under control". This is the aim of a good quality management system to provide the "operator" with consistency and satisfaction in terms of methods, materials and equipment.

Audits and reviews are systematically carried out and if it is discovered that better products can be achieved by changing the method or materials, then a change may be effected. To maintain consistency, it must be ensured that the appropriate changes are made to the documented system [DTI 1991].

1.2.2 Statistical process control (SPC)
This is a strategy for reducing variability, the cause of most quality problems: variation in products; in times of deliveries; in ways of doing things; in materials; in people's attitudes; in equipment and its use; and in maintenance practices. SPC methods backed by management commitment and good organisation, provide objective means of controlling quality in any transformation process, whether used in the manufacture of articles, the provision of services or the transfer of information. Process control is essential and SPC forms a vital part of the TQM strategy. SPC is not only about plotting charts on the walls of a plant or office, it must become part of the company-wide adoption of TQM and act as the point of continuous improvement [DTI 1991].

1.2.3 Teamwork
The use of a team approach to problem solving has many advantages over allowing individuals to work separately on problems. These include:

- a greater variety of problems may be tackled;
- problems are exposed to a greater diversity of knowledge, skills and experience;
- the approach which cross departmental or functional boundaries can be dealt with more easily; and
- recommendations which are more likely to be implemented than individual suggestions;

When properly managed teams improve the process of problem solving, producing results quickly and economically. Teamwork throughout any organisation is an essential component of the implementation of TQM for it builds up trust, improves communications and develops interdependence on all facets of Human Resource Management [DTI 1991].
1.3 PROJECT AIMS AND OBJECTIVES

Against this background, the aim of the thesis is to ascertain why quality is the crucial issue for companies, especially those in the construction industry in the 1990's and beyond and how companies are striving to achieve......"right first time, every time".

To achieve this aim the following objectives were chosen to:

- establish the current thinking on the subject area from a state of the art review;
- define the meaning of TQM and the benefits that it can bring;
- highlight the structural components of TQM;
- determine the benefits, if any, on selected companies that have introduced TQM;
- analyse the effect that TQM has had on the employees of such companies; and
- develop an evaluation model of solutions and actions for organisations in their pursuit of TQM.

1.4 RESEARCH METHODOLOGY

The methodology used to satisfy the objectives is shown in Figure 1.4. It can be divided into four phases each interlinking with the whole:

Phase I
The initial stage was to identify, review and choose the literature that was expected to give the broadest outlook across the subject matter from conceptual beginnings through to actual day to day application of TQM policies within UK industries. The subject matter was identified initially by the use of CD ROM and microfiche obtained from the library.

Phase II
The structure of TQM and its application was reviewed with emphasis on the backbone of the system and the internal supplier/customer chain. The findings of the various Quality Guru's were noted from the literature obtained in the previous phase, together with the evolution of ISO 9001, all of which was encapsulated in Chapters 2 and 4.
Phase III
Following on from the previous phase the author determined the methodology for analysing the effects of TQM on the selected companies: the Miller Group, British Telecom and GKN Sinter Metals. As stated on page 3, the three companies were chosen as they had all implemented management systems to ISO standards. A common benchmark was required to compare and contrast. A Questionnaire was designed to cover a wide spectrum of the management system in place, including employee/management commitment and the like. It was extended to ascertain the perceptions from the bottom up. The data was analysed and is displayed graphically in Chapter 5, identifying strengths and weaknesses in the system for each of the target companies. To further the research and to substantiate the results of the questionnaire each company was interviewed. The results of both of these activities was used as the basis of an evaluation model to provide companies with proposed solutions for the identified problem areas.

Phase IV
This phase covers both the conclusions and recommendations.

Throughout the thesis, the author has identified the essential criteria for the successful implementation of TQM under five key themes: effectiveness; flexibility; competitiveness; commitment; and leadership.
Identification of Topic  
Literture Review  
Preface  
Introduction  
Project Aims  
Analysis & Main Study  
Literature Review  
Guru's  
ISO 9000 Requirements  
Summary of Main Findings  
Data Collection  
Manufacturing Questionnaire  
Contractors Questionnaire  
Service Industry Questionnaire  
Data Analysis  
Interviews  
Discussion  
Proposed Solutions  
Validation  
Conclusions  
Limitations of Research  
Recommendations  

Phase i: Literature Review & Research Definition Ch. 1-2  
Phase ii: Theoretical & State of the Art Review Ch. 2, 3, 4  
Phase iii: A Practical Review, Comparative Study & Analysis  
Phase iv: Validation, Conclusions & Limitations of Research & Recommendations

Figure 1.4: Research methodology

11
1.5 OVERVIEW OF THE CONCLUSION

The Construction Industry as a whole has been, and still is, wary of Total Quality Management with pay-back generally set at in excess of three years. TQM addresses much more than rigid adherence to existing quality procedures, it is much more flexible and addresses continuous improvement.

Efficiency dictates that quality should not necessarily mean the best quality available but rather the appropriate quality to satisfy the client’s requirements. This is the main theme running through this thesis.

The research has examined the theoretical content of Total Quality Management, what it means, what the barriers are and how pressure from external forces is changing the view of quality in the construction industry, taking into consideration the various schools of thought from the "teachers" of quality collectively known as the Guru's. The review continues with an insight into the "standard" adopted by many companies, and how it has adapted and changed to meet the requirements of the nineties and beyond.

This theory has been coupled with a practical study and insight into three leading companies and three different industries namely The Miller Group, British Telecom and GKN Sinter Metals. The evaluation is frank and critical through analysis of in depth questioning and interviewing from a cross section of personnel. The main highlight from viewing Total Quality Management in practice is that although there are loop-holes from the companies implementation and approach towards TQM they are learning by their mistakes and are continuing to move forward with their explanation. Lessons may be learnt from their "tools and techniques" but TQM has been embedded in each of the three companies and they can move forward with commitment taking cognisance of the ever demanding and changing market needs.

Quality can have a much wider application, covering the manner in which a company carries out all its business activities and its inherent culture commonly known as Total Quality Management. The thesis analyses this further by reviewing the gaps, where different, in the "system" providing an evaluation model of possible solutions and actions to them and providing conclusion and recommendations that would support the theory that whilst Quality Assurance (QA) promotes consistency and is often perceived as a goal in itself, reliant on paperwork systems, the underlying principle of TQM is the continuous improvement of business processes.
1.6 GUIDE TO THE THESIS
This thesis is divided into four phases, within eight chapters, a guide of which is given below:

PHASE I: Literature Review and Research Definition.

Chapter 1 a broad outline of the project aims and objectives, an introductory section to the subject area and a concise overview of the conclusion.

PHASE II: Theoretical and State of the Art Review.

Chapters 2, 3 & 4 contains the state of the Art Review consisting mainly of literary reviews on the subject areas of the supplier/customer chain, what is happening with regards to Quality Management in today's industry paying particular attention to the construction industry and the way forward. It also provides a review of the Quality "Guru's" and ISO 9000 series and examines whether it is the right "tool" for industry.

PHASE III: A practical review, comparative study and analysis

Chapter 5 reviews TQM in practice, analysing the responses from the questionnaires and interviews with the three selected companies.

Chapter 4 provides comparative studies of The Miller Group, British Telecom and GKN and gives factual evidence on the implementation of TQM within different industries.

Further to this it identifies and analyses any "gaps" with the implementation and continued practice of TQM and the ISO 9000 Standard.

PHASE IV: Validation and Recommendations.

Chapter 6 provides conclusions and recommendations regarding TQM.
Chapter Two

State of the Art Review of Total Quality Management (TQM)
Within the Construction Industry

2.1 Introduction

2.2 Quality and the supplier/customer chain

2.3 Why is there a need for TQM in today's industry?

2.4 The changing face of quality

2.5 The barriers to TQM and how they can be alleviated

2.6 Pressure for change in the construction industry

2.7 Summary
Chapter 2

State of the Art Review of Total Quality Management (TQM)
Within the Construction Industry

2.1  INTRODUCTION
As was noted in chapter one, if an organisation is to be truly effective, each of its individual elements must interact together, because every person and every activity affects and, in turn, affected by others.

This chapter examines why the supplier/customer chain is significant to the implementation of TQM; Why there is pressure to change within industry as a whole and more specifically within construction (with particular emphasis on the Latham and Egan reports); and finally what barriers organisations may encounter in their pursuit of TQM.

2.2  QUALITY AND THE SUPPLIER/CUSTOMER CHAIN
Quality is often used to signify "excellence" of a product or service [Oakland 1990] talks about "Rolls Royce Quality" and "top quality". To define quality in a way which is useful in its management, then the need to include in the assessment of quality, the true requirements of the "customer" must be recognised [Oakland 1990]. The Miller Group define quality as:

"Fully satisfying agreed customer requirements at the lowest internal cost"

Quality is then simply meeting the customer requirements and this has been expressed in many ways in particular by the Quality Guru's Juran and Feigenbaum who describe Quality as "fitness for purpose" and "the total composite product and service characteristic of marketing, engineering, manufacture and maintenance through which the product and service in use will meet the expectation by the customer" respectively [Oakland 1991, Bendell 1991].

Another word that needs to be defined is reliability. Part of the acceptability of a product or service will depend on its ability to function over a period of time, and it is this aspect of performance which is termed "reliability". It is the ability of the product or service to continue to meet the customer requirements.
The ability to meet the customer requirements is vital, not only between two separate organisations, but within an organisation. There exists, in every department, every office, even every household, a series of customers and suppliers [Oakland 1990]. If so, then we have a quality service. Throughout and beyond all organisations, whether they be manufacturing concerns, banks, retail stores, universities or hotels, there is a series of quality chains which may be broken, at any point, by one person or one piece of equipment not meeting the requirements of the customer, internal or external [Oakland 1991].

Quality has to be managed - it will not just happen. It must involve everyone in the process and be applied throughout the organisation. Some people, in customer organisations, never see, experience or touch the products or services that their companies purchase, but they do see things such as invoices. If every fourth invoice, from a certain supplier, carries at least one error, what image of quality is transmitted? Failure to meet the requirements, in any part of a quality chain, has a way of multiplying and failure in one part of the system creates problems elsewhere, leading to yet more failure. The price of quality is the continual examination of the requirements and the ability to meet them [Oakland 1991]. This will lead to a "continuing improvement" philosophy. Figure 2.1 illustrates what companies can achieve from quality improvements based on the cost of poor quality.
Within organisations, between internal customers and suppliers, the transfer of information regarding requirements is frequently poor (Oakland 1991). The internal supplier/customer relationships are often the most difficult to manage in terms of establishing the requirements. To achieve quality throughout an organisation each person in the quality chain must interrogate and interface as shown in Figure 2.2.
Suppliers
- who are my immediate suppliers?
- what are my true requirements?
- how do I communicate the requirements?
- do my suppliers have the capability to measure and meet the requirements?
- how do I inform them of changes in the requirements?

Customers
- who are my immediate customers?
- what are their true requirements?
- how can I measure my ability to meet the requirements?
- do I have the necessary capability to meet the requirements? (if not, then what must change to improve the capability?)
- do I continually meet the requirements? (if not, then what prevents this from happening when the capability exists?)
- how do I monitor changes in the requirements?

---

*Source: The Miller Group 1996*

*Figure 2.2 - Supplier Customer Chain*
2.3 WHY IS THERE A NEED FOR TQM IN TODAY'S INDUSTRY?

Many British companies are talking about TQM but few appreciate that it requires total effort in order to survive.

Sony UK, the colour TV manufacturer, have changed from assuring the quality of the finished product by means of inspection to in-process quality. The key issue has been motivation and establishing a company theme that was simple; common to everyone; quantifiable and ongoing. Targets and goals were set which were known and understood throughout the company. By setting goals together with an emphasis on product design and an investment programme Sony UK have achieved quality and productivity levels to equal the best Sony plants in Japan [Quality Today 1994]. IBM's plant in Havant has been at the forefront of quality improvement for many years the key to this sustained quality improvement is the motivation of its people. They have instigated such techniques as Departmental/Purpose analysis whereby it enables the staff to understand why they have come to the company, what they do each day to benefit it, then to understand that customers are not something only marketing deal with. As Mr Nakamura the Managing Director stated for Sony UK [Quality Today 1994] .... "if a manager is to convince people about quality you have to go out and see what is actually going on so that people can see that you are really interested.... asks about results, gives advice and helps to create good habits.... this is the essence of leadership...." Leadership is one of the key requirements for the successful implementation of TQM.

Today's business environment is such that managers must strive for competitive advantage to hold on to market share, let alone increase it. Consumers now place a higher value on quality than on loyalty to their home-based producers and price is no longer the major determining factor in consumer choice [Holberton 1990]. Price has been replaced by quality and this is true in industrial (as seen above), service, hospitality and many other markets. Consumers have ever increasing expectations and this presents renewed challenges for the TQM concept. Indeed both the Latham and Egan Reports 1994 and 1997 respectively advocated this for the Construction Industry.

Companies today compete on three issues - quality, price and delivery, something which many companies in the Construction Industry are now familiar with. Price is no longer the only issue.

There cannot be many senior managers, in the UK who remain to be convinced that
quality is the most important of these [BT 1988]. Moreover, as shown in Figure 2.1, as quality improves, costs fall through reduction in failure and detection costs. The absence of quality problems also removes the needs for the "hidden operations" devoted to dealing with failure and waste, and delivery performance benefited from increased output and higher productivity.

Many companies, throughout the world, are turning to total quality management to increase their share of existing markets by tying in existing customers and opening up new markets through added value management. Quality is now seen as a crucial issue for companies in the last decade and beyond, and is essential if they are to survive and command positions of leadership. Today's industry is very competitive and with challenging markets quality should not be seen as an additional cost of manufacture. Quality can save money and help companies survive.

The public and private sector have recognised that the quality of the product and service is what can differentiate them from their competitors. It can be the most powerful weapon to entry into world markets, which organisations can pursue to guarantee a long-term future. As a direct result of competition, companies are now focusing more on the requirements of the customer. At Nissan UK they see high quality as the price of entry into a market. They understand that unless quality levels are up with the best, you will go out of business. At Ford UK, Mike Bowes, Director of Supply, [Holberton 1990], stated that quality has been the single most important aspect of his business, and life, over the past five or six years.

"Quality is the one thing we have stuck to consistently over the years. It helped get the levels of supplier productivity we want and it has increased the ease of doing business." [Holberton 1990].

As Vernon Zelmer, Managing Director of Rank Xerox in the UK stated, [Holberton 1990], "Customer expectations keep you on your toes. If you have found a way of doing something in two steps you can be sure that someone in the Far East has found a way to do it in one. Satisfying the customer is a race without a finish."

Since the highly developed industrialised countries find it very difficult to compete with low-wage countries on price, they must, in future, compete on quality. The most important competitive factors in industry today - product innovation, productivity, cost efficiency and quality - represent a special challenge in domestic
and internal competition. In industrial products, not only cost-efficient production but also other aspects such as innovation and quality have become increasingly important. Sustained market leadership is the pay-off for long-term strategic commitment to quality and one which British companies are doing something about.

2.4 THE CHANGING FACE OF QUALITY IN THE CONSTRUCTION INDUSTRY

Much has been written in recent years on the need for the industry to adopt quality management techniques (Oakland 1990). Experiences with ISO 9000 quality management systems within industry and more especially the construction industry have shown that there is the potential to obtain significant, real benefits through obtaining registration, although the achieved benefits are often very different from those that were foreseen prior to implementation (CIRIA 1996).

The principles and practice of quality management, whether it is a registered system or not, should provide management systems to achieve specified end-product quality on the construction site. However, in practice, conformity with the specification is not always achieved, which depending on the range of operations being carried out and their complexity, may be a general failing or specific to one or more tasks or products. Ideally product quality can, and should be achieved through clear method statements or quality procedures and the existence of, and adherence to, defined routes for corrective action in the event of a failure to achieve specification.

To achieve product quality requires the commitment of all concerned with the construction process, the client and all on-site staff, including site managers, supervisors, foreman and operatives, whether employed by the client, the contractor or subcontractor. While there is guidance and information on establishing and operating quality management systems, further information and guidance is needed on achieving product quality.

With the aid of various literary reviews the changes in attitudes and problems with the implementation of ISO 9000 specifically in the construction industry are reviewed. The future adoption of a suitable standard is also discussed.

Research has indicated (Quality Liaison Group 1995) that although the use of ISO 9000 series of standards in the construction industry has made a valuable contribution to improving quality of a companies performance, the benefits have
not been as great as expected. Criticisms associated with applying ISO 9000 tend to focus on bureaucracy, administrative cost (particularly for small companies), loss of innovative opportunity and limitation to conformity rather than improvement [Bethell 1993].

There is nothing new about "QA". It is basic good management practice and control with the purpose of ensuring that customers are satisfied and to reinforce, sustain and improve the communications and the methods of the companies concerned. ISO 9000 has been sold to many companies as say what you do, do what you say and show that you have done it as can be demonstrated in Figure 2.3.

![Diagram of the Documented System](source)

(NB. Each stage is also interactive, eg the entire System is audited.)

**Figure 2.3 - The Documented System**

Critics agree that, despite too much jargon, the standard itself is not the problem. It is the way it is applied that concerns companies. The principle is admirable, "Say what you do, do what you say and prove that you have done it" says Juby, a critic and a representative of the Federation of Small Business, [Bendell 1994]. He goes on to say "the problem is that there are too many consultants around with big business experience who have filled this simple principle full of jargon and
forgotten that much of it is not applicable to a small business."

He says that the main threat to small businesses comes from laziness by purchasing departments in large firms that prefer to oblige suppliers to adopt the standard than to visit the companies and assess their products and records. Juby further comments "misconceptions about the standard have spread to the public, which sees the BSI kitemark on a product and assumes that it guarantees high quality. The standard is about internal quality management not about product management." It is here where the problems lie. ISO 9000 requires the company to listen to what its customers want, to ensure it has the mechanisms for assessing product quality and that it applies whatever lessons are learnt in the process.

Although the standard has grown in popularity, more than 70,000 organisations registered with the standard in 1998, its reputation has become tarnished with companies complaining that their customers increasingly demand they be certified for what many believe is an expensive and inappropriate standard. This can certainly ring true within the construction industry. In the early 80's through to the 90's Clients were demanding that their suppliers should be certified to BS 5750/ISO 9000, if not, they would not do business with them, [Bendell 1994]. This has spread throughout the supplier/customer chain to the small businesses, to the family owned subcontractor without fully realising the impact it would have within the industry.

Within other industries such as manufacturing the ISO 9000 standard is used as a foundation and notable customers Chrysler, Ford and General Motors have developed QS 9000 which brings together their Quality Assurance methods. Under the remit of QS 9000, an approved supplier gains the opportunity to bid for supply contracts to all three "parties" - Chrysler, Ford and General Motors [Holder 1996]. QS 9000 aims to promote continuous improvement through defect prevention, greater consistency and the reduction of waste in the supply chain. Suppliers have to prepare and provide different procedure manuals for each customer and whilst Chrysler and General Motors call for third party accreditation for QS 9000, Ford accept a self-assessed audit and monitor the supplier's conformance through a set of around forty performance metrics. Evidence suggests that the formal request for suppliers to carry out strategic business planning and continuous improvement has moved strategies away from gut feel and opinion to hard facts, with good qualitative data on issues that are being done well such as quality of the product, productivity, service (including delivery) and
price. QS 9000 although prescriptive directs attention to getting the basics right [Holder 1996].

In two recent surveys one by the National Quality Assurance Ltd (NQA) [Quality World 1997] and one by the Quality Liaison Group 1995; it has been shown that companies would like to see their certification bodies providing other services such as training and marketing support. Customers are rightly proud of their certification but do not always know how to get the most out of it. Understanding the expectation of end-users is of fundamental importance in expanding certification services and it is perhaps surprising that more information is not widely available. To ensure the competitiveness of British Industry, certification bodies must take notice of their customers' needs and so must client organisations.

In another recent study undertaken by CIRIA [1996], in close collaboration with four contractor organisations, it was noted that the implementation of QA is widespread amongst large contractors but that only in a minority of cases is this insisted upon by the client in the terms of the contract as shown in Figure 2.4. It is even less common for the client to audit the quality assurance system operated by the contractor. This clearly demonstrated a lack of understanding and commitment on the part of client organisations to the implementation of quality management systems in construction, and that a more proactive stance from client organisations would benefit the industry, and therefore the clients themselves.
Of even more concern was the summary of questionnaire responses to the implementation of the contractors quality management system as shown in Table 2.1.
Table 2.1 Summary of questionnaire responses to implementation of the contractor's quality management system.

<table>
<thead>
<tr>
<th>Contract type and no of examples</th>
<th>Percentage of sites attracting each level of client inspection</th>
<th>Number of sites on which quality management system was required by client</th>
<th>audited by client</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
</tr>
<tr>
<td>Traditional</td>
<td>16</td>
<td>63%</td>
<td>25%</td>
</tr>
<tr>
<td>Design and Build</td>
<td>6</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td>Management Contracting</td>
<td>1</td>
<td>-</td>
<td>100%</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Note: Percentages may not represent whole numbers of sites where client inspection was reported as midway between the levels defined.

The table shows the variation in the levels of inspection undertaken by clients, together with the clients' contractual requirement for a quality management system to be implemented by the contractor and the percentage of these that were audited by the client. The levels of client inspection were defined in the questionnaire as:

- **Level 1**: Inspects all materials and work prior to covering up and does not permit further progress without approval (on the basis of no liability);
- **Level 2**: Inspects/witnesses on a random basis, with or without approving further progress;
- **Level 3**: Carries out little or no quality control inspection.

The results summarised in the table suggest that on traditional contracts, where the design and contract teams are appointed separately, clients put less emphasis on quality management systems as a contract requirement and take a greater role through their site representatives, in inspecting and approving the work of the contractor.

In contrast, on design and build contracts, there is a greater emphasis on the specification of quality management systems as a contract requirement, and the level of client supervision is reduced to random or little inspection. The level of supervision and planning by the contractor is by necessity increased as a result of
the client's hands-off approach or by the client's specification of a quality
management system.

This can be compared to the responses to the contractor questionnaire, in the
same study, regarding the type of quality non-conformances that have been
identified on each site and the possible causes and the required remedial action.
It can be seen from Figures 2.4 and 2.5 that the greatest area of
non-conformance was lack of inspection on behalf of the contractor and that
minor reworking to bring within specification was reported on virtually all sites,
although a significant percentage reported that major demolition or redesign had
been required to correct quality non-conformances. It is not within the scope of
the study to calculate the value of all the remedial work, but other sources have
estimated that the correction of quality non-conformances can cost 6 per cent of
the production costs and occupy 10 per cent of the work time spent on the
project [Hammarlaund, Jacobsson and Josephson 1989].
Figure 2.5 Number of contracts studied reporting each category of non-conformance

Key to Figure 2.5

<table>
<thead>
<tr>
<th>Reason for non-conformance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Communication Breakdown</td>
<td>The error was caused by some breakdown in communication, either between the designer and the contractor, or within the contractor's site team.</td>
</tr>
<tr>
<td>b Error on drawing</td>
<td>The drawing issued to the contractor contained an error.</td>
</tr>
<tr>
<td>c Lack of checking</td>
<td>The non-conformance was due to the contractor or work team not checking their own work before submitting it for approval (e.g., setting-out not checked before construction).</td>
</tr>
<tr>
<td>d Lack of Supervision</td>
<td>The non-conformance was judged to be due to the contractor not supervising his own or his subcontractors' work (e.g., concrete not compacted properly).</td>
</tr>
<tr>
<td>e Materials</td>
<td>The materials used did not meet the specification.</td>
</tr>
<tr>
<td>f Unachievable specification</td>
<td>The terms of the specification were not practically achievable.</td>
</tr>
<tr>
<td>g Workmanship</td>
<td>The workforce did not have the skills to carry out the operation to comply with the specification.</td>
</tr>
<tr>
<td>h Other causes</td>
<td>These included fabrication errors, invalid design criteria used, supplier problems, inclement weather.</td>
</tr>
</tbody>
</table>
Despite the criticisms in the past few years it appears that ISO 9000 is here to stay and if implemented correctly, provides the best way of improving and sustaining internal control and providing objective confidence to clients. However, companies need to go further than this if they are to succeed with the implementation of quality and hence if they are to increase their market share and competitive edge. Firstly they will need to alleviate or at least be aware of the
barriers to TQM and secondly they need to react to change. Each of these is now reviewed.

2.5 THE BARRIERS TO TQM AND HOW THEY CAN BE ALLEVIATED
Implementing the wrong type of quality management system can devastate an organisation's business strategy and ruin its prospects for gaining a competitive edge [Hasegawa 1986]. Managing total quality has moved beyond the awareness stage. Companies are actively pursuing the TQM route to success [European Quality 1994]. However, since every organisation has its own culture and management philosophy, it can be very difficult to identify the key factors which assist or hinder the successful implementation of total quality. The main point companies have cited, in implementing TQM, are [Mortiboys 1991]:

- culture change/management behaviour - almost all companies have found it difficult to achieve cultural change and to get management, especially lower and middle management, to change their thinking;
- finding the time - TQM takes time and effort from everyone. There is never enough time, on top of day-to-day tasks, to give to the programme - the more inefficient the company's processes and therefore, the greater the need for TQM, the worse the problem!
- cannot measure the result/no tangible benefits;
- the sheer number of initiatives in TQM;
- lost momentum and poor communications; and
- the workforce viewing TQM as "just another management gimmick".

However, the above-mentioned problems can be alleviated provided that TQM is adequately planned for in an organisation. Before embarking on TQM companies must ensure that they know the direction of the business. The key objectives in promoting a valued and successful TQM philosophy is to ensure that [Mortiboys 1991]:

- efficient lines of communication are set up inside the company, and with suppliers and customers, so that everyone knows what is expected of them;
- educate everyone in the key principles of TQM and ensure that benefits are gained from the process early in the implementation;
- emphasise that it is a continuous process, not just a separate one-off exercise.
Finally, and most importantly

- culture change, management behaviour and making time must be addressed early on, by senior management, if an organisation is to become a true TQM company.

2.6 PRESSURE FOR CHANGE IN THE CONSTRUCTION INDUSTRY
There has been additional pressures for change in other areas in recent years which will, in the long term, have a beneficial effect to all industries and none more so than the construction industry. The growing concerns of the construction industry which was brought to the fore by the publication of Rethinking Construction, the report of the Construction Task Force by Sir John Egan which was preceded by the Latham Report, Constructing the Team by Sir Michael Latham. Latham recommended that a productivity target of 30 percent real cost reduction by the year 2000 should be launched [Latham 1994]. He also advocated that Quality Assurance certification should continue to be encouraged within the construction industry as a potentially useful tool for improving corporate management systems. However, Latham stated that more evidence was required that it would also raise standards of site performance and project delivery before it could be made a pre-qualification condition for consideration for public sector work. A consensus was required from the industry and professions as to how BS 5750 accreditation, as it was then, can improve project delivery and site performance as well as office management systems. Encouraging a Total Quality approach should pervade the whole implementation phase. It should involve heavy emphasis upon teamwork and co-operation [Latham 1994]. Latham also recommended that the DOE should set up a task force drawn from the public sector as a whole to prepare a single qualification document for contractors seeking to do work for any public sector body. Latham noted that the perception of the industry has certainly been that tender lists have increased in recent years, and that most lists are excessive. Tables 2.2 to 2.4 show the findings of the "New Builder/JT Design Build Construction Industry Survey" [March 1994]. It is interesting to note that a significant proportion of clients were concerned. 36 per cent of clients agreed that lists had grown, 30 per cent believed that the majority of all projects involved excessive lists and 46 per cent thought that public sector lists were more likely to be excessive than those in the private sector [Latham 1994].
Table 2.2: The number of firms being invited to tender for individual contracts over the last 3 years

<table>
<thead>
<tr>
<th></th>
<th>All Respondents</th>
<th>Material Producers</th>
<th>Constructors</th>
<th>House-builders</th>
<th>Consultants</th>
<th>Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased significantly</td>
<td>41%</td>
<td>40%</td>
<td>47%</td>
<td>40%</td>
<td>46%</td>
<td>24%</td>
</tr>
<tr>
<td>Increased slightly</td>
<td>31%</td>
<td>34%</td>
<td>43%</td>
<td>20%</td>
<td>38%</td>
<td>12%</td>
</tr>
<tr>
<td>About the same</td>
<td>19%</td>
<td>16%</td>
<td>8%</td>
<td>20%</td>
<td>15%</td>
<td>42%</td>
</tr>
<tr>
<td>Decreased slightly</td>
<td>9%</td>
<td>10%</td>
<td>2%</td>
<td>20%</td>
<td>-%</td>
<td>22%</td>
</tr>
</tbody>
</table>


Table 2.3: The Majority of all Construction Projects involve excessive Tender Lists

<table>
<thead>
<tr>
<th></th>
<th>All Respondents</th>
<th>Material Producers</th>
<th>Constructors</th>
<th>House-builders</th>
<th>Consultants</th>
<th>Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>25%</td>
<td>40%</td>
<td>25%</td>
<td>24%</td>
<td>25%</td>
<td>12%</td>
</tr>
<tr>
<td>Slightly Agree</td>
<td>33%</td>
<td>32%</td>
<td>33%</td>
<td>38%</td>
<td>42%</td>
<td>18%</td>
</tr>
<tr>
<td>Neither</td>
<td>18%</td>
<td>8%</td>
<td>32%</td>
<td>18%</td>
<td>8%</td>
<td>24%</td>
</tr>
<tr>
<td>Slightly Disagree</td>
<td>15%</td>
<td>12%</td>
<td>8%</td>
<td>14%</td>
<td>14%</td>
<td>29%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>9%</td>
<td>8%</td>
<td>2%</td>
<td>6%</td>
<td>11%</td>
<td>17%</td>
</tr>
</tbody>
</table>


Table 2.4: Public Sector Projects are more likely to involve excessive Tender Lists than Private Sector Projects

<table>
<thead>
<tr>
<th></th>
<th>All Respondents</th>
<th>Material Producers</th>
<th>Constructors</th>
<th>House-builders</th>
<th>Consultants</th>
<th>Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>27%</td>
<td>40%</td>
<td>32%</td>
<td>24%</td>
<td>23%</td>
<td>20%</td>
</tr>
<tr>
<td>Slightly Agree</td>
<td>18%</td>
<td>24%</td>
<td>14%</td>
<td>12%</td>
<td>16%</td>
<td>26%</td>
</tr>
<tr>
<td>Neither</td>
<td>36%</td>
<td>32%</td>
<td>29%</td>
<td>46%</td>
<td>46%</td>
<td>26%</td>
</tr>
<tr>
<td>Slightly Disagree</td>
<td>13%</td>
<td>4%</td>
<td>20%</td>
<td>11%</td>
<td>11%</td>
<td>18%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>5%</td>
<td>-%</td>
<td>5%</td>
<td>7%</td>
<td>4%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Whilst a manageable list of tenderers is important for traditional procurement routes, it is vital for design and construct work, the cost of which can be high, Table 2.5 refers. Latham advocated that in those circumstances clients ought to limit design and build tenders to 3, with 2 "reserve" names available if someone declines to tender, [Latham 1994].

Recently there has been recognition that this policy of procuring at the lowest tender price rarely leads to the lowest out-turn cost and even more rarely, the lowest whole life cost. This led to a Government White Paper in May 1995 entitled Setting New standards, A Strategy for Government Procurement.

The move away from procurement driven by lowest current price has been widely welcomed by all sides of the construction industry [Quality Liaison Group 1995]. Best value for money, world class professional procurement, and an emphasis on integrated procurement processes, covering the whole cycle of acquisition and use from start to finish are key elements of the strategy "to ensure quality and economy over time, not short term lowest price". Another element of the strategy states that "Relationships with suppliers will combine competition with co-operation. Contracts with suppliers will be designed where-ever practicable to promote continuous improvement and benefit sharing": To achieve their strategic objective clients are turning to partnering as a means of procuring. They consider that the environment and mutual understanding created by a longer term, multi-project relationship yields worthwhile benefits to all parties in the construction process by means of continuous improvement.

Latham's report on the industry led to the development of the Construction Industry Board and legislation on adjudication and fair payment.

The Task Force led by Sir John Egan set about building on the firm foundations which Latham had laid. There had been a need to improve and the Construction Task Force was set up by the Deputy Prime Minister against a background of deep concern in the industry and among its clients that the construction industry was under-achieving, both in terms of meeting its own needs and those of its clients.

Construction in the UK was seen as one of the pillars of the domestic economy. The industry in its widest sense was likely to have an output of some £58 billion in 1998, equivalent to roughly 10 per cent of GDP, and employs around 1.4 million people.
Table 2.5:  An analysis of the cost of tendering

<table>
<thead>
<tr>
<th></th>
<th>£5M</th>
<th>£10M</th>
<th>£15M</th>
<th>£25M</th>
<th>£40M</th>
<th>£60M</th>
<th>£80M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D &amp; B Stage 1 Costs</td>
<td>Traded D &amp; B Stage 1 Costs</td>
<td>D &amp; B Stage 1 Costs</td>
<td>D &amp; B Stage 1 Costs</td>
<td>D &amp; B Stage 1 Costs</td>
<td>D &amp; B Stage 1 Costs</td>
<td>D &amp; B Stage 1 Costs</td>
</tr>
<tr>
<td>Design fees</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>3,000</td>
<td>Nil</td>
<td>Nil</td>
<td>6,000</td>
</tr>
<tr>
<td>Presentation brochures</td>
<td>2,500</td>
<td>Nil</td>
<td>2,000</td>
<td>3,500</td>
<td>Nil</td>
<td>3,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Quantities</td>
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<td>Nil</td>
<td>7,000</td>
<td>Nil</td>
<td>Nil</td>
<td>10,000</td>
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<td>3,000</td>
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<td>4,000</td>
<td>3,000</td>
<td>6,000</td>
<td>5,000</td>
<td>6,000</td>
<td>5,000</td>
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<tr>
<td>Tender planning</td>
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<td>4,000</td>
<td>2,500</td>
<td>4,500</td>
<td>4,500</td>
<td>3,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Legal, insurance commercial</td>
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<td>2,000</td>
<td>1,000</td>
<td>3,000</td>
<td>3,000</td>
<td>2,000</td>
<td>3,500</td>
</tr>
<tr>
<td>D&amp;B management</td>
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<td>3,000</td>
<td>4,000</td>
<td>Nil</td>
<td>3,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Total</td>
<td>25,000</td>
<td>13,000</td>
<td>14,000</td>
<td>36,000</td>
<td>16,500</td>
<td>19,000</td>
<td>49,500</td>
</tr>
</tbody>
</table>

| Factor         | 1.79 | 1.89 | 2.11 | 2.18 | 2.18 | 2.26 | 2.50 |
| Tender value%  | 0.50 | 0.26 | 0.28 | 0.36 | 0.17 | 0.19 | 0.33 |

Source: CIEC February 1994
The industry is also eminently flexible. Its labour force, willing, adaptable and able to work in the harshest conditions. Its capability to deliver the most difficult and innovative projects matches that of any other construction industry in the world.

Nevertheless, the industry recognised that it needed to modernise in order to tackle the severe problems facing it, not least that:

- it had a low and unreliable rate of profitability. Margins were characteristically very low. The view of the Task Force was that these were too low for the industry to sustain healthy development and that they wished to see those companies who serve their clients well making much better returns;
- it invested little in research and development and in capital. The house R & D had fallen by 80 per cent since 1981 and capital investment was a third of what it was twenty years ago. This lack of investment was damaging the industry's ability to keep abreast of innovation in processes and technology;
- there was a crisis in training. The proportion of trainees in the workforce appeared to have declined by half since the 1970's and there was increasing concern about skill shortages in the industry. Too few people were being trained to replace the ageing skilled workforce, and too few were acquiring the technical and managerial skills required to get full value from new techniques and technologies. Construction also lacked a proper career structure to develop supervisory and management grades; and
- too many clients were undiscriminating and still equated price with cost, selecting designers and constructors almost exclusively on the basis of tendered price. The tendency was widely seen as one of the greatest barriers to improvement. The public sector, because of its need to interpret accountability in a rather narrow sense, was often viewed as a major culprit in this respect. The industry needed to educate and help its clients to differentiate between best value and lowest price [Egan 1998].

Egan and the Task Force recommended seven performance indicators for the scope for sustained improvement, with defined improvements per year and the current performance of leading clients and construction companies as shown in Figure 2.7.
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Improvement per year</th>
<th>Current performance of leading clients and construction companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>Reduce by 10%</td>
<td>Leading clients and their supply chains have achieved cost reductions of between 6 and 14% per year in the last five years. Many are now achieving an average of 10% or greater per year.</td>
</tr>
<tr>
<td>Construction Time</td>
<td>Reduce by 10%</td>
<td>Leading UK clients and design and build firms in the USA are currently achieving reductions in construction time for offices, roads, stores and houses of 10-15% per year.</td>
</tr>
<tr>
<td>Predictability</td>
<td>Increase by 20%</td>
<td>Many leading clients have increased predictability by more than 20% annually in recent years, and now regularly achieve predictability rates of 95% or greater.</td>
</tr>
<tr>
<td>Defects</td>
<td>Reduce by 20%</td>
<td>There is much evidence to suggest that the goal of zero defects is achievable across construction within five years. Some UK clients and US construction firms already regularly achieve zero defects on handover.</td>
</tr>
<tr>
<td>Accidents</td>
<td>Reduce by 20%</td>
<td>Some leading clients and construction companies have recently achieved reductions in reportable accidents of 50-60% in two years or less, with consequent substantial reductions in project costs.</td>
</tr>
<tr>
<td>Productivity</td>
<td>Increase by 10%</td>
<td>UK construction appears to be already achieving productivity gains of 5% a year. Some of the best UK and US projects demonstrate increases equivalent to 10-15% a year.</td>
</tr>
<tr>
<td>Turnover and Profits</td>
<td>Increase by 10%</td>
<td>The best construction firms are increasing turnover and profits by 10-20% a year, and are raising their profit margins as a proportion of turnover well above the industry average.</td>
</tr>
</tbody>
</table>

Figure 2.7 The Scope for Sustained Improvement

The Task-Force saw that the adoption of this model, which other industries had followed with success would dramatically improve performance, in order to deliver
the challenging targets for increased efficiency and quality, [Egan 1997]. To date the Major Contractors Group, as its name suggests, includes the major construction companies of which Miller is one, has been tasked with implementing the seven performance indications as advocated by Egan as a way of benchmarking and measuring improvements within the industry. This is in addition to the demonstration projects which are advocating best practice.

The pressure for change within the construction industry was heightened by the publication of these two reports. However, other publications have been written advocating the use of Business Systems Engineering as a way forward for improving construction productivity [Towill 1998]. Towill noted that modern industry has the characteristic that it learns quickly, not only from competitors, but also from other market sectors. A significant method for such "methodology transfer" into the construction sector is Business Systems Engineering (BSE). As the name implies, it is the application of engineering techniques to business processes and comes with a comprehensive and proven tool kit. BSE can improve construction sector productivity via the targeting of reduction in total cycle time, and show that significant benefits of up to 50 per cent accrue with the emphasis on proper process analysis, implementation and follow-up, [Towill 1998]. Other articles accelerated the implementation of TQM in construction by posing the question as to whether Total Quality Management can “Add Value” in construction [Stockdale 1998].

A recent report [Smith and Cowley 1997] stated that the most admired companies had the following characteristic:

- strong leadership;
- clearly defined and understood objectives;
- focus on quality of marketing, to deliver products and services that satisfy customers;
- applies innovation;
- has the ability to attract, develop and retain talent; and
- makes a contribution to the community through national economic growth.

The same report summarised that the top 25 “most admired companies” are generating:

- 75 per cent more economic value from each £ of sales;
- 35 per cent more market value for investors for each £ of invested capital;
- 39 per cent higher return and 39 per cent more cash flow on invested capital;
- 22 per cent more profit from each £ of sales.
The authors, Smith and Cowley, stated that it appeared that this transformation in business performance was being brought about by the adoption of new systems and processes that are constantly evolving.

Stockdale, [1998] stated that the primary aim of the construction industry was to satisfy customer's needs. However, a parallel objective in the adoption of TQM principles must be to share learning within construction companies. The best TQM programmes are systematic attempts to build company learning [Stockdale 1998].

Other papers such as construction project teams for TQM; factor-element impact model and the importance of TQM in the construction industry [Ahmad & Sein 1995] has demonstrated how TQM has become a crucial aspect in the construction industry.

Coupled with these is the additional concept of the Business Excellence Model as shown in Figure 2.8, first introduced by Malcolm Banbridge in the USA in 1987. The first European Quality Award based on a Business Excellence Model was started in 1992. The UK Quality Award for Business Excellence was introduced in 1994. This provides a new focus for all industries, by becoming a framework used by companies such as the Rover Group to monitor their performance and highlight performance opportunities [British Quality Foundation 1997]. The process based on Self Assessment identifies nine elements as the key components of business excellence verified by extensive research with the model being validated by several hundred companies throughout Europe [British Quality Foundation 1997]. The model enables companies to bring cohesion to their activities, linking together company initiatives and programmes, including ISO 9000 and Investors in People.
Self Assessment is a structured approach to the pursuit of excellence based on a framework known as the Business Excellence Model (or the European Model for Total Quality Management). It enables an organisation to objectively assess its performance under a number of headings (known as nine criteria), identify strengths and areas for improvement, put an improvement plan in place, and repeat the process. Implementation of Self Assessment with the Model enables comparisons to be made between units of an organisation, and between organisations. Thus benchmarking against best practice becomes possible, enhancing the value of the process.

There are huge opportunities for all companies and, in particular the construction industry, providing that they stay competitive and can measure up to the best if they are to succeed against their competitors in an increasingly global market.

2.7 SUMMARY
This chapter has highlighted the need for the construction industry to adopt systems and more importantly TQM in order to move it from a culture of ".... 70 per cent of the work hours going into a building is absolutely and completely wasted ...." [Hope 1999]. The steps to TQM have been shown together with the
barriers that need to be alleviated in order to be successful in implementing TQM. The construction industry is now in the position where they have to "convince customers that what they get is what they bargained for", and that QA is the answer [Seymour and Low 1990].

The end-user is also a customer and therefore part of the quality chain. There is a growing demand from the public at large for buildings and infrastructure to be sympathetic with and to improve their local environment. Today, clients are having to accept that projects and hence their costs must satisfy such demands [Quality Liaison Group 1995].

Clients are looking at more than just a tender price and are asking prospective contractors to pre-qualify for contracts and hence limiting tender lists. Moves in the industry are also being made towards whole life costing [Quality Liaison Group 1995] looking at a structured method for the continuous reassessment of a project's aims and requirements together with all aspects of function, design, construction, and operation during whole life.

The Latham and Egan reports suggest that there is evidence that there are potential cost savings and scope for improvement by learning from other successful companies from other sectors in the market.
Chapter Three

Guru's Influence on Total Quality Management (TQM)

3.1 Introduction

3.2 The emergence of the TQM exponents commonly known as the quality Guru’s

3.3 W Edwards Deming

3.4 Joseph M Juran

3.5 Shigeo Shingo

3.6 Philip B Crosby

3.7 Dr Armand V Feigenbaum

3.8 Dr Kaoru Ishikawa

3.9 Dr Genichi Taguchi

3.10 Claus Moller

3.11 A comparison of the Guru’s

3.12 Summary
Chapter 3

Guru's Influence on Total Quality Management (TQM)

3.1 INTRODUCTION

One of the key emerging themes in Chapter 2 was that, in order for the construction industry to move from a culture of ".... 70 per cent of the work hours going into a building is absolutely and completely wasted ...." [Hope 1999], it needs to adopt a TQM approach. However, to enable organisations to apply this approach it was noted in Chapter 1 that the steps to TQM need to be supported by a documented management system, statistical tools and teamwork which includes both the internal/external supplier/customer chains.

This chapter investigates how the emergence of TQM exponents commonly known as the Quality Guru's, represented the concept and approaches to Quality and TQM, which have had a major impact on the way organisations think and act today.

The Quality Guru's characterised the responses to changes in the American and Japanese markets and the need to adapt to survive covering the development of both philosophy and tools as has been noted in Chapters 1 and 2. Quality Assurance is only part of Total Quality Management (TQM) providing a systematic approach. TQM provides the principles, tools and techniques to obtain continuous improvement of all activities. These tools include technical tools to control industrial design and manufacturing (including the contributions of Quality Guru's Shingo, Ishikawa and Taguchi). They also include management tools to achieve quality such as the zero defect approach of Crosby and the concepts of company wide and total quality associated with Ishikawa and Feigenbaum.

3.2 THE EMERGENCE OF THE TQM EXPONENTS COMMONLY KNOWN AS THE QUALITY GURU'S

In the 1880's, Frederick W Taylor, studied the organisation of work in factories. His purpose was to make the manual work more productive, and therefore better paid, and at the same time to relieve him of unnecessary and wasteful labour.
His method was to identify and analyse all the operations which had to be performed for a given task and then to optimise the sequence of operations to create the smoothest and most economical flow of work.

In the UK, one of the first large scale applications of the Taylor principle was in armaments manufacture during the First World War. A largely female work force quite unskilled and without any previous experience, was drafted to the ordnance factories. They were taught simple repetitive tasks. The craftsman who taught them became inspectors. However, the system was neither efficient nor cost effective and lying at the heart of this inefficiency was the belief that quality could be adequately controlled solely by inspection [Ashford 1989].

Such were the problems of attempting to control quality by inspection that it was recognised that a better way could be found and it was.

To regenerate their industries after the 2nd World War the Japanese sent teams abroad to study the Management practices of other countries and invited foreign experts to provide advice. Of these, two Americans W E Deming and J M Juran brought a new message which has since been identified under the generic term of quality management [Ashford 1989].

The contribution of these Guru's and others is discussed in turn.

3.3 W EDWARDS DEMING

Deming was a statistician who gained fame by helping Japanese companies to improve quality after the second World War. Deming defined quality as a predictable degree of uniformity and dependability, at low cost and suited to the market [Oakland 1990]. Deming’s basic philosophy is that quality and productivity increase as variability decreases and because all things vary, statistical methods of quality control must be used. He explained that statistical control does not imply absence of defective items. It is a state of random variation in which the limits of variation are predictable [Oakland 1990].

Although Deming's message was primarily statistical, it was however a systematic rigorous approach to quality. He was a leading disciple of W A Shewhart, the
famous statistician, at Bell Laboratories, and whose book the Economic Control of Quality of Manufactured Product, [Shewhart 1931], had revolutionised quality control. It was a development of these ideas of Shewharts that Deming presented in his early writings (1934) that became an integral part of his lectures to the Japanese. Following Shewhart, Deming urged managers to focus on problems of variability in manufacture and their causes. He focused on identifying and separating "special causes" of production variability from "common causes". Special causes are those effects assignable to individual machines or operators, whilst common causes like faulty raw materials are shared by various operations and which were clearly management's responsibility. The primary statistical technique employed for the separation were statistical process control charts.

However, Deming's lectures and work extended considerably beyond statistical methods. He encouraged the Japanese to adopt a systematic approach to problem solving. This approach later became known as the Deming or PDCA (Plan, Do, Check, Action) cycle. He also pushed senior managers to become actively involved in their company's quality improvement both at the individual, Company and Societorial level.

3.3.1 Demings 14 Points [Bendell 1991]
Deming saw the adoption and action of his 14 points (below) as a signal that management intend to stay in business and are aiming to protect investors and jobs no matter what size or what part of an organisation they belonged to.

1. Create a constancy of purpose towards improvement of product and service.

2. Adopt the new philosophy. We can no longer live with commonly accepted levels of delays, mistakes, defective workmanship.

3. Cease dependence on mass inspection. Require instead statistical evidence that quality is built in.

4. End the practice of awarding business on the basis of price tag.

5. Find problems. It is management's job to work continually on the system.

6. Institute modern methods of training on the job.
7. Institute modern methods of supervision of production workers. The responsibility of foreman must be changed from numbers to quality.

8. Drive out fear, so that everyone may work effectively for the company.


10. Eliminate numerical goals, posters and slogans for the workforce asking for new levels of productivity without providing methods.

11. Eliminate work standards that prescribe numerical quotas.

12. Remove barriers that stand between the hourly worker and his right to pride of workmanship.

13. Institute a vigorous programme of education and retraining.

14. Create a structure in top management that will push, every day, on the above thirteen points.

Demings 14 points are very important aims but in themselves do not provide tools. Later guru’s provide these. Deming provided a seven point action plan for change, starting from management struggling over each of the 14 points and the Deadly Diseases and obstacles which he saw as afflicting most companies in the Western World.

3.3.2 Demings Deadly Diseases:
• A lack of constancy of purpose;
• Emphasis on short term profits;
• Evaluation of performance, merit-rating, or annual review;
• Mobility of management;
• Management by use only of visible figures, with little or no consideration of unknown or unknowable figures.

He saw the following as being obstacles in addition to the deadly diseases: motivational, educational, continued reliance on standards, use of technology.
The Action Plan which Deming proposed for management and organisation alike was:

1. management struggles over the 14 points, Deadly Diseases and obstacles and agrees meaning and plans direction;

2. management takes pride and develops courage for the new direction;

3. management explains to the people in the company why change is necessary;

4. divide every company activity into stages, identifying the customer of each stage as the next stage. Continual improvement of methods should take place at each stage, and stages should work together towards quality;

5. start as soon and as quickly as possible to construct an organisation to guide continual quality improvement. Deming advocates the Deming or Shewhart Cycle as a helpful procedure for improvement;

6. everyone can take part in a team to improve the input and output of any stage; and

7. embark on construction of organisation for quality.

Deming being a statistician was a great advocate of applying statistical techniques for controlling quality. However, it is coupled with 14 strong points for management which includes ensuring that there is employee participation and that they are involved in the decision making.

3.4 JOSEPH M JURAN

Along with W E Deming, Joseph M Juran brought a new message to industry:

1. the management of quality is crucial to company survival and merits the personal attention and commitment of top management;

2. the primary responsibility for quality must lie with those doing the work.
Control by inspection is of limited value;

3. to enable production departments to accept responsibility for quality, management must establish systems for the control and verification of work, and must educate and indoctrinate the work force in their application; and

4. the costs of education and training for quality, and any other costs which might be incurred will be repaid many times over by greater output, less waste, a better quality product and higher profits.

These were the basic principles of management concept and have since been identified under the generic term of quality management [Ashford 1989].

Both Deming and Juran propounded the philosophy that management should devote its attention to the improvement and maintenance of quality not because someone else might oblige them to do so, but because it was a desirable end in itself [Ashford 1989]. It is interesting to note that this philosophy is practised by the Japanese.

It was Juran who first coined the term "fitness for use or purpose" and distinguished it from the definition of quality often used "conformance to specifications". He pointed out that a dangerous product could meet all the specifications, and not be fit for use. Juran was the first to deal with the broader management issues of quality and this distinguishes him from those who espouse specific techniques. In the 1940's he claimed that the "technical aspects of quality control" had been well covered, but that companies did not know how to manage to achieve quality. He identified problems such as:

- organisation;
- communication; and
- coordination of functions.

In other words the human element [Oakland 1990].

Juran's "Quality Planning Road Map" consists of the following steps [Bendell 1991]:

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1. identify who are the customers;
2. determine the needs of those customers;
3. translate those needs into our language;
4. develop a product that can respond to those needs;
5. optimise the product features so as to meet our needs as well as customers needs;
6. develop a process which is able to produce the product;
7. optimise the process;
8. prove that the process can produce the product under operating conditions; and
9. transfer the process to operations.

Juran concentrated not just on the end customer, but identified other external and internal customers. He illustrated his idea via the QUALITY SPIRAL.

Figure 3.1 - The Quality Spiral
If company's were to progress Juran proposed three basic steps:

- structured annual improvements;
- massive training programmes; and
- upper management leadership.

In his view, less than 20 per cent of quality problems are due to workers, with the remainder caused by management. Just as all managers need some training in finance, all should be trained in quality to enable them to manage and participate in quality improvement projects [Oakland 1990].

As [Oakland 1990] stated, Juran like, Deming, believed that companies should avoid campaigns to motivate the workforce, but instead establish specific plans to meet these goals. Juran favoured the concept of quality circles as they improve communication between management and employees. He also recommended Statistical Process Control (SPC), and he did not believe that "quality is free", Juran was not in favour of single sourcing for critical purchases and he believed that training for purchasing managers should include techniques for rating vendors. Above all Juran advocated that the project approach is important. When it comes to quality there is not such a thing as improvement in general.

Like Deming, Juran proposed 10 steps to quality improvement [Oakland 1990]:

1. build awareness of the need and opportunity for improvement;
2. bet goals for improvement;
3. organise to reach the goals;
4. provide training;
5. carry out projects to solve problems;
6. report progress;
7. give recognition;
8. communicate results;
9. keep score; and

10. maintain momentum by making annual improvement part of the regular systems and processes of the company.

Juran is a great advocate for recommending teamwork and the instigation of Quality Councils and the like. However, he does not recommend campaigns "to do perfect work". He advised a vendor rating but states that companies should help the supplier improve thus taking TQM beyond the boundaries of the company.

3.5 SHIGEO SHINGO

Shigeo Shingo's approach to Quality emphasised production rather than management. His motto was "Those who are not dissatisfied will never make any progress". He believed in achieving careful thought, pursuit of goals, planning and implementation of solutions".

Shingo was the inventor of the single-minute exchange of die (SMED) system in which set-up times are reduced from hours to minutes and the poka-yoke (mistake proofing) system [Oakland 1990]. He was a key developer of the Toyota Production System in which no defects or errors are produced. To achieve this two things are required: "poka-yoke" and source inspections [Oakland 1990]:

1. poka-yoke - here defects are examined, the production system stopped and immediate feedback given so that the root causes of the problems may be identified and prevented from occurring again; and

2. with regard to Source Inspections - errors are looked at before they become defects and the system is either stopped for correction or the error condition automatically adjusted to prevent it from becoming a defect.

Zero quality control systems may be implemented combining both source inspections with 100 per cent inspections and providing immediate feedback and action.
A zero quality control system, according to Shingo, is based on the following basic ideas:

a. use source inspection;

b. use 100 per cent inspections rather than sampling inspections;

c. minimise the time it takes to carry out corrective action when abnormalities appear; and

d. set up poka-yoke devices, human workers are not infallible!

Companies such as Toyota which have implemented these systems have virtually eliminated the need for acceptance sampling methods.

By recommending the use of poka-yoke and source inspection systems, as advocated by Shingo, it has enabled companies such as Toyota to eliminate the need for acceptance sampling methods [Oakland 1990].

3.6 PHILIP B CROSBY

Crosby is best known for the concept of "zero defects" and "Do it right first time" which he developed in the early 1960's whilst in charge of quality for various missile projects, and later a Quality Director of ITT [Oakland 1990].

Crosby's definition of quality is "conformance to requirements" which he says can only be measured by the cost of non-conformance. He prefers people to talk of the existence of only one standard - zero defects. Crosby sums up quality management in one word, prevention, which should replace the conventional view that quality is achieved through inspection, testing and checking. There is no place in his philosophy for statistically acceptable levels of quality, for this leads to the belief that errors are inevitable and are planned for.
In his book "Quality is Free" [Crosby 1982], a number of quality-building tools are identified including his 14 step programme for Quality Improvement, the Quality Management Maturity Grid enabling a company to measure its present quality system and company position, the Make Certain Programme for defect prevention in non-manufacturing and Management Style Evaluation for self-examination by managers of the effects of their personnel qualities on product quality.

Like Deming, Crosby has 14 Points, or rather Steps, to Quality Improvement. He also has identified Four Absolutes of Quality Management. These being:

1. quality is defined as conformance to requirements, not as "goodness" nor "elegance";
2. the system for causing quality is prevention, not appraisal;
3. the performance standard must be Zero defects, not "that's close enough"; and
4. the measurement of quality is the Price of Non-conformance, not indices.

In Quality is Free he adds a Fifth Absolute:

5. there is no such thing as a quality problem.

The Four Absolutes of Quality Management are the basis of the Quality Improvement Process as seen by Crosby. The 14 Steps of the Process are a practical, common-sense Program to implement quality improvement. The Steps are:

1. establish Management Commitment;
2. form the Quality Improvement Team from representatives from each department;
3. establish Quality Measurements throughout the company;
4. evaluate the Cost of Quality;
5. establish Quality Awareness by employees;
6. instigate Corrective Action;
7. establish an Adhoc Committee for the Zero Defects Program;
8. supervisor/employee training;
9. hold a Zero defects Day to establish the new attitude;
10. employee Goal Setting should take place, usually on a 30-, 60-, 90-day basis;
11. error cause removal should be set up to follow the collection of problems;
12. establish recognition of those who meet goals or perform outstandingly by (non-financial) award programs;
13. quality councils composed of quality professionals and team chairpersons should meet regularly;
14. do it all over again.

Like Deming and Juran, Crosby has suggested, steps to quality improvement, 14 in total and is strong on the responsibility of management for quality. However, he totally rejects statistically acceptable levels of quality as he feels this leads to the belief that errors are unavoidable and are thus planned for.

3.7 DR ARMAND V FEIGENBAUM

Feigenbaum is the originator of Total Quality Control. He stressed that "quality" does not mean "best" but "best for the customer use and selling price" [DTI 1981]. The word "control" in quality control represents a management tool with four steps:

- setting quality standards;
• appraising conformance to these standards;
• acting when standards are exceeded; and
• planning for improvements in the standards.

Feigenbaum argued that statistical methods are used in an overall quality-control programme whenever and wherever they may be useful. However, such methods are only part of the overall administrative quality control pattern, they are not the pattern itself. The statistical point of view, however, is seen as having a profound effect upon Modern Quality Control at the concept level. Particularly, there is the recognition that variation in product quality must be constantly studied within batches of product, on processing equipment, between different lots of the same article, on critical quality characteristics.

Feigenbaum saw Quality Control as a means of stimulating and building up operator responsibility and interest in quality. The need for “quality-mindedness” throughout all levels is emphasised, as is the need to “sell” the programme to the entire plant organisation and the need for the complete support of top management with management recognising that it is not a temporary quality cost-reduction activity. The programme, as Feigenbaum argued, must be allowed to develop gradually within a given plant or company.

On a final note Feigenbaum stated that “in effect quality and its costs are managed and engineered and motivated throughout the organisation with the same thoroughness and depth with which successful products and services are themselves managed and engineered and produced and sold and serviced.” These type of total-quality-control programmes are highly cost-effective because of their results in improved levels of customer satisfaction, reduced operating losses and field service costs, and improved utilisation of resources.

3.8 DR KAORU ISHIKAWA

Dr Kaoru Ishikawa is best known for his Ishikawa or fishbone diagram. This cause and effect analysis was seen as a useful way of mapping the inputs which affect quality. The effect or incident being investigated is shown at the end of a horizontal arrow. Potential causes are then shown as labelled arrows entering the main cause arrow. Each arrow may have other arrows entering it as the principal
factors or causes are reduced to their sub-causes, and sub-sub-causes by brainstorming. An example of a fishbone diagram is shown in Figure 3.2.

Turning to organisational, rather than technical contributions to quality; Ishikawa is associated with the Company Wide Quality Control movement that started in Japan in the years 1955-1960. Under this, quality control in Japan was characterised by company-wide participation from top management to the lower-ranking employees. Furthermore, Ishikawa advocated the use of Quality Control audits both internally as well as externally and was quoted as saying:

"The results of these company-wide Quality Control activities are remarkable, not only in ensuring the quality of industrial products but also in their great contribution to the company's overall business."

Figure 3.2 - The Cause & Effect, Ishikawa or Fishbone Diagram
Ishikawa saw the Company Wide Quality Control movement as implying that quality does not only mean the quality of the product, but also of after sales service, quality of management, the company itself and the human being!

3.9 DR GENICHI TAGUCHI

Genichi Taguchi was a noted Japanese engineering specialist who advanced "quality engineering" as a technology to simultaneously reduce costs and improve quality [Oakland 1990].

Taguchi's methodology is concerned with the routine optimisation of the product and process prior to manufacture rather than emphasising the achievement of quality through inspection. Instead concepts of quality and reliability are pushed back to the design stage. The method provides an efficient technique to design product tests prior to entering the manufacturing phase. However, it can also be used as a trouble-shooting methodology to sort out pressing manufacturing problems.

Taguchi defines the quality of a product as "the (minimum) loss imparted by the product to society from the time the product is shipped". This loss includes not only the loss to the company through costs of rework or scrap, maintenance costs downtime due to equipment failure and warranty claims, but also costs to the customer through poor product performance and reliability, leading to further losses to the manufacturer as his market share falls. Taguchi associates a simple quadratic loss function with deviations from this target. Third loss function shows that a reduction in variability about the target leads to a decrease in loss and a subsequent increase in quality. With this conception a loss will occur even when the product is within the tolerance allowed, but is minimal when the product is on target.

The Taguchi methodology may be applied as off-line quality control in the design state or, less commonly, as on-line quality control during production. In the belief that if quality is designed into a product, on line quality control become much less important, emphasis is concentrated on off-line quality control.
Taguchi breaks down off-line quality control into three stages:

- system design;
- parameter design; and
- tolerance design

which can be described as follow:

### 3.9.1 System Design

This is the application of scientific, engineering and technical knowledge to produce a basic functional prototype design. This requires a fundamental understanding of the needs of the customer and the production environment.

### 3.9.2 Parameter Design

This includes the identification of the setting of product or process parameters that reduce the sensitivity of the designs to sources of variation. This requires a study of the whole process system design to achieve the most robust operational settings, in terms of tolerance to ranges of the input variables. This is similar to the experiments needed to identify the plant varieties which can tolerate variations in weather conditions, soil and handling.

### 3.9.3 Tolerance Design

This is the determination of tolerances around the nominal settings identified by parameter design. This requires a trade-off between the customer's loss due to performance variation and the increase in production or operational costs.

Taguchi also pointed out that a statistically planned experiment should be used to identify the settings of product and process parameters that will reduce variation in performance. He classifies the variables that affect the performance into two categories: design parameters and sources of "noise". The sources of noise are all the variables that cause the performance characteristics to deviate from the target values. The key noise factors are those that represent the major sources of variability and these should be identified and included in the experiments to design the parameters.
Statistically planned experiments may be used to identify:

- the design parameters which have a large influence on the product or performance characteristic;
- the design parameters which have no influence on the performance characteristics;
- the settings of design parameters at which the effect of sources of noise on the performance characteristic is minimal; and
- the settings of design parameters that will reduce costs without adversely affecting quality.

The use of "design of experiments" to improve industrial products and processes is not new: Tippett used these in the textile industry more than 50 years ago [Oakland 1990]. However, Taguchi has expanded the scope of these techniques to off-line quality control.

3.10 CLAUS MOLLER

Moller with his trade mark, the "Time Manager" [DTI 1991] was concerned with a "Time Management System" to help avoid situations that lead to stress, tension and failure. As part of this system, time needs to be reserved for delegation, planning and completing tasks, whatever are the competing pressures.

3.10.1 Moller's Message

Recently, Claus Moller has been turning his attention to Quality in the conventional sense [DTI 1991]. However, his earlier work, is wider in that it represents an approach to life for the individual that aims to bring fulfilment and success through the better organisation of time and tasks at home as well as at work.

Claus Moller's message is well packaged into the Time Manager loose leaf system and TMI's courses. His Ten-Point Training Philosophy is:

1. training should bring about change;
2. training is a process;
3. training is an integral part of the company's strategy;
4. training requires Management commitment;
5. training must be inspirational;
6. training is for everyone in the company;
7. training should be easily understood;
8. training should include tools and written material;
9. training should be geared to the target group; and
10. training should be holistic.

Mollers work is now concerned with Quality, starting with Personal Quality, and going on to other quality concepts. Product quality is often judged by the customer in terms of the people representing the product, and there is a need for mutual respect within the company. Underlying this is a belief that personal and organisational growth and development are inseparably linked.

3.11 A COMPARISON OF THE GURU'S
The methods advocated by the Guru's such as Deming, Crosby, Shingo and the like in this chapter, should not be read and applied in isolation, but be an integral part of Total Quality Management. Table 3.1 compares directly the various approaches of each of the guru's. The differences and similarities have been classified under eight different factors. The factors take from the requirements necessary for implementation of TQM as seen in Figure 1.3, Chapter One, Section 1.2.
Table 3.1  A comparison of the TQM elements shown by each of the Guru's

<table>
<thead>
<tr>
<th>TQM Elements</th>
<th>Deming</th>
<th>Juran</th>
<th>Shingo</th>
<th>Crosby</th>
<th>Feigenbaum</th>
<th>Ishikawa</th>
<th>Taguchi</th>
<th>Moller</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Understanding through education and awareness programmes, quality principles</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B  Commitment, policy &amp; planning</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>C  Measurement costs</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>D  Purchasing and goods received</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>E  Quality Systems, design, implementation and review</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F  Capability and control</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>G  Teamwork, involvement, problem solving</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>H  Training and education</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
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</tbody>
</table>
Table 3.1 shows that Deming was clearly in favour of an education and awareness programme as indeed did the other Guru's. He also advocated commitment from the top, ie Senior Management as they were responsible for the majority of the quality problems and advocated steps for improvement again as did Juran and Crosby and the use of statistical methods and techniques. However, he failed to consider the inspection of goods inwards and outwards as shown in Table 3.1. letter D. This was in total contrast to Crosby and Juran who advocated the use of formal surveys and that the supplier is an extension to the business and that help should be given to them to improve.

Shingo argued that zero quality control is the ideal scenario as no defects or errors are produced. This compliments the work of Crosby as he identified four absolutes of quality management one of which was the performance standard of zero defects. Shingo has total belief in the concept of breaking components, processes and like into their smallest elements and unlike the other Guru's he has concentrated his work in this area and ignored the need for commitment, measures and costs, vendors, capability and control commonly known as SPC and the requirement for training.

Ishikawa was another that failed to consider teamwork and training amongst other requirements of TQM. However, he did consider and argued that the concept of cause and effect looked at each element in turn and concluded what the effect of any action could have on its outcome and the severity of that outcome. This compliments the work of both Crosby and Shingo with Crosby noting that error cause removal should be set up to follow the collection of problems (A · F as shown in Table 3.1) and Shingo with his poka-yoke and in source inspections.

3.12 SUMMARY

The importance of the Guru's work is that each of them have recommended different concepts in the steps to the Implementation of TQM some of which contrasts and compliments with each other. However, what it does highlight is that for companies considering embarking on the route of TQM the steps of which is shown in Figure 1.3 and used as the basis for the factors to compare and contrast; the Guru's cannot be used in isolation. All should be applied as much or as little as is necessary as they are all essential elements of TQM.
Chapter Four

The Development and use of ISO 9000 Standards

4.1 Introduction
4.2 The history of the ISO 9000 standard requirements
4.3 Evolving quality standards
4.4 What are the implications for companies?
4.5 The quality system
4.6 Does a "system" need to be registered by a third party?
4.7 Summary
4.1 INTRODUCTION

In Chapter 2, Section 2.3 there was evidence [CIRIA 1996] that within industry and more specifically the construction industry there is the potential to obtain significant real benefits through obtaining registration with a third party such as British Standards Institution (BSI) to ISO 9000. However, there was also evidence, in Chapter 2, that whilst the ISO 9000 series of standards has made a valuable contribution to improving the quality of construction company’s performance although the benefits have not been as great as expected. Criticisms that have been associated with ISO 9000 tend to focus on bureaucracy, administration cost, loss of innovative opportunity and limitation to conformity rather than improvement [Bethell 1993]. Chapters 1, 2 and 3 also highlighted that to successfully implement TQM there are other requirements than the implementation of a documented management system based on the framework of ISO 9000, such as the application of tools and techniques as advocated by the Quality Guru’s and other exponents. This is further evidenced by the Business Excellence Model, Chapter 2, Figure 2.8, whereby "processes" is represented by a figure of 14 per cent out of a possible 200. This Self Assessment Model being the framework to the pursuit of excellence.

It was concluded that the ISO 9000 series of standards needs reviewing to ascertain:

- why they were instigated;
- what was their purpose;
- whether there is any correlation between the ISO 9000 standard and the messages of the quality exponents and Guru’s;
- how they have aided industry and in particular the construction industry to improve performance; and
- how it will continue to meet those industry needs.
4.2 THE HISTORY OF THE ISO 9000 STANDARD REQUIREMENTS

The standards most frequently encountered in construction work in the United Kingdom may be described under two headings, "general purpose standards" and "nuclear standards". Both general purpose and nuclear standards specify systems which will maintain and assure quality. The difference is that whereas the first category is oriented to the requirements of the marketplace, the second is aimed more at satisfying the statutory requirements imposed by regulatory authorities particularly in respect of safety. This results in a difference of emphasis, although the aspects covered and the systems specified are not dissimilar.

The focus of this research is based on the general purpose standards as these are foundation of the development of TQM in the workplace. Most standards within the general purpose category owe their origin to the AQAP series established for defence procurement purposes by the North Atlantic Treaty Organisation in 1968 [Ashford 1989]. The AQAP series was adopted by the British Ministry of Defence in 1970. A report by Sir Frederick Warner in 1977, on "standards and specifications in the engineering industries", rationalized what had become a proliferation of standards, issued by various purchasing and third party organisations into BS 5750; 1979 and formed the centre-piece of a series of standards issued by the British Standards Institution on a number of quality related subjects including metrology, reliability, measurement and calibration. Its provision were followed closely by a number of equivalent European national standards and it provided a foundation for the international standards for quality systems issued in 1987 by the International Organisation for Standardization (ISO).

The ISO standards for quality systems are known as the ISO 9000 series. This consists of three standards designed for contractual use, two guidance documents and a vocabulary of terms. The series was adopted by the European Committee for Standardization (CEN) and it now forms part of the national standards systems of the members of CEN, which includes the sixteen member states of the European Union and the European Free Trade Area. It has also been incorporated into the American ANSI/ASQC series of standards. Of the major western industrial nations, only Canada has retained its own national quality standards. In the United Kingdom the British Standards Institution reproduced the ISO 9000 series of standards as the 1987 version of BS 5750. Table 4.1 illustrates the equivalent standards in each of the member states. It is interesting to note the strong correlation between what the Quality Guru's have been advising industry throughout the world for many years on how it should manage quality and the International Standard developed by ISO. The over bearing message from
both the "Guru's" and the "Standard" is that there are no quick fixes to quality, companies need full commitment, leadership and support from top management coupled with extensive training and participation of all employees. The "Guru's" preach the same messages in their 10 and 14 step programme as the ISO Standard. These advocate the use of quality control audits both internally and externally, giving recognition, maintain momentum by making annual improvements as part of the regular systems and processes of the company, instigation of corrective actions and the use of quality control and SPC. These are all clauses of the standard in their own right.

BS 5750; 1987 follows a philosophy generally similar to that of the 1979 issue, although there have been changes in detail and wording. Many of these arose from the elimination of military terminology which had made the standard difficult to interpret in a commercial environment. It is supported by BS 4778; 1987 Quality vocabulary, Part 1 of which is identical with ISO 8402; 1980 Quality vocabulary and provides definition of 22 terms in common use in the quality context together with their equivalents in French & Russian.

BS 5750 was issued in four parts:

Part 0 Principal concepts and applications  
   Section 0.1 Guide to selection and use  
   Section 0.2 Guide to quality management and quality system elements.

Part 1 Specification for design/development, production installation and servicing

Part 2 Specification for production and installation

Part 3 Specification for final inspection & test.
Table 4.1: Quality system standards

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>International ISO</td>
<td>ISO 9000</td>
<td>ISO 9004</td>
</tr>
<tr>
<td>European CEN</td>
<td>EN 29000</td>
<td>EN 29004</td>
</tr>
<tr>
<td>United Kingdom BSI</td>
<td>BS 5750; Part 0 Section 0.1</td>
<td>BS 5750; Part 0 Section 0.2</td>
</tr>
<tr>
<td>USA ANSI/ASQC</td>
<td>Q90</td>
<td>Q94</td>
</tr>
<tr>
<td>Germany DIN</td>
<td>ISO 9000</td>
<td>ISO 9004</td>
</tr>
<tr>
<td>France NF</td>
<td>X50-121</td>
<td>X50-122</td>
</tr>
</tbody>
</table>

**External Quality Assurance**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>International ISO</td>
<td>ISO 9001</td>
<td>ISO 9002</td>
<td>ISO 9003</td>
</tr>
<tr>
<td>European CEN</td>
<td>EN 29001</td>
<td>EN 29002</td>
<td>EN 29003</td>
</tr>
<tr>
<td>United Kingdom BSI</td>
<td>BS 5750; Part 1</td>
<td>BS 5750; Part 2</td>
<td>BS 5750; Part 2</td>
</tr>
<tr>
<td>USA ANSI/ASQC</td>
<td>Q</td>
<td>Q92</td>
<td>Q93</td>
</tr>
<tr>
<td>Germany DIN</td>
<td>ISO 9001</td>
<td>ISO 9002</td>
<td>ISO 9003</td>
</tr>
<tr>
<td>France NF</td>
<td>X50-131</td>
<td>X50-132</td>
<td>X50-133</td>
</tr>
</tbody>
</table>

*Source: Ashford 1989*

4.2.1 Guidance on the Various Parts

**Part 0** - Is a guidance document. Section 01 outlines the principal concepts and offers guidelines for the selection and use of the appropriate part of the standard for different applications. Section 02 describes the basic elements of a quality system and advises on their development and implementation. Section 0.1 gives guidance on obtaining "external" assurance from suppliers or contractors, whereas section 0.2 gives "internal" advice on how to establish one's own system.
Part 1. Is for use when detailed specifications are not available and the purchaser's requirements have yet to be established or can only be stated in terms of the performance to be achieved. The supplier is expected to develop the design and to control quality throughout all stages of the work. Part 1 would thus be appropriate to Project Management contracts in which one contractor undertakes total responsibility for a project including design, construction and commissioning. They would also be applicable to contracts for the shop-detailed, supply and erection of structural steel or for the design, fabrication and installation of a hearing and ventilating system.

Part 2. Applies when the requirements of the purchaser can be stated in terms of an established design and specification but where conformances to these requirements can be adequately established only by inspections and test performed during manufacture or construction - such specifications could thus be applied to typical construction contracts let against drawings and technical specifications supplied by or on behalf of the purchaser. Other applications could include the supply of reinforcing steel or pre-cast concrete units.

Part 3. Is applicable to products of established design where conformance with specification can be established by inspection or testing in their finished state. Examples of such products encountered in the construction industry include aggregates, window glass or sanitary ware.

These quality system standards are designed for a number of uses. An organisation may, for example, decide to set up a quality system in accordance with a chosen standard in order to safeguard the quality of its work and to satisfy its own management's need for assurance that its customers are receiving the products or services which they have specified. Guidance on establishing such a system may be obtained from BS 5750 Part 0.2. However, the organisation may well find that an important part of its system will be the procedures to be followed to gain assurance that its suppliers are not jeopardizing its efforts by delivering sub-standard materials or components. If so Part 0.1 will advise on the selection of the appropriate system model (Part 1, 2, & 3) against which potential supplier's systems can be assessed or audited before a contract is entered into. The organisation may then go further and decide to make compliance with the selected quality system standard by its suppliers a contractual requirement. Having implemented all these activities, the intention is that the organisation will not only be more certain of its own and its suppliers' ability to perform, it will also be able in turn to provide similar assurance to its customers.
4.3 EVOLVING QUALITY STANDARDS
A revised version of the BS 5750 quality standard was published in August 1994.
This was the first revision since 1987, when it was adopted by the ISO as ISO 9000.

Compared with the 1987 versions, there are over 170 changes to BS 5750 parts 1 & 2. Most, however, are minor: paragraph renumbering, and clarifying or placing greater emphasis on existing text. However, some changes are important and need to be recognised as such.

Having established the same clause numbering, the key changes to BS 5750 Parts 1 and 2 were as follows:

- the use of customer "replaced purchaser", and product was defined in terms of the four generic categories of hardware, software, processed material and service. This served to emphasise that quality system requirements were essentially the same for all products;
- management responsibility required top management to be clearly involved with quality policy and objectives. It moved the focus of resources from verification to providing training and skills at all levels;
- a quality manual was required that included or referred to the documented procedures. Every clause referred to documented procedures, but it was emphasised that it is only necessary to provide sufficient quality system documentation to match the skills and training of the company’s personnel;
- all forms of contract had to be reviewed, and the procedure for communicating changes to contracts through the company had to be described;
- design control separated the need to review and verify designs, and introduced the new requirement to validate designs;
- purchasing required the evaluation of subcontractors, as well as their selection and the company had to state the methods used to verify products at a subcontractors premises;
- controlled conditions for processes included maintenance of equipment; and
- corrective action was separated into short-term and long-term actions especially in the area of data analysis.

BSI Standards has also taken the opportunity of this revision to change the numbering of the standards in order to reflect their primary source (ISO) and indicate those areas where they have been formally adopted ie the UK and Europe. The new
number is now BS EN ISO 9000.

However, to ensure a degree of continuity, the new standards have the message "formerly BS 5750 (Part 1, etc)" printed on the cover.

Compared to the above changes, the changes to BS 5750 Part 3 were major. The scope of the standard addressed much more than final inspection and test. It includes clauses on contract review, control of customer supplied product, corrective action, and internal quality audits.

4.3.1 Why have the standards changed?
It is a requirement of the ISO that all of its standards are reviewed and either revised or revalidated every 5 years. The 1994 version of the ISO 9000 series is a result of such a review.

However, this revision is part of a broader programme, the "Vision 2000", [BSI 1993]. It is part of a long term strategy adopted by the international standards committee responsible for the ISO 9000 series.

Vision 2000 calls for a programme that addresses the following elements.

- the need to correct inconsistencies and errors that have emerged in the world-wide usage of the standard;
- the need to improve the wording of the standard so that it is more easily applicable to the increasingly wide scale of usage, particularly in the non-manufacturing sectors such as service industries; and
- the need to make more significant changes to take account of the move towards the principles of total quality management.

In order to make these changes manageable, they have been split into two phases:

- the 1994 changes (which addressed the first and some aspects of the second element described above); and
- the proposed changes for 1998 (which are addressed below will complete the programme).
4.3.2. The proposed changes for ISO 9000: Year 2000

In 1997 ISO/TC 176 carried out a survey of users and customers of the QMS Standards. The survey showed that what users and customers of the standard wanted was [Quality World 1998]:

- better compatibility with ISO 14000 (the Environmental Standard);
- a common structure for standards setting out requirements and guidance for QMS's, based on a process model one standard for QMS requirements, instead of three (ISO 9001, 2 and 3), with tailoring to omit requirements for QMS, (ISO 9001) should include demonstration of continuous improvement and prevention of non-conformity;
- requirements for QMS, (ISO 9001) should address effectiveness of the system but the guidance standard (ISO 9004) should address effectiveness and efficiency of the system;
- the guidance standard (ISO 9004) should be directed at producing benefits for all parties with an interest in the success of an organisation, but the requirements standard should be customer oriented;
- the standards should be simpler to use, easier to understand and use clearer language and terminology;
- the QMS standards should be suitable for self evaluation; and
- where the previous standards were biased toward manufacturing industry and generally to the requirements of large organisations, the new standards must be suitable for all sizes of organisations, in any industry or economic sector, supplying both products and services.

In the UK, the first committee drafts of ISO 9001: 2000 (the new ISO 9000) QMS’S requirements and ISO 9004: 2000 (the new ISO 9004) QMS’s guidelines were issued in August 1998 as draft British Standard. Two significant changes from previous issues of the standard are clear. These are, a process model approach and a common clause structure of the two standards. The process model involves two major cycles which both focus on the central management activity of any type of organisation. Both cycles share measurement, analysis and improvement as a final area, serving as a feedback loop and involves extracting information from customer responses to the product and/or services provided by the organisation which are evaluated so that improvements can be made [Quality World 1998 and British Standards Institute].
The common clause structure contains a nine clause structure which groups all operational activities relating to the actual processes involved in developing, producing and delivering a product/service into one clause. All other aspects of an organisation's activities loop back toward the process management activities with use of a plan - do - check - act (which Deming recommended in Chapter 3 in his steps to improvement) cycle in the internal processes of the QMS [Quality World 1998 and British Standards Institution]. The proposed draft is also compatible with other standards such as ISO 14001.

As stated in Section 4.2.1 the standards are either revised or revalidated every 5 years and section 4.2.2 demonstrates clearly that this process is being carried out with this revision completing the "vision 2000". Much work has been carried out to this revision to the standard and it is causing a great deal of speculation with its users and customers as the early drafts indicate that the standard will meet the requirements of its users and customers and that the ISO/TC 176 listened to and has incorporated results from the survey that they carried out on users and customers of the QMS standards in 1997.

4.4 WHAT ARE THE IMPLICATIONS FOR COMPANIES?
The significance of the changes in the 1994 version was dependant upon how a company originally implemented the quality system requirements of the 1987 versions. Thus, highlighting the importance of interpretation and adopting a common sense approach when using the standards.

Companies found that the changes only served to reinforce what they are already doing, and confirm their original interpretation of what particular clauses were required in practice. This was the case where a company had worked to ensure that its BS 5750 quality system produces real value and maximum benefit for its business. However, registered companies which only just satisfied the minimum requirements of the 1987 standards would have found that they did not meet the new 1994 requirements.

The ISO 9000: Year 2000 update will not necessitate a change in the Organisations Quality Manual to match the structure of the new standard. The accreditation bodies will guide organisations to ensure a smooth transfer for already certified organisations and a transition process model is currently available to help companies. BSI's current advise is to use their customer services, their website and in-depth training in readiness for changes in the Year 2000.
4.5 THE QUALITY SYSTEM
A quality system is the organisational structure, procedures, processes and resources needed to implement quality management. The organisation's management should develop, establish and implement a quality system to accomplish the stated polices and objectives. The system should be structured and adapted to the organisation's particular type of business and should take into account the appropriate elements outlined in the ISO 9000 series. It should function in such a manner as to provide confidence that the system is understood, implemented, maintained and effective, that the products satisfy customer needs and expectations: the needs of both society and the environment have been addressed and finally that emphasis is placed on problem prevention rather than dependence on detection after occurrence.

The extent of application of a quality system applies to, and interacts with, all activities pertinent to the quality of a product. It will involve all phases in the life cycle of a product and processes, from initial identification of market needs to final satisfaction of requirements, as shown in Fig 4.1.
The philosophy of the ISO 9000 series is that in order for a company to be successful it must offer products or services that:

1) Meet a well defined need, use or purpose;
2) Satisfy Customer's expectations;
3) Comply with applicable standards and specifications;
4) Comply with statutory (and other) requirements of society;
5) Are made available at competitive prices;
6) Are provided at a cost which will yield a profit.
This is achieved by developing a quality management system which aims "to get it right first time" as shown in Figure 4.1. Client assurance requires demonstration of an organisation's capability to control the processes that determine the acceptability of the product supplied. The requirements of the Standard are aimed primarily at preventing and detecting any nonconformity during production and installation. This includes the implementation of a means of preventing its recurrence. But just how does the standard already described in great detail and its clauses interrelate to each other and how are other elements which may be found within an industry process but are not specifically referred to in the Standard fit into the overall link? In order to describe the various links and interrelationships a series of diagrammatic representations have been developed, Figure 4.2 to 4.13.

The shadowed boxes represent the ISO clause numbers, with the balance being shown as links between the various elements eg corrective action clause 4.14.
Figure 4.2 - Overall diagrammatic representation of BS EN ISO 9002 1994
Taking each of the clauses in turn a brief description of the essential features of the clauses is given in the following section. An extract from Figure 4.2 together with a description of that element and its relationship to the other clauses is then examined.

4.5.1 Management (Clause 4.1)
Management must:

- define and document its policy for quality to include its objectives and commitment to quality;
- ensure that the policy is understood, implemented and maintained at all levels;
- ensure that the responsibility, authority and the interrelation of personnel who manage, perform and verify work affecting quality is defined and documented;
- identify resource requirements and provide adequate resources, including the assignment of trained personnel; and
- nominate/appoint a member of its own management to ensure that the quality system is established, implemented and maintained; and regularly review the system to ensure its continuing effectiveness.

It is important to note here that all the Quality Guru's recognized that there was no short-cuts to quality and that improvement required full commitment and support from the top.

![Diagram of Quality Assurance System]

*Source: Hughes & Williams 1991*

Figure 4.3 - Quality Assurance
Figure 4.3 shows that management is directed via the Quality System, which management establishes and maintains via regular feedback. Control is exercised via Audit Procedures, which is a two-way process of continual improvement for the Quality System (as advocated by Joseph Juran in his 10 steps to quality improvement).

4.5.2 Quality Assurance System (Clause 4.2)

- A quality manual shall be prepared and include/make reference to the quality system procedures and outline the structure of the documentation used in the quality system;
- The organisation shall establish, document and maintain a quality system; and
- The document must be available to all personnel who have defined roles and responsibilities within it;

Figure 4.4 shows the QA system at its heart with its constituent elements feeding both to and from it. In a construction organisation the system exists at two levels. At company level are those processes and procedures which management require to be common to the whole organisation. At project level are the specific processes and procedures to operate in the unique circumstances of the project. The system must firstly be well planned and managed and secondly must produce documentary evidence of its existence and effective use. The Quality Plan is a vital element of the system but need only be as detailed as the complexities of
each particular project demands. The Quality Manual is in effect a description of the way an organisation conducts its business.

4.5.3 Contract Review (Clause 4.3)
A procedure must be included at both Tender and Pre-commencement stages to review the clients requirements.

![Diagram showing QA System, Contract Review, and Quality Plan]

*Source: Hughes & Williams 1991*

**Figure 4.5 - Quality Assurance**

Figure 4.5 shows that the procedures to be adopted within the review noted above are defined within the system. Also that the documented results specific to the project are a necessary element to assist in the compilation of the Quality Plan.

4.5.4 Document Control (Clause 4.5)
Procedures shall be included to ensure that all drawings, specifications and other quality related documents, including revisions, are properly controlled and distributed.
Figure 4.6 - Quality Assurance

Figure 4.6 illustrates the position of document control. The QA system establishes the procedures to be used and the Document Control system feeds those records relevant to the maintenance of the system back to the system to be available for inspection and audit. These records also assist management in its task of pursuing the continual improvement of the QA system noted in Clause 4.1.

4.5.5 Purchasing (Clause 4.6)

Procedures shall be established and maintained to ensure that purchased product conforms to specified requirements.

Subcontractors shall be evaluated and selected on the basis of their ability to meet subcontract requirements including the quality system and any specific quality assurance requirements.

Procedures shall also be included for the continual reassessment of bought-in resources based upon performance.

Procedures must be included to ensure that client supplied services or products, including information, also comply with the appropriate quality standard. (Clause 4.0)

Also include procedures that enable the standards and sources of products incorporated within the works to be identified and traced. (Clause 4.8)
Figure 4.7 - Quality Assurance

Figure 4.7 illustrates the nature of the resources to be purchased including those supplied by the client. The traceability element shown on the main diagram is fed back to the system via the quality records and document control.

4.5.6 Process Control (Clause 4.9)
Procedures must be included for:

- planning;
- subsequent control; and
- documentation.
Figure 4.8 shows Purchasing, Process Control and Inspection and Testing all feeding into the project specific Quality Plan. It is therefore within the Quality Plan that the documented project specific details of control of these elements will be produced. The excerpt above shows those elements of process control normally required to be catered for. Written method statements or instructions should be recorded within the Quality Records.

4.5.7 Inspection and Testing (Clause 4.10)

Procedures must be included for:

- verification of compliance with specification. These must be produced at each of the following stages;
  - upon receipt;
  - operation of the process; and
  - at completion.
• the routine checking and documentation of measuring and test equipment (4.11);

• the prevention of defective materials or workmanship being finally incorporated in the works through a system of instructions and records (Clause 4.12) and the control of non-conforming products (Clause 4.13);

• the implementation by management of corrective and preventative action in the event of actual or potential non-conformities (Clause 4.14);

• the use of documented procedures for performing, verifying and reporting that the servicing meets the specified requirements; and

• the use of statistical techniques in establishing conformance (Clause 4.20).

Figure 4.9 - Quality Assurance

Figure 4.9 links Statistical Techniques, Equipment Tests, Inspection and Test status and Non-conformance control within the area of Inspection and Testing. All of these elements would form part of the Quality Plan and have been advocated by Juran (Chapter 3, Section 3.3).
4.5.8 Handling and Storage (Clause 4.15)

Procedures must be included for:

- receipt of materials;
- identification of materials;
- inspection of materials;
- handling and storage of materials in accordance with the manufacturers' recommendations to ensure protection from damage or deterioration; and
- protection of completed work until handover.

![Diagram showing the flow of processes related to quality assurance.](source: Hughes & Williams 1991)

**Figure 4.10 - Quality Assurance**

Figure 4.10 indicates that a number of the above procedures will be common to all projects but that particular circumstances may well require project specific procedures which would then be identified and written down within the Quality Plan.

4.5.9 Quality Records (Clause 4.16)

Records must be maintained, safely stored and be accessible for verification that work has been carried out in conformance with the quality system.
Figure 4.11 - Quality Assurance

Figure 4.11 illustrates the wide variety of sources from which the Quality Records are required to be drawn. Any meaningful system must aim to make full use of these records as they form an important element of the feedback necessary for management's role in the continuous improvement and upgrading of the Quality System.

4.5.10 Audit (Clause 4.17)
A planning sequence of internal audits must be defined to ensure the effectiveness of the quality system a method advocated by the Guru Ishikawa [Oakland 1990] both for external as well as internal use. The results of the audits should be documented and the records should indicate deficiencies, corrective actions and its timing and the person responsible for such action.
Figure 4.12 - Quality Assurance

Figure 4.12 shows audit as the means of management control via the QA system and in particular the Quality Records feed back via document control to that system. It must be remembered that the audit is concerned with the operation of the system; the responsibility for ensuring that the required quality standards are attained, through use and improvement of the system, rests with management at all levels.

4.5.11 Training (Clause 4.18)

Procedures must be included to ensure that:

- personnel records are kept and are available to confirm that staff or operatives requiring particular skills have been trained, tested or otherwise checked;
- provision is made for additional training where a general or specific need is identified;
- provision is made for quality awareness training; and
- particular attention is given to new personnel.
Figure 4.13 shows management's direct input into the improvement of what is undoubtedly its most important long term resource. The development of this resource concerns management at all levels of the organisation. Procedures for training, although primarily operating company wide, can also be project specific if the needs of a project introduce particular training requirements. Again the Quality Guru's advocated extensive training and participation of all employees.

In summary there is a strong correlation between what the Quality Guru's have advocated in Chapter 3 and the ISO Standards described in this Chapter 4. One will not work effectively and efficiently without the other. The ISO Standard provides a framework for management systems, procedures and work instructions. However, it is only part of a Total Quality Management System whereby managements involve employees in a continuous process of improvement in all company activities. This systematic approach needs to be supplemented with principles, tools and techniques for cultural change and continuous improvement all of which has been advocated by the Guru's as a means best suited to process and quality control. Figure 1.1, Chapter 1, best illustrates the correlation between ISO Standards and that of the Guru's and how the work of both complement each other.
4.6 DOES A "SYSTEM" NEED TO BE REGISTERED BY A THIRD PARTY?

So does a "system" need to be registered by a third party? This is the question every company needs to consider. In Chapter 2, Section 2.3 the surveys undertaken by the National Quality Assurance Ltd [Quality World 1997] and Quality Liaison Group 1995 showed that companies wanted more from their certification bodies, for example, taking notice of their customer needs. Chapter 2 also highlighted that the reputation of ISO 9000 and its certification bodies had been tarnished by companies that believed it to be an expensive and inappropriate standard, [Bendell 1994]. However, the ISO 9000 standard is a very flexible document and common sense needs to prevail when developing a system in compliance with the standard. The standard is a "management tool" and should be seen as such. How a company develops, writes and implements the system is up to individual needs. How constraining or stringent the procedures are is again the individual companies own choice and dependent on how the clauses are interpreted. This section details the steps that are necessary in order for an organisation to register with a third party.

However, there has been much debate as to whether there is a need to register the "system" once it has been developed and implemented. This may depend on several factors:

- management decisions;
- cost;
- commitment towards quality within the company; and
- customer needs.

If management decision is taken as the first factor and is applied to the Miller Group, Chapter 5, it can be seen from their Quality Policy that each section of the Group will:

".......develop and implement quality management systems which are appropriate to its own operation and take account of the internal and external client services it provides. The Quality Management System shall be developed in accordance with the requirements of the relevant part of BS 5750/ISO 9000 or nationally/internationally recognised sector scheme - where appropriate, third party accreditation shall be obtained.........." [The Miller Group Quality Policy 1996]

This has been endorsed by their Chairman and as such is the Policy of The Miller Group. The Third Party scheme developed by ISO was designed to reduce and
even remove the need for many second party audits (assessment of suppliers or sub-contractors by clients), by providing a list of companies whose systems had been assessed and shown to be in compliance with a level of BS EN ISO 9000 commensurate with their business. The bodies that are responsible for undertaking these audits are collectively known as Certification Bodies and are themselves assessed by the United Kingdom Accreditation Services (UKAS), and given accredited status if successful. There are a number of Certification Bodies, the popular ones being BSI, Yarsleys, Lloyds and Bureau Veritas. The assurance thus provided to potential customers would mean that they may not have to audit them as well, which can be expensive both for clients and suppliers as only a small minority of assessments may lead to actual orders, if the assurance given by the third party satisfied their needs.

The auditee pays for the programme by employing a Certification Body to audit them on a regular basis. The auditee if successful in this programme is entered into the BSI Buyers Guide (if BSI is their certification Body) and is able to use the achievement of recognition in his marketing effort. The customer may use the Buyers Guide and thus reduce the number of second party audits. The supplier may not have to undergo so many audits by his customers as they had previously. If a company decides to go for third party accreditation, then the process is as shown in Figure 4.14.
Company registration
the goal

Contacts BSI QA

BSI prepares proposal

Company does work on system

Agree date with BSI for assessment

Auditors recommendation to BSI board

Board considers recommendations

Board decides
No - Company advised - reapply reassessment/cease

Yes - Company receives registration

Surveillance by BSI

NB (Assumption made that BSI is the certification body)

Source: BSI Q.A. 1996

Figure 4.14 - Process for Third Party Accreditation with BSI

However, there is the cost implication to consider. At current prices, February 1999, the cost of a Third Party Audit by BSI and maintaining registration is as follows:

NB BSI were chosen as they are considered to be the world leader by experience and number of companies registered with them.
Application Fee: £480/single site
Pre-assessment (optional): £530
Initial Assessment: £530/man days

NB This is dependant upon a number of factors for example number of employees.

**Maintenance of Certification**

Management Fee: £450/year
Continuing Assessment Fee: £495/audit (normally 3-4/year)

This is normally the draw back for many companies - the cost of registering the system and the surveillance audits. However there does seem to be a definite move towards registering a Company's system with a Third Party and more than 70,000 companies are registered with BSI in 1998. These figures were obtained from BSI and show the number of sites that have obtained certification. It must be noted that some companies may have more than one licensed site, ie Miller Civil Engineering have three licensed sites - Washington, their Head Office in Rugby and Edinburgh.

The main benefits of obtaining third party certification are that it reduces the number and extent of quality system assessments by customers and it enables an independent third party to review, guide and advise on the Quality Management System in place ensuring that it continually reflects the business needs. The benefits of implementing such a system and maintaining it will far out weigh the initial cost and incurring costs in the long term providing that there is commitment and teamwork from everyone from the top to the bottom of an organisation. As indicated in Chapter 2, research has shown that ISO 9000 has made a valuable contribution to improving the quality of a company's performance.

However, it is also perfectly reasonable to have a documented quality management system, without obtaining Third Party Certification but the Company, may then be subject to more Second Party Audits. It also depends on the demands of the customers dependent upon business needs.

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4.7 SUMMARY
The chapter has highlighted why the ISO 9000 standards were developed and that the standards play just a small part in the pursuit and implementation of TQM. The manufacturing sector major customers are using ISO 9000 as a foundation and have also developed an additional customer specific standard namely QS 9000, refer to Chapter 2. In the construction sector clients are relying on their suppliers to "self check" their work (Chapter 2 Section 2.3 refers) which by instigating ISO standards will allow them to do so in a systematic manner. However, by registering the ISO standard by a third party it gives the customers a third party independent verification by an organisation such as BSI which will provide them with extra confidence in the application of ISO standards within the organisation, at a very small outlay and maintenance cost. It is also a standard that is regularly reviewed and updated to reflect changes across all industries.
Chapter Five

**Total Quality Management in Practice**

5.1 Introduction  
5.2 Data Collection  
5.3 Methodology  
5.4 The questionnaire  
5.5 Analysis of questionnaire  
5.6 Statistical significance  
5.7 Discussion  
5.8 The three targeted companies approach to TQM: The interviews  
5.9 Proposed solutions for constructions low uptake of quality  
5.10 Summary
Chapter 5
Total Quality Management in Practice

5.1 INTRODUCTION
One of the key emerging themes in Chapter 2 was that price was no longer the
determining factor. Customers are now turning their attention to the quality of the
product or service using Management Systems, accredited by third parties, as an
assurance of that product or service meeting their or their customer
requirements. However, in order for Management Systems to be successful in
companies, total commitment of everyone including the client, staff, supervisors,
operatives and the like is required with a clear understanding of who the
customers and suppliers are.

There was also evidence that the supplier customer chain was becoming
increasingly important with a strong emphasis of each part of the chain
interrogating each other to ensure that they got the product or service they
required at the right time and the right place. However, in order to successfully
implement Management System the literary review highlighted that it requires
clear leadership and a complete culture change coupled with a system that is
flexible enough to meet unknown risks and avoids bureaucracy. It entails
providing the correct education and ensuring personnel have the right tools to do
their job and encouraging them to take responsibility for their own job ie, self-
checking and to raise the appropriate corrective actions when necessary.

However, as shown in the survey’s within the literary review there has been
criticism with the implementation of Management Systems more particularly the
ISO Standard upon which the majority of these systems are based, with the public,
perceiving the BSI Kitemark on a product as guarantee for high quality. The
standard has been branded expensive and is full of unnecessary clauses and
jargon. It was therefore concluded that the key aspects highlighted in Chapters 2,
3 and 4 and summarised in this Chapter would form the basis of the questionnaire
in which to gather tangible data on the implementation of TQM in three chosen
companies. The first company was the Miller Group, for which Miller Civil
Engineering was the Division on which the research was principally based. They
are a medium sized Civil Engineering contractor primarily working in the UK with a
turnover of £81 million. The division is based in Rugby with regional offices
throughout the UK. They operate in all sectors of Civil Engineering including
water, tunnelling, bridge and road building. They currently have contracts
between £500,000 to over £107 million. Each project is different, with different teams in different locations.

The second chosen company was British Telecom plc, a well-known international company selling a service of telecommunications, again with diverse teams operating in varied locations. The turnover is circa £16 billion. However, the research was based in their London Offices which has a turnover of circa £10 billion.

The third company was GKN Sinter Metals, a powder metallurgy company in the manufacturing sector, who are a first tier supplier to all the major automotive companies including, Ford, Rover, Volkswagen, Nissan and Honda. Their turnover is £25 million, working in the same location, with the same team, employing the same processes.

In order to validate this research it was necessary to connect the empirical data produced by research to the study's initial research questions and ultimately to its conclusions [Yin 1989]. Three criteria were considered crucial in identifying the companies. The first was that concepts of Total quality had to be studied within a range of different industries in order that best practice could be established. The second was that the companies had implemented ISO Standards and embarked on TQM concepts and principles. Lastly, the companies had to be operating in different conditions. The companies were selected on the basis of their accessibility and for meeting the criteria. A letter was sent directly to a named individual for quality outlining the scope of the research and asking if the organisation was willing to participate in the research, a meeting could be arranged, with other representatives from the company if necessary, to discuss the matter further. The organisations were positive and a visit was undertaken to discuss the research. All were willing to contribute to the research. This formed the initial interview. The identification of the organisations had been carried out by means of self-selection.

The remaining Sections of this Chapter defines the data collection, the methodology that was undertaken for this research, the design of the questionnaire and the analysis of results from the returned questionnaires and subsequent interviews.
5.2 DATA COLLECTION
The research design is the logical sequence that connects the empirical data produced by research to the study's initial research questions and ultimately to its conclusions [Yin 1989]. One of the principal purposes of the design is to help avoid the situation in which the collected data does not address the initial research questions.

The research design should therefore:

- make explicit the questions the research should answer;
- provide hypothesis/propositions about these questions;
- develop the data collection methodology;
- discuss the data in relation to the initial research questions and the hypothesis/propositions [Simister 1994].

The aim of the data collection for this research was to ascertain where each of the three companies, the Miller Group (Miller Civil Engineering), British Telecom plc and GKN Sinter Metals, were in terms of leadership, flexibility, commitment, effectiveness and competitiveness, all key components in the implementation of TQM as highlighted in Chapters 1 and 2. There are a number of research methodologies for data collections available. The first, surveys, collects data in a standardised form from samples of a population and allows the researcher to carry out statistical inferences on the data [Simister 1994]. This statistical inference, moving from the particular observations of the sample to the wider generalisations of entire populations, is a major reason why surveys are popular with researchers [Oppenham 1992]. The second form of data collection, experiments, are undertaken to measure the effects of manipulating one variable on another variable and for finding casual relationships between variables [Robson 1993]. The final form is case studies, which allow data to be collected in its rawest form. However Robson [1993] suggests that the research design of case studies has traditionally been very loose, the design often only emerging after a prolonged involvement in the field collecting data. Robson favours Yins [1989] approach in suggesting that a case study research design should be drawn up explicitly at the commencement of the research. The research design can be tailored during the research to take account of any changing circumstances that the field work throws up. The use of case studies allows a "naturalistic enquiry" [Lincoln & Guba 1985] to be undertaken, allowing the research findings to be intrinsically linked to the data. A case provides a framework within which the units of analysis are fitted [Simister 1994].
The data collection for this research was based on the third methodology, case studies, as it enabled the research findings to be linked to the data. However, Yin’s [1989] methodology of data collection was used whereby the research design, the questionnaire and interview were drawn up at the start of the research as it provided a structured approach and only limited time was available in the field collecting data.

5.3 METHODOLOGY
As stated in Section 5.2 the case study methodology was chosen as the method of data collection, of which there are two main sources of data; documentation and people [Simister 1993]. For the purpose of this research a questionnaire was developed and a structured interview was undertaken at each organisation. Each method shall now be discussed in turn. A questionnaire, the design of which is discussed under questionnaire, Section 5.4, was sent to each of the companies the number sent dependent upon size and turnover of each company. A total of 125 questionnaires were sent out and 110 returned. Miller Civil Engineering were sent 20 and 20 were returned, British Telecom 70 with 61 returned and GKN 35 with 29 returned. In order to ensure a representative mix of departments and personnel was surveyed, each company was asked to send a number of questionnaires to all departments and support functions, ie quality, accounts, procurement, administration as well as the engineering functions. Each company was to ensure that for each department/support function a Director/Senior Line Manager to the Junior Secretary was asked to complete a questionnaire. These departments were chosen because they would be common in all three companies. If the questionnaires had been sent by job title they may have only been common to one type of industry and one company and there may not have been an equivalent in the other industries/companies. For example, Site Agent is common terminology in Construction but not in Manufacturing or the Service Industry.

The questionnaire contained closed questions as objective answers were required in the initial research which was necessary to see whether a trend was occurring in the different organisations. The same questionnaire was used in a further study in the same organisations with the personnel that had been actively involved in the implementation of TQM in the organisations. These personnel had already been identified in the initial interview as described in the introduction, Section 5.1.

The Simister [1994] method of interview technique was used which combined several categories together. In this research the interview was "focused"
moving from general to specific topics: questions about the respondents' role on TQM; the timing of their first involvement; an outline of the tasks undertaken; and totally unstructured questioning. The next stage was very specific questioning based on the questionnaire to pick up points that the researcher had noted in the initial analysis of the questionnaires which had been returned from the three organisations, but had not been discussed. The aim of this research was to substantiate the responses to the questions further; to provide subjective data and to provide bias free data from the respondent.

5.4 THE QUESTIONNAIRE

The questionnaire design, see Tables 5.1 and 5.2, consisted of simple statements grouped under five main headings, leadership, flexibility, commitment, effectiveness, and competitiveness, these being the five key areas from the literary reviews as indicated in Chapters 1, 2 and 3, which are considered fundamental to the successful implementation or otherwise of TQM in organisations.

Under these five main headings a series of sub-elements were established, again based on the literary survey. For example, under commitment is the question as to whether Quality is the responsibility of the Quality Department.

The literary survey highlighted that Quality was everyone's responsibility from which tangible evidence was required as to whether this was being advocated in each of the three companies.

Alongside each statement there are three boxes headed, agree, don't know and disagree. The respondents were asked, from their experience, to tick the appropriate box alongside each heading. Upon return of the questionnaires the number of ticks under each box heading for each sub-element were added and the percentage based on the total number of returned questionnaires for each company was calculated with a brief overview. An example is given below:

Example

For leadership three respondents from Miller agreed with sub-element 1.1 "My Manager is personally involved in the quality of my work". 3/20 x 100 ≈ 15 per cent of the total number of respondents agreed with this statement.

In addition to this, individual scores for each main criteria for leadership, flexibility,
commitment, effectiveness and competitiveness was also calculated to gain an insight into the overall perception of leadership etc., in its entirety within each company. An example is given below:

Example
For leadership there was a total of 30 responses to the questions asked out of a possible 100 responses overall, i.e., 5 questions under agree, 20 questionnaires distributed. The total percentage score relating to leadership under agree for Miller is $\frac{30}{100} \times 100 \cdot 30$ per cent.

A detailed analysis of each main heading for each sub-element against the percentage of response to each sub-element and individual percentages for each main criteria can be found in Section 5.5, Figures 5.1 to 5.30

5.5 ANALYSIS OF THE QUESTIONNAIRE
The five elements of TQM that were highlighted in Chapters 1, 2 and 3, were adopted as the basis for the questionnaire. Under these five main headings a series of sub-elements were established, based on Chapters 1, 2 and 3, for example under commitment is the question as to whether Quality is the responsibility of the Quality Department. Chapter 1 and 2 highlighted that Quality was everyone’s responsibility, which was further advocated, by Juran, Chapter 3, it was decided to collect tangible evidence as to whether this was being preached in each of the three target companies.

A copy of the questionnaire and the number of responses percentage scores and a table for individual scores for each of the main criteria that were distributed to each of the companies is shown in Tables 5.1, 5.2 and 5.3. Figures 5.1 to 5.15 present bar charts that summarises the response to each main heading for each sub-element against the percentage of response to each sub-element which is further substantiated by Figures 5.16 to 5.30. Figures 5.1 to 5.3 indicated that there was little in the way of leadership with regards to TQM in Miller with limited involvement from the Senior Managers which was further substantiated by the results in Figure 5.2, sub-elements 1.1 and 1.4 and Figures 5.16 to 5.18. The results also indicated that the majority of respondents disagreed with the statement that Senior Managers believe in TQM in Miller. Within BT and GKN the results from the questionnaires indicated the reverse to this, with the majority of respondents agreeing that their Senior Managers do believe in TQM and that their behaviour is consistent with the company quality values. Figures 5.4 to 5.6 and
Figures 5.19 to 5.21 show that the three companies were comparable on flexibility with the majority of respondents agreeing that their company systems allow flexibility. However 31 per cent of respondents indicated that within sub-element 2.2 (Rules and procedures do not prevent me from meeting Customer requirements) did not know whether this was correct or not. This highlights that customers demands of a first tier automotive company do not allow for deviations from set procedures unless authorisation is obtained from the customer. This clearly shows the involvement that customers have with automotive companies and the high standard they expect from their suppliers. Figures 5.7 to 5.9 and Figures 5.22 to 5.24 show that there is a high degree of commitment within BT and GKN but significantly lower in Miller. The results also show that BT and GKN see Quality not being a function of the Quality Department whereas in Miller the philosophy, from the results of the questionnaires, is that Quality is the function of the Quality Department. Figure 5.8 demonstrates that personnel within Miller do not understand that the lack of quality ultimately costs the company money. Figure 5.10 to 5.12 show that BT and GKN undertake measures to focus on strengths and weaknesses within their organisations to strive for continuous improvement. Figure 5.11 indicates that Miller do not focus their attention on the use of such tools for continuous improvement. Figures 5.10 to 5.12) also demonstrate that within the Civil Engineering Industry the relationship between Customer and Supplier is devoid of active participation, communication and feedback. One of the benefits of implementing TQM is that it may improve a company's financial position. However Figures 5.13 to 5.14 indicate that the respondents within Miller do not appreciate the financial implication that a TQM philosophy can contribute to a company's efficient management. This may be due, as shown in Figure 5.11, to the lack of measuring that has been undertaken. It is also evident from Figures 5.14, 5.28, 5.29, and 5.30 that personnel within Miller believe that they are not given the tools and techniques to fulfil the role that they are employed to do and as a result it appears that they have found it difficult to adopt the TQM philosophy unlike BT and GKN.

5.6 STATISTICAL SIGNIFICANCE
The questionnaire, table 5.1, was divided into five sections, each then divided under agree, don't know and disagree. A summary of the results of the questionnaires are shown on pages 104-124. As the sample size was small where n<30, a t test was applied to each section to rest the efficacy of the responses.

Each sub-section for example 1.1 to 1.5 under agree was tested and then don't
know and disagree. This was applied in a like manner to sub-sections 1.5. The formula that was applied is shown below, along with a working example and finally a table of the results. The calculations shown are to a 95 per cent confidence limit. Standard t distribution tables were used with the appropriate degree of freedom. The formula that was used is given below:

\[ t\text{ test} \]

\[ S^2 = \frac{\sum x_i^2 - (\sum x_i)^2}{n-1} \]

\[ s = \sqrt{S^2} \]

\[ \bar{x} \pm t_{\alpha} \frac{s}{\sqrt{n}} \]

An example is shown below to test the efficacy of the responses to section 1, leadership, agree, sub-criteria, 1.1 to 1.5.

\[ S^2 + 75^2 + 74^2 + 93^2 + 64^2 + 81^2 - (75 + 74 + 93 + 64 + 81)^2 \]

\[ \frac{5}{4} \]

\[ S^2 = (5625 + 5476 + 8649 + 4096 + 6561) - 29954 \]

\[ S^2 = 30407 - 29954 \]

\[ S^2 = 113.25 \]

\[ S = \sqrt{113.25} \]

\[ S = 10.64 \]

therefore, \( \bar{x} \pm t_{\alpha} \frac{s}{\sqrt{n}} \)

\[ 77.4 \pm 2.776 \]

\[ 4.75 \]

therefore, 77.4 ± 13.18

upper = 9.58

lower = 64.22

* For this example \( t_{\alpha} \) is to 4 degrees of freedom.
Table 5.4 Summary of results to test the efficacy of the responses.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Agree</th>
<th>Don't Know</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>77.4 ± 13.2 **</td>
<td>20.6 ± 6.2</td>
<td>17 ± 10</td>
</tr>
<tr>
<td>Flexibility</td>
<td>63 ± 11.4</td>
<td>18 ± 7.2</td>
<td>25 ± 7.3</td>
</tr>
<tr>
<td>Commitment</td>
<td>50 ± 389</td>
<td>19 ± 5.2</td>
<td>42.5 ± 28.6 **</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>85.8 ± 9.52</td>
<td>10.4 ± 3</td>
<td>15.4 ± 7.6 **</td>
</tr>
<tr>
<td>Competitiveness</td>
<td>79.3 ± 35.2</td>
<td>12.7 ± 17.3</td>
<td>18 ± 11.0</td>
</tr>
</tbody>
</table>

By applying the t test, the results marked with asterisks call into question the efficacy of the responses as sub-criteria 1.3, 3.1 and 4.1 under agree and disagree respectively fall outside the allowable limits. By comparing these to the percentage of response, table 5.2, it is noticeable that there is a significant difference between Miller and the other two companies, BT and GKN who are closely aligned. This would substantiate the claim further that total quality management within this company is not fully understood and is not led by the managers of the company.
Table 5.1 Questionnaire

<table>
<thead>
<tr>
<th>LEADERSHIP</th>
<th>AGREE</th>
<th>DON'T KNOW</th>
<th>DISAGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 My Manager is personally involved in the quality of my work</td>
<td>3</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>1.2 I get help and support from my Manager when I need it</td>
<td>5</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>1.3 The behaviour of my Manager is consistent with the company quality values</td>
<td>14</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1.4 My Manager's Manager can be relied upon to do what he/she says, he/she will do</td>
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NB 125 Questionnaires were sent out - 110 returned
20 were sent to Miller Civil Engineering - 20 returned
71 were sent to British Telecom - 61 returned
35 were sent to GKN Sinter Metals - 29 returned

102
### Table 5.2 Percentage of response

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<th>DISAGREE</th>
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<td>MILLER BT GKN</td>
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<td>FLEXIBILITY</td>
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**LEADERSHIP - AGREE**

![Bar chart showing the percentage of response for each sub-element](image)

**Figure 5.1**
### LEADERSHIP - DON'T KNOW

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### LEADERSHIP - DON'T KNOW

![Graph showing response percentages for different sub-elements](image)

Figure 5.2
LEADERSHIP - DISAGREE

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LEADERSHIP - DISAGREE

Figure 5.3
## FLEXIBILITY - AGREE

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**Figure 5.4**

% of response to each sub-element

- MILLER
- BT
- GKN

Sub-element

107
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<td>8 13</td>
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<td>2.2 Rules and procedures do not prevent me from meeting Customer requirements</td>
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<td>2.3 Within the TQM framework I have sufficient freedom to achieve my objectives</td>
<td>3 15</td>
<td>7 11</td>
<td>5 17</td>
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**FLEXIBILITY - DON'T KNOW**

![Bar chart showing % of response to each sub-element for questions 2.1, 2.2, and 2.3.](image)

- **MILLER**
- **BT**
- **GKN**

**Figure 5.5**
The System allows me to take risks to meet Customer requirements

Rules and procedures do not prevent me from meeting Customer requirements

Within the TQM framework I have sufficient freedom to achieve my objectives

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**Figure 5.6**
3.1 The cost of quality is the expense of doing things wrong

3.2 Quality is the responsibility of the Quality Department

3.3 If something goes wrong, it is usually the fault of my supplier

3.4 My customer makes unreasonable demands about getting the job done on time

**Figure 5.7**

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Figure 5.8
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**COMMITMENT - DISAGREE**

Figure 5.9
# EFFECTIVENESS - AGREE

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![Graph](image)

Figure 5.10

113
EFFECTIVENESS - DON'T KNOW

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<td>8</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 5.11

114
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MILLER</th>
<th>% OF RESPONSE</th>
<th>BT</th>
<th>% OF RESPONSE</th>
<th>GKN</th>
<th>% OF RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 I understand what Customers expect from my team</td>
<td>7</td>
<td>35</td>
<td>13</td>
<td>21</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>4.2 My team measures performance against the Customers requirements</td>
<td>4</td>
<td>20</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4.3 My team actively uses feedback from Customers and Suppliers to help improve performance</td>
<td>9</td>
<td>45</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4.4 My team meets the agreed Customer requirements</td>
<td>6</td>
<td>30</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4.5 People in the Company take responsibility for their Customer requirements</td>
<td>6</td>
<td>30</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**Figure 5.12**
### COMPETITIVENESS - AGREE

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MILLER</th>
<th>% OF RESPONSE</th>
<th>BT</th>
<th>% OF RESPONSE</th>
<th>GKN</th>
<th>% OF RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TQM has given my Company an advantage over others</td>
<td>8</td>
<td>40</td>
<td>55</td>
<td>90</td>
<td>25</td>
<td>86</td>
</tr>
<tr>
<td>A Company inspires confidence in its Customers</td>
<td>9</td>
<td>45</td>
<td>35</td>
<td>57</td>
<td>19</td>
<td>66</td>
</tr>
<tr>
<td>I have the necessary tools to do my job</td>
<td>7</td>
<td>35</td>
<td>56</td>
<td>92</td>
<td>24</td>
<td>83</td>
</tr>
</tbody>
</table>

**COMPETITIVENESS - AGREE**

- **MILLER**
- **BT**
- **GKN**

![Bar chart showing % of response to each sub-element](image)

**Figure 5.13**

116
## COMPETITIVENESS - DON'T KNOW

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MILLER</th>
<th>% OF RESPONSE</th>
<th>BT</th>
<th>% OF RESPONSE</th>
<th>GKN</th>
<th>% OF RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TQM has given my Company an advantage over others</td>
<td>8</td>
<td>40</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>A Company inspires confidence in its Customers</td>
<td>3</td>
<td>15</td>
<td>10</td>
<td>16</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>I have the necessary tools to do my job</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

### Figure 5.14

![Bar chart showing % of response to each sub-element for Miller, BT, and GKN](image_url)
COMPETITIVENESS - DISAGREE

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>MILLER</th>
<th>% OF RESPONSE</th>
<th>BT</th>
<th>% OF RESPONSE</th>
<th>GKN</th>
<th>% OF RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 TQM has given my Company an advantage over others</td>
<td>4</td>
<td>20</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>5.2 A Company inspires confidence in its Customers</td>
<td>8</td>
<td>40</td>
<td>16</td>
<td>26</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>5.3 I have the necessary tools to do my job</td>
<td>12</td>
<td>60</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Figure 5.15
Table 5.3  Individual Percentages for leadership, flexibility, commitment, effectiveness and competitiveness.

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Don't Know</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miller</td>
<td>BT</td>
<td>GKN</td>
</tr>
<tr>
<td>Leadership</td>
<td>30</td>
<td>80</td>
<td>79</td>
</tr>
<tr>
<td>Flexibility</td>
<td>56</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Commitment</td>
<td>43</td>
<td>52</td>
<td>35</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>49</td>
<td>82</td>
<td>83</td>
</tr>
<tr>
<td>Competitiveness</td>
<td>40</td>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>

Figure 5.16 - Miller Leadership

Figure 5.17 - B T Leadership
Figure 5.18 - GKN Leadership

Figure 5.19 - Miller Flexibility

Figure 5.20 - BT Flexibility
Figure 5.21 - GKN Flexibility

Figure 5.22 - Miller Commitment

Figure 5.23 - BT Commitment
Figure 5.24 - GKN Commitment

Figure 5.25 - Miller Effectiveness

Figure 5.26 - BT Effectiveness
Figure 5.27 - GKN Effectiveness

Figure 5.28 - Miller Competitiveness

Figure 5.29 - BT Competitiveness
5.7 DISCUSSION
Section 5.5 highlighted significant differences between the three targeted companies, with flexibility being the only comparable area. Chapter 2 indicated that there were significant deficiencies and inefficiencies within the Construction Sector and the respondents to the questionnaires appear to substantiate these claims. It would be inappropriate to end the research here between the three companies without visiting the respective organisations and discussing the areas of shortfall in order to establish definitive areas of strengths and weaknesses and hence best practice.

5.8 THE THREE TARGETED COMPANIES STRATEGIC APPROACH TO TQM - THE INTERVIEWS
From the results of the analysis of the questionnaire each Quality Manager within each company, Miller Civil Engineering, BT and GKN were interviewed; The purpose of the interview was to:

• substantiate or otherwise the results of the questionnaire;
• to determine the philosophy and values within each organisation; and
• to determine the location and geographical spread to ascertain as to whether this had an effect on the implementation of TQM.

In order to collect the data and to ensure that there was continuity between the interview, the first data collection exercise and the five key themes in the implementation of TQM as highlighted in Chapter 1, Section 1.4, the questionnaire was again used as the basis of the interview along with the analysis of the results. In addition to this the steps to TQM [Oakland 1990] Figure 1.3, Chapter 1, Section

124
1.2, was also used to gather specific information in order to benchmark each of the companies which would highlight areas of strengths and weaknesses.

5.8.1 Miller Civil Engineering (MCE)

MCE are part of the Miller Group; a privately owned company that has an annual turnover of £81 million. MCE have implemented Management Systems since circa 1990 and have been third party accredited with BSI since 1992 and ISO 9001 registered since 1997.

They have a quality policy which states:

"........develop and implement quality management systems which are appropriate to its own operation and take account of the internal and external client services it provides. The Quality Management System shall be developed in accordance with the requirements of the relevant part of BS 5750/ISO 9000 or nationally/internationally recognised sector scheme - where appropriate, third party accreditation shall be obtained..........."[The Miller Group Quality Policy 1996]

The Quality Department initially in 1990 consisted of one person the Quality Manager who had been seconded from the Design Office to "write a management system in order to get ISO 9002". That person had no training in managements systems, no contact with Clients or the like in order to learn from others and no form of quality training was undertaken with other personnel. No form of cost exercise was carried out to determine whether a Management System would make the company more efficient, indeed no form of measurement was undertaken. The Management System was one large volume based exactly on the ISO standard. The culture of the company was very much bottom up. However they did achieve registration to ISO 9002 in 1992.

Since circa 1995 the Quality Department has increased to four, although there is still no representation on the Board. There is a strategy and moves are afoot to implement key performance indicators on softer issues for example absenteeism, corrective action reports, (Appendix A, B, C) as well as those advocated by Sir John Egan as members of the Major Contractors Group, refer to Chapter 2. Attendance at local forums with other contractors, academia and the like is undertaken in order to "learn and improve" from others and continuous improvement teams are actively encouraged. A rigorous training programme has now been undertaken from the basic of "why implement Management Systems?"to Quality Planning to instilling the tools and techniques of continuous improvement.
with either cross or non cross-functional teams. However the use of these are limited and are still led by the Quality Team. The setting of targets and objectives and measures for improvement, although progressing in that direction is slow and is again being led by the Quality Team. The only form of statistical analysis is on concrete.

The indication is that quality is still being paid lip-services from top management and that their participation in for example the Major Contractors Group is because their competitors are in the same Group.

The diversity of the business in terms of location, distance and different teams per project is still a problem area as there is still a learning curve that needs to be overcome on each project. MCE have seen over the past two years a greater interest in the implementation of their Management Systems especially at tender stage. Clients are undertaking audits as part of the process from moving from lowest price to reviewing other significant issues. However, the split is still 80/20 with 80 representing the lower price.

5.8.2 British Telecom PLC

BT sell a service of telecommunications with an annual turnover in London of £10 billion. BT have embarked upon the route of management systems since circa 1987 when the Chairman of BT issued the Quality Policy Statement, together with the Company Vision and Mission Statement. A Group Quality Director for BT was appointed who sat on the main board. Each division for which London is one, a Quality Department was instigated with that Quality Manager reporting to a Director.

Initially all management staff were introduced to the concept of quality by using simple models as laid down by the experts in quality Chapter 3 such as which car epitomises quality - the Rolls Royce or the Mini. The concept of quality was realized although at this stage not fully understood. People were left with the thought that quality is not synonymous with cost, but delivers to a customer a commodity to suit both their needs and pockets. In fact the mini should be and was as reliable as the Rolls Royce for any given mileage up to the manufacturers stated maximum. BT also gave each manager a one day seminar to understand the concepts of fit for purpose at the most economic cost with the courses being run by the Quality Department in conjunction with BSI. All management staff attended a two day seminar for the introduction of the Tools and Techniques of QMS with the first part concentrating on the QMS Activity Model [BT 1988] and the
second part on the tools and techniques. Following this, management staff attended a series of seminars of three days in duration where real live issues were subject to scrutiny - students applied QMS techniques to improve the throughput of a particular service. Techniques that they had learnt to date.

Following this management training, the workforce was then educated in the purpose and operation of a QMS. They were conducted within Business Unit Groups, still in multi-disciplined geographical areas. A cross-section of personnel for Business Units were inducted into Quality with their internal customers and suppliers with the courses being led by a Business Unit Manager, their Line Manager, with guidance only being provided by the Quality Department. The courses were a mixture of lectures and syndicate work. The seminars proved useful in helping people to understand who were their internal suppliers and customers.

The procedures which had been issued to all parties, tended to be written in pseudo-legal terms and some tended to be over bureaucratic. Quality Improvement Plans were instigated where non-managerial staff sought to resolve problems at the supplier customer interface. All staff were encouraged to believe that they were responsible for quality with everyone being issued a job file with processes and procedures covering all disciplines that had not been based on the ISO standard. Measures were introduced within BT in order for them to benchmark to see whether they were improving from one year to the next. Every person knew what was expected of them and felt that they at last knew what was happening which had a knock on effect to the external customer with costs for example being reduced because of greater efficiency with customers coming to expect telephones to be installed within 2 or 3 days of ordering as opposed to the 2 or 3 weeks in the past, fault clearance being reduced.

BT achieved accreditation to ISO 9001 in 1992 and the European Quality Award in 1995 which was the directive the Chairman issued in 1987.

5.8.3 GKN Sinter Metals Ltd (GKN S.M.L.)
GKN S.M.L. Lichfield, which is where the research was based, in one of twenty-three powder metallurgy companies that GKN plc own, with a turnover of £25 million.

The company has a dedicated Quality Department consisting of a Quality Manager who reports to the Operations Director, who in turn reports to the Vice President
of Operations and Technology who sits on the board of GKN Sinter Metals worldwide; a Supplier Quality Auditor, who has a two year rolling programme to audit the company's preferred suppliers; and a number of Quality Engineers who's responsibility is to discuss any concerns with GKN Sinter Metals (Lichfield) customers.

Prior to 1992 there was no policy towards TQM on the Lichfield site. The philosophy was that quality was the responsibility of the Quality Department and that they would ensure the quality of products produced. This culture was not only limited to some managers but was endemic on the shop-floor where the average time with GKN was fourteen years.

In 1992 a plan was put together by Senior Management that would be lead by them and would involve all employees. The plan was initiated by the introduction of Management Systems based upon ISO 9002. The company successfully gained accreditation in 1990 and as a result wanted to build upon this with continual measures and timing plans commonly known in the company as TQM.

All employees were taken through the devised training programme of what the TQM philosophy was, why they needed to embrace the concept and the benefits that could be gained from it. The courses were provided by the Quality Department in particular by the Quality Manager and were in house and lecture based. It was completed within 12 months.

Training programmes were put together explaining the total philosophy behind SPC again by the Quality Department and how they could be involved in reducing scrap and rework, refer to Appendix D for an example. In 1991 post process gauging, where components are measured after being produced against a specification and recorded in the form of a chart, commonly known as statistical process control had been introduced. It had been the start of the philosophy of people being responsible for their own work.

Team working and problem solving was introduced which in turn encourage people to identify issues. Other tools and techniques such as Productivity Europe [1997] meaning workshop organisation which educates personnel on house-keeping, the tools and techniques of Continuous Improvement such as Ishikawa [Oakland 1990] and the fishbone Diagram to mention but a few. Gemba Kanri and Group Technology, [Productivity Europe 1997] was introduced by an external consultant and delegates on the course ranged from the very top, the Operations
Director through to Senior Managers, Shift Managers, Group Leaders and the like. Personnel were given the time and resources by management to instigate small working parties using the tools and techniques.

GKN has actively employed the philosophy of the supplier/customer chain, Chapter 2, Section 2.1, educating people that delighting the customer does not refer just to the external customer i.e. Ford or Rover but it also means your colleague further down the process route, ensuring they do not have problems that were created by others. Ensuring paperwork is completed correctly so that administration staff can do their job without timely delays. This is how the personnel at GKN S.M.L. Lichfield have been given the “Tools and Techniques” to move forward on the road of continuous improvement where things are constantly reviewed looking at how to refine things even more. Initially all of these initiatives were time consuming when people would be training or working in teams on problems. These constraints on valuable time are needed so that the gains can be made and are eventually self financing in that by preventing problems occurring, frees up time that had previously been spent resolving problems. This can now be spent producing products. Investments have been made to reduce time spent on mundane and labourious operations such as automated SPC, where once measured the pressing of a button will record the reading on to a computerised SPC screen. In-process gauging is now used whereby the component is measured during the machining cycle, thus allowing the machine to continue unless the specification is not achieved. This also helps to reduce scrap by finding problems earlier in the process cycle.

Table 5.5 provides a comparison of three targeted companies.

5.9 A COMPARATIVE DISCUSSION OF THREE TARGETED COMPANIES
From the results of the analysis and the interviews it can be observed that, for the three targeted companies, five factors dominate the implementation of TQM in their companies and hence the focus of their continual improvement. These are:

- location and geographical spread;
- training;
- measures and target areas of improvement;
- leadership; and
- commitment.
The dominant factor of location and geographical spread is a concern in the implementation of TQM in the civil engineering sector as the products and services of their business operations are not transportable. Different teams, different working conditions and different projects varying in length of time do not encourage teamwork one which is of strategic importance in the other two industries.

The general absence of any structured training within Miller present a case for an improvement in the scope of their concerns.

Both Juran and Deming pointed to the fact in their messages and briefs that training needs to be provided and that the costs of education and training for quality will be repaid many times over by greater output. Indeed the training clause in the ISO 9000 standard states that "The supplier shall establish and maintain documented procedures for identifying training needs and provide for the training of all personnel performing activities affecting quality....." All three companies in the Case Studies have seen the wisdom in doing this with clear training programmes in place from educating personnel on the meaning of quality through to the understanding of ISO 9000 to the tools and techniques of continuous improvement. However for the likes of Miller it has been done many years after the Management System has been implemented. Only a handful of personnel had been on any specific quality training courses prior to accreditation which the author feels has been of hindrance to the company ever since.

Evidence from the analysis and interviews point to the absence of measures and targeted areas of improvement in Miller but one which is employed with success to the other two companies where measured improvement has been instrumental in the implementation and understanding of TQM in BT and GKN. Exploiting the development of such tools and techniques have provided an opportunity of improvement which Miller and the construction sector could use to minimise business risks but increase awareness.

As seen in Chapter 2, quality has to be managed - it will not just happen. The ability to meet the customer requirements is vital, not only between two separate organisations, but within an organisation and that the quality chain can be broken at any point, by one person or piece of equipment not meeting the requirements of the customer, internal or external. How many companies have put measures in place or carried out departmental purpose analysis or indeed raised a corrective action report as ISO 9000 states - all methods of continuous improvement? All
standard practice at BT and GKN but at Millers even after many years of implementing Management systems not one Senior Manager has raised a corrective action report and very few other "internal" customers and suppliers have done so!

The non-inclusion and lack of clear leadership and commitment from Senior Managers within Miller provides perhaps a consistent view of an industry that is still constrained by scepticism and legal and contractual frameworks.

The first clause of ISO 9000 states that "The supplier's management with Executive responsibility shall define and document its policy for quality. The supplier shall ensure that this policy is understood, implemented and maintained at all levels of the organisation." Leadership and commitment are the key words here with management having a policy and committing the organisation to management systems. These key words are advocated by all the Guru's especially Crosby with his first step in his fourteen steps to Quality Improvement stating "Make it clear that Management is committed to quality". This can be substantiated further by the results and analysis of the questionnaires in Chapter 5. It is in this one company namely Miller where Quality and Management Systems is seen as a public relations exercise, with little or known measurable output, with individuals having no accountability or ownership to problems. But this same company has a Quality Policy signed by the Chairman which clearly commits the company to Management Systems by stating in response to the question "Senior Managers believe in TQM" The percentage of respondents polled in the three companies 10% agreed with this statement in Millers, 89% agreed in BT and 86% agreed in GKN.

In BT and GKN the long-term commitment of their Senior Managers in terms of resource, time and lead has provided a long-term relationship with both their employees and clients which has significantly influenced the implementation of TQM in their companies and their business sectors. It has provided areas of real improvements, in process management the relationships with their customers and provided savings both in time and money which, ultimately will be a mutual benefit to all parties.
<table>
<thead>
<tr>
<th>TQM Elements</th>
<th>Miller</th>
<th>BT</th>
<th>GKN</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Understanding through education and awareness programmes, quality principles.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>• MCE now undertake training, although it has been and afterthought. • BT and GKN have instigated structured training programmes from the start involving all levels.</td>
</tr>
<tr>
<td>B Commitment, policy &amp; planning.</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>• clear commitment, values and leadership from the top at BT &amp; GKN</td>
</tr>
<tr>
<td>C Measurement costs.</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>• MCE do not undertake any kind of measurement in terms of the setting of objectives and targets. Common practice at BT and GKN.</td>
</tr>
<tr>
<td>D Purchasing and goods received.</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>• Evidence that supplier customer chain has an impact at BT and GKN.</td>
</tr>
<tr>
<td>E Quality Systems, design, implementation and review.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>• Companies are comparable on this.</td>
</tr>
<tr>
<td>F Capability and control.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>• SPC common practice at GKN with measured success. • SPC at Miller in the area of concrete.</td>
</tr>
<tr>
<td>G Teamwork, involvement, problem solving.</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>• continuous improvement teams are evident at Miller but is limited. • Time freed up at BT and GKN.</td>
</tr>
<tr>
<td>H Training and education</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>• Training and education is structured and ongoing at BT and GKN. Embarking on it at Miller. Programme in place.</td>
</tr>
<tr>
<td>Barriers to the Implementation of TQM within the Construction Industry</td>
<td>Proposed Solutions and Actions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of Leadership and Commitment</td>
<td>Senior Management to have clear, defined roles within the companies Management System. Consider Job Files with defined targets and measures.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior Management to be included more frequently on the internal audit programme.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Take Ownership to procedures.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior Management to take an active role in the deployment of the system i.e. question that method statement, perform an internal audit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accreditation Bodies to include Senior Management on their audit programmes.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding the word QUALITY</td>
<td>Take out the word quality use Business Systems or Management Systems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not base the companies system around ISO 9000 clauses.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use terminology and headings that people are familiar with.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After initial implementation a dedicated Quality Department is not needed. A co-ordinator would suffice so long as individuals have clear lines of communication, targets, ownership, accountability and are proficient in auditing techniques.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Have clear ownership of procedures rather than a member of the Quality Team.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure all staff understand the word quality and its significance within the organisation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encourage personnel to audit other departments as part of the customer supplier chain.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-conforming product</td>
<td>Instead of the non-conformance or corrective and preventive action corrective action report use the word &quot;Business Improvement&quot;.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Always include cost.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure the root cause is identified.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analyse trends.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Publicise results showing areas of improvement and non-improvement.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set clear targets and have clear action plans to meet those targets.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>Have a clear education and training programme in place before embarking on implementing systems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure all personnel attend including the very top. If they do not attend it will demonstrate a lack of commitment to other personnel and start the &quot;tip-service&quot; syndrome.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure the training programme is not a one of exercise and is developed and continued.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encourage procedural owners to present training on procedures.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers to the Implementation of TQM within the Construction Industry</td>
<td>Proposed Solutions and Actions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility of the system</td>
<td>Keep it simple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not base the company procedures on ISO standard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Have procedural owners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider the use of flow/process charts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laminate the flow/process charts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider the use of technology such as computers to make the system more accessible and to use search methodologies associated with these</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure</td>
<td>Measure, measure, measure on both soft and hard issues such as absenteeism, plant, breakdown, safety, defects etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure different department/managers take responsibility for these measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instigate improvement plans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Publicise results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forum</td>
<td>Take up membership with the like minded companies both inside and outside business sector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benchmark - but remember the European Code of Conduct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benchmark internally if your company is part of a group.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.10 SUMMARY
The chapter has employed a case study analysis and a "focussed" interview to evaluate the strategic approach of TQM in each of the three targeted companies. The analysis revealed that five factors dominate the implementation of TQM. These were location and geographical spread, training, measures and targeted areas of improvement, leadership and commitment. The evidence from the analysis suggests that Miller and hence the construction industry give little or no consideration to these factors and that location and geographical may have an influence. If the data from this analysis is compared to the thoughts of the experts in Chapter 3 and the steps to TQM Chapter 1 the following strengths and weaknesses in the implementation of TQM in the three targeted companies may be summarised.

One or two inferences could be drawn from the outcome of the analysis. First, that construction contractors give consideration to the factors of geographical spread and training, in their search for meeting their target for the implementation of TQM, however, no advantage is seen in the factors of measurement, leadership and commitment and that TQM can be implemented bottom up. Second, and the most obvious, is that these factors do not receive any attention from construction contractors in their search for continuous improvement. The evaluation model Table 5.6, highlights the cited problems in this research in the implementation of TQM within the construction industry and provides solutions to avoid unnecessary pitfalls in its pursuit of TQM. Each contractor can identify from the model where their weaknesses are and put an action plan in place. As with the Guru's they cannot be used in isolation.
Chapter Six

Conclusions and Recommendations

6.1 Conclusions

6.2 Contributions of the research

6.3 Recommendations for further research
Chapter 6

Conclusions and Recommendations

6.1 CONCLUSIONS
The motivation for this research was the need to improve the effectiveness and efficiency of the Construction Industry, and specifically the implementation of TQM within the industry. The importance of this "tool" to the long-term survival of the construction industry is self-evident. In a business environment which traditionally earned a reputation as a costly, inefficient and confrontational business, the need to improve its structure, image, education/training and R & D cannot be over emphasised. The nature of the construction industries business and the pressures it is facing has been depicted in Chapter 2 as changing from a national outlook to a global one. This change has meant that reliance on the present as the basis for the future of the industry may no longer be satisfactory. The industry needs to anticipate and shape their long-term future, while remaining flexible enough to respond to changing situations.

As a first step to improving the industries effectiveness and efficiencies of its practices, the main objectives of this research, as stated in Chapter 1, Section 1.3, was to establish the current thinking on the subject area from a state of the art review; to define the meaning of TQM and the benefits that it can bring; to highlight the structural components of TQM; to determine the benefits, if any, on selected companies that have introduced TQM; and to analyse the effects that TQM has had on the employees of such companies. An industries approach and the importance it places on the implementation of TQM is usually distracted by the importance that its clients place on it. The research was developed by using a questionnaire and structured interview approach for assessing the implementation of TQM in the three targeted companies. The rational of the questionnaire and interview was to provide evaluations that would facilitate the construction industry to move from a costly, in-efficient industry, Chapter 2, to one of improved structure and image.
The following conclusions which relate to the various objectives and hence sections of this thesis have been drawn from the research.

Objective One
Establish the current thinking on the subject area from a state of the art review - the overriding theme and conclusions that may be drawn from the current thinking is that price is no longer the determining factor. Consumers are now placing a higher value on the quality and reliability of that product or service and if that means being disloyal to home-grown industries then albeit. Companies are now competing on three issues - quality, price and delivery. Quality needs to be managed, involving everyone in the internal/external supplier/customer chain knowing that the failure to meet the requirements, in any part of the quality chain has a way of multiplying with failure in one part of the system creating problems elsewhere, leading to yet more failure.

ISO 9000 was to aid the construction industry but unfortunately has been associated with criticisms that it is too bureaucratic, costly administratively and causes loss of innovation. However, it was also significant in this review that the client within the Construction Industry has a less active role in the implementation of ISO 9000 with only a handful of client's within construction demanding that their contractors operate a quality assurance system with even fewer auditing their system. In the other two industries one has to be prepared to implement an industry standard QS 9000 developed by leading clients within the manufacturing industry and the other has a very high public profile overlooked by an industry "watch-dog" - OFTEL. Finally other conclusions that can be drawn from this review is that "partnering" with your clients and contractors will soon become the norm moving the product or service even further away from price alone and other initiatives come into being for example the BFQM Model. Companies have to be prepared to review their current business objectives and directives to see whether they will be a company for the next millennium.

Objective Two
Define the meaning of TQM and the benefits that it can bring - TQM is a way of improving the effectiveness, flexibility and competitiveness of a business as a whole. It involves teamwork, is applicable to any industry and involves everyone in the supplier/customer chain, each person and each activity affecting the other in turn. Chapters 2 and 5 highlights that for those companies that implements TQM successfully and believes in it the rewards can be tremendous. It enables a company to focus clearly on its markets, critically and continually examine all
processes to remove non-productive activities and waste, it enables effective communications and involvement and it encourages improvements and suggestions from individuals and work groups.

Objective Three
Highlight the structural components of TQM. There are three major components to TQM:

- a documented management system with the aim of providing the "operator" with consistency and satisfaction in terms of methods, materials and equipment;
- statistical process control (SPC) - this being a strategy for reducing variability whether it be variation in products, peoples attitudes, in equipment and its use and so on. However, the most significant aspect of the company-wide adoption of TQM and act as the focal point of never-ending improvement; and
- teamwork - essential for the implementation of TQM as it builds up trust, improves communication and develops interdependence on all facets of Human Resource management.

The most important factor when implementing TQM and one which cannot be ignored is the level of Management Commitment that is involved. As highlighted in Chapters 1, 2, 3, 4 and 5 without this important criteria TQM is endanger of becoming a "gimmick" with no ownership rather than an important Management tool.

Objective Four
Determine the benefits, if any, on selected companies that have introduced TQM. Within the Miller Group it has been difficult to determine the benefits that have derived from them implementing TQM as very few measures have been instigated. It has undoubtedly increased the level of team-work, identified and encouraged areas for improvement and it has enabled them to compete and successfully win some prestigious contracts as they see more of their clients move away from the traditional price only criteria. However, in the area of whether it has made them more efficient they are currently unable to quantify this. With regard to British Telecom customers can now expect to have their telephones installed 2 or 3 days after placing an order, fault clearance times have reduced and more and more services such as friends and families are being introduced to meet the ever growing demands of the consumer. All of which are used as benchmarks to see whether they are improving from one year to the next. They have undoubtedly benefited from ensuring all staff were given the right level of education and training to ensure that they understood and grasped TQM and
they ensured procedures from day one were not bureaucratic. For GKN the introduction of TQM has resulted in the reduction of scrap, customer concerns both internal and external, improved administrative efficiency and improved morale. No doubt the success of GKN has been increased with the interest of their major client(s) namely Ford and the necessity of obtaining QS 9000. However, this must not distract from the knowledge and commitment that all the employees have played in the implementation of TQM within GKN, the various educational programmes, tools and techniques and numerous measures that have been instigated to aid the transitional process.

Objective Five
Analyse the effect that TQM has had on the employees of such companies. In all three companies the implementation of TQM has encouraged an active involvement by all its employees with the introduction of suggestion schemes, work-groups, continuous improvement teams and the like. There is evidence in the case study of GKN that it has increased morale. However, there is also evidence in the survey’s that the level of commitment shown by Managers is significantly different between Miller and BT and GKN which has had, and continues to have, a detrimental affect on employees morale and attitude towards TQM in the companies more especially in Miller as the response to the survey question "Senior Managers believe in TQM" demonstrates. The percentage of respondents polled in the three companies 10 per cent agreed with this statement in Miller, 89 per cent agreed in BT and 86 per cent agreed in GKN.

Objective Six
Develop an evaluation model of solutions and actions for organisations in their pursuit of TQM. The research highlighted the problems that organisations, especially the construction industry, can and have encountered in their pursuit and implementation of TQM. The development of the model was for companies to evaluate their position with regard to each of the barriers of TQM as highlighted in the research to avoid unnecessary and costly pitfalls.

6.2 CONTRIBUTIONS OF THE RESEARCH
The research has made three main contributions. These are: the mapping out of the activities with regard to TQM in three targeted companies; identification of the focus and deficiencies in the expressed approach of TQM in the three companies; and the development of an evaluation model which should encourage a more
proactive stance for the construction industry. In addition other developments of significant contribution were achieved.

6.2.1 The New Focus for the Construction Industry
Previously very little information had been available on how the construction industry was to move from a costly inefficient business. Although reports such as those by Egan and Latham provided targets to strive for and Case Studies had been conducted, an industry wide perspective of how they would achieve them was not available. The research addressed this by providing an insight into the activities of other established industries and how forums such as the Major Contractors Group will provide the industry with the tools which in the long-term will provide useful benchmarks for contractors such as Miller.

6.2.2 Focus of the Construction Industries Approach to TQM
Having examined the focus of the three targeted companies approach to TQM from analysis of questionnaires and structured interview, the research identified key areas that the construction industry needs to address as part of an implementation plan for TQM, in order to enhance competitive advantage. Of particular significance here is the factor of measures, which was revealed to have a secondary role to the construction industry.

6.2.3 The Evaluation of the Guru's and ISO 9000 Standards for TQM
The third major contribution of the research was the evaluation of the approaches of the Guru's and of the evolving of ISO standards. Of importance here was that in order to achieve a TQM philosophy and approach the tools and techniques advocated by the Guru's could not be used in isolation and that the ISO standard provided a strong and essential basis for TQM.

6.3 LIMITATIONS OF THE RESEARCH
Current practice of the TQM approach within three targeted industries, one of which was construction, and hence companies has been characterised by a structured formal approach. However, the need to observe confidentiality in issues of current practice and the lack of interest and co-operation from some companies has meant that academic knowledge of organisational processes and the extrapolation of information that related to TQM within the construction industry, has been limited.
A further limitation is that the period of research has been over an extended period of time which has seen further developments in TQM techniques, such as the Business Excellence Model, of which the benefits and effects that this may have on the implementation of TQM have not been fully explored. The three targeted companies that were chosen to gather the evidence for this research, have continued to progress in their pursuit of excellence and this is on-going.

6.3.1 The role of the researcher
Care had to be given to potential bias as the researcher was also the researched. As Cordaro and Ison (1963) have stated, consideration had to be given to the possible effects of the experimenter expecting particular results, and the resultant consequences. It was therefore important to be aware of any potential bias as the "expectations" could distort the results and the researchers interpretation of data.

6.4 RECOMMENDATIONS FOR FURTHER RESEARCH
A number of issues have been identified from the research, for further development which could yield useful results both for academic development and practical applications to enhance the effectiveness of the construction industry.

- A key issue that came out of the review of the Miller business environment was the need for networking in a market which is increasingly becoming global. This can be achieved through the establishment of forums such as those of the Major Contractors Group. However, their use could be further extended by inviting companies from other industries in order that the construction industry can broaden their approach and style and reduce inevitable learning curves. There is currently little evidence that this option has received attention in the construction industry. The potential of such forums/alliances for enhancing the effectiveness and competitiveness of the construction contractor therefore needs to be further explored.

- There is further scope to explore the involvement that clients have with contractors during the project phase. There is evidence to suggest that some clients are asking contractors to self-certify their work, but as to what extent needs further exploration.

- The identification, development and deployment of a construction industry standard similar to that of QS 9000 could be employed by further analysing the strategic reasons for doing so in other industries such as manufacturing. This can be achieved by employing the identified factors that form the specific industry standard.
The research highlighted that contractors and clients alike are partnering and the industry as a whole is choosing this preferred method of business to improve service quality, delivery better designs, make construction safer and meet earlier completion deadlines. This is recommended for further research and development.
References


BSI · QA, 1996. How to become Registered to BS EN ISO 9000 with BSI Quality Assurance. BSI.


Clark, S., 1997. How was it for you?, Quality World, October, pp 840-842.


Holberton, S., 1990. An idea whose time has not only come but will prevail, Financial Times.


Shewhart, W.A., 1931. The Economic Control of Quality of Manufactured Product. Van Nostrand.


<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A</td>
<td>Definitive list of business and performance review to be undertaken by Miller Civil Engineering.</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Analysis of corrective actions raised during audit.</td>
</tr>
<tr>
<td>Appendix C</td>
<td>Analysis of corrective actions raised outside audit.</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Analysis of scrap value undertaken by GKN Sinter Metals Ltd.</td>
</tr>
</tbody>
</table>
## APPENDIX A
### BUSINESS AND PERFORMANCE REVIEW

### ABSENTEEISM (%)

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\text{Total number of ours absent}}{\text{Total number of hours worked}} \times 100 )</td>
<td></td>
<td>Indication of employee morale</td>
</tr>
</tbody>
</table>

- **Total number of hours absent**: Total of lost hours includes sick hours, doctors/hospital visits etc.
- **Total number of hours worked**: Total number of hours x people in Team. Overtime hours should be excluded.

### NUMBER OF EMPLOYEE SUGGESTIONS IMPLEMENTED

<table>
<thead>
<tr>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indication of employee participation level on continuous improvement activities.</td>
</tr>
</tbody>
</table>

**Number of employee suggestions implemented**: (written only)

### NUMBER OF CONTINUOUS IMPROVEMENT PROJECTS COMPLETED

<table>
<thead>
<tr>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>An indication of teamwork involvement in continuous improvement activities.</td>
</tr>
</tbody>
</table>

**Number of continuous improvement projects completed**: Number of specific projects completed by teams

### NUMBER OF ISO 9001 NON-CONFORMITIES

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Internal Audit</td>
<td>Indication of how well we are managing our management system.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Client Audit</td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>BS Audit</td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>In house</td>
<td>Number of ISO 9001 NC's: Number of NC's defined as in left hand column.</td>
</tr>
</tbody>
</table>

### PLANT BREAKDOWN

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Own Plant breakdowns</td>
<td>Indication of the reliability of our plant/hired plant.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Hired Plant breakdowns</td>
<td>Number of plant breakdowns: Number of plant breakdowns of more than 1 hour duration.</td>
</tr>
</tbody>
</table>

### SUPPLIER DELIVERY ON TIME

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\text{Total number of orders received on time from suppliers} \times 100}{\text{Total number of orders}} )</td>
<td></td>
<td>Indication of reliability of our suppliers.</td>
</tr>
</tbody>
</table>

- **Number of orders received on time**: Total number of orders received from supplier on time.
- **Total number of orders**: Total number of orders scheduled to be delivered.

### VALUE ADDED CONTRIBUTION INDEX (PRODUCTIVITY)

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Purpose of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\text{Revenue} - \text{Supplier &amp; External Service Cost}}{\text{Employment cost}} )</td>
<td></td>
<td>Indication of internal productivity</td>
</tr>
</tbody>
</table>
## Appendix A

### Business and Performance Review

#### % of Invoices Not Paid on Time

<table>
<thead>
<tr>
<th>Number of invoices not paid by due date</th>
<th>Purpose of measure: Indication of our efficiency in paying suppliers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of invoices</td>
<td>Number of invoices not paid on time: Total number not paid on time.</td>
</tr>
<tr>
<td></td>
<td>Number of invoices: Total number of invoices for the same period.</td>
</tr>
</tbody>
</table>

#### Sub-contractor Completion

| Purpose of measure: Indication of the reliability of our sub-contractors. |
| Sub-contractor completion: Number of sub-contractor jobs that failed to be completed by the agreed programme date. |

#### Number of Public Complaints

| Purpose of measure: Indicate public perception of our activities. |
| Number of public complaints: Number of complaints received. |

#### Energy Consumption Rate

| Purpose of measure: Indication of how efficiently we can manage cost of energy consumption. |
| Cost of energy: Total amount spent on electricity, gas, oil. |

#### Number of Environmental Reportable Incidents

| Purpose of measure: An indication of how environmentally safe working areas are obtained. |
| Number of environmental reportable incidents: Number of incidents that have to be reported to local authorities. |

#### Intranet Usage

| Purpose of measure: An indication of the usage of the intranet and subject area |
APPENDIX B: ANALYSIS OF CARS AND OBSERVATIONS RAISED DURING AUDITS WITHIN MILLER
APPENDIX D: ANALYSIS OF SCRAP VALUE WITHIN GKN SINTER METALS LTD

ACTION PLAN

<table>
<thead>
<tr>
<th>Ref</th>
<th>Action</th>
<th>Target</th>
<th>Progress (%)</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commence 3186 trials in Cremer</td>
<td>Feb 97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>314/445 Establish main cause of scrap</td>
<td>March 97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>544 Establish main cause of scrap</td>
<td>Feb 97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Commence 3186 in house sintering</td>
<td>Sept 97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REF PERIOD: November 97

SOURCE OF SCRAP

- S.S. FILT
- S.S. PART
- BRONZE
- CUPER
- OTHER

%AGE OF TOTAL