AN INVESTIGATION INTO QUALITY ASSURANCE WITH RESPECT TO THE MANAGEMENT OF QUALITY IN THE SOUTH AFRICAN BUILDING INDUSTRY

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I, Arthur Rory Mills, submit this thesis for the degree of Master in Industrial Administration. I claim that this is my original work and that it has not been submitted in this or in a similar form for a degree at any University.

ABSTRACT

This thesis contains a descriptive research(1) concerning the Building Industry in South Africa and Quality Assurance(1). The study identifies the Building Industry and investigates the process of quality management.

The thesis does not attempt to solve any problems in the industry but shows the need for the application of quality assurance to the industry. Through experience the author has identified this need, which is not confined to the Building Industry alone. The urgency of this need is what has prompted research in this area.

Quality Assurance (QA) is defined as a management philosophy that specifically tackles quality problems in design, manufacture and operation. It's evolution into the highly specialised management science that it is today, is discussed as well as the success it has brought to many nations. It is shown how QA is widely responsible for better products, reductions in cost and increases in productivity. QA is explained as a system designed to achieve optimisation of scarce resources, which is applicable to any industry involved in the production of goods and services.

The Building Industry which is South Africa's third largest employer, preceeded only by the Civil Service and the Mining Industry is then discussed. It is revealed as being a complex but relatively unsophisticated industry, where in 1981, 49% of annual gross domestic fixed investment was in building construction works(2). It is explained how growth in the building industry is influenced largely by monetary and fiscal policies and is characterised by fits and starts occurring in sympathy with (although somewhat delayed due to the 'pipe-line' effect) cyclical economic circumstances; during economic upswing phases, building costs rise at a greater rate than average consumer prices. Further, it is shown that there is very little control over material and labour price increases from within this troubled industry.

The Building Industry is often cited as being the most cost inefficient industry in the economy.The efforts of the Building Industries Federation of South Africa (B.I.F.S.A.) who for some time have put great effort into a nationwide 'loss-control' programme to improve the costs situation, is discussed. It is discussed how the industry is characterised by a critical shortage of skilled labour, and how employment in the industry follows the business cycle quite closely. These two factors are seen to render the labour situation quite unstable and to affect productivity adversely. At the end of 1981, BIFSA decided to invest R50m of its funds in a training programme to increase the number of artisans and improve productivity. Nothing has yet been done by them from a quality management aspect.

Questionnaires, interviews and other researched information show that few managers in the Building Industry are familiar with the principles of quality assurance. It is seen that many regard it with suspicion as yet another 'new-fangled' system that will increase costs. It is concluded that this misconception and the stigma attached to the term 'quality assurance' are not helping the quality conscious clients in the industry nor the institutions such as the S.A.B.S. and others engaged in promoting QA in industry. Today we see that many quality management consulting organisations have sprung up in the R.S.A. because of the sudden awareness of and need for Q.A. The author feels that too few have responded with the level of expertise required to introduce QA to a 'virgin' country in the desired manner.

It is shown that there is gross ignorance amongst professions and contractors on the subject of quality and its management. With this unhealthy predicament and that of cost, labour and productivity added to the volatile nature of the industry, it is argued that no manager, be he design consultant, contractor, manufacturer or of a controlling organisation such as BIFSA, can ignore his changing environment and the management techniques and tools that are currently being developed around him to meet these changes. This thesis concludes that the Building Industry needs to become aware of quality management principles and to implement QA without delay.

This thesis is not intended to cover the entire QA "mission", but a strategy is identified and recommendations for its implementation are made.

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GLOSSARY

APPROVAL	An act of endorsing or adding positive authorisation, or both.
ATTRIBUTE	A qualitative characteristic of an item (as opposed to a quantitative or measurable characteristic).
AUDIT	An activity to determine through investigation, the adequacy of and adherence to established procedures, instructions, specifications, codes and standards or other applicable contractual and licensing requirements and the effectiveness of implementation.
AUDIT	A documented activity performed in accordance with written procedures or checklists to verify by examination and evaluation of objective evidence, that applicable elements of the quality assurance programme have been developed, documented and effectively implemented in accordance with specified requirements.
CHARACTERISTIC	Any property or attribute of an item, process or service that is distinct, describable and measurable as conforming or non-conforming to specified quality requirements. Quality characteristics are generally identified in specifications and drawings which describe the item, process or service.
COMPONENT	A piece of equipment such as a vessel, piping, pump, valve or core support structure, which will be combined with other components to form an assembly.

CONFORMITY	The ability of an item to meet a stated performance and/or characteristic, the assessment of which does not depend essentially on the passage of time.
CONTRACTOR	Any organisation under contract for furnishing items or services. It includes the terms vendor, supplier, sub-contractor, fabricator and sub tier levels of these where appropriate.
CUSTOMER (CLIENT)	The organisation doing the buying. The ultimate owner of the plant or structure.
DEFECT	Any non-conformance of the unit or product with specified requirements.
DEFECTIVE MATERIAL	A material or component which has one or more characteristics that do not comply with specified requirements.
DESIGN REVIEW	The independent evaluation of design work performed by an individual or group not involved in the original design.
DOCUMENTATION	Any written or pictorial information describing, defining, specifying, reporting or certifying activities requirements, procedures or results.
EVALUATION	An appraisal to determine whether or not production and quality control systems are capable of producing quality products, data systems, or services; and generating evidence that support decisions of acceptibility.

EXAMINATION	An element of inspection consisting of investigation, without the use of special laboratory appliances or procedures or supplies and services to determine conformance to those specified requirements which can be determined by such investigations. Examination is usually non-destructive and includes simple physical manipulation, gauging and measurement.
INSPECTION	The actual act of verifying the conformance of a material, structure, component or system to its requirements.
MANUFACTURER	One who constructs any class of component, part or appurtenance to meet prescribed design requirements.
MATERIAL	A substance or combination of substances forming components, parts, pieces and equipment items.
NONCONFORMANCE	A deficiency in characteristics, documentation or procedure which renders the quality of an item unacceptable or indeterminate.
OBJECTIVE EVIDENCE	Any statement of fact, information, or record, either quantitative or qualitative, pertaining to the quality of an item or service based on observations, measurements or tests which can be verified.
PROCEDURE	A document that specifies or describes how an activity is to be performed.

PROCUREMENT DOCUMENTS	Contractually binding documents that identify and define the requirements for which items and services must meet in order to be considered acceptable.
STORAGE	The act of holding items at a construction site or in an area other than its permanent location in the plant.
SUPPLIER	Organisation that supplies hardware systems.
SURVEILLANCE	Witnessing or monitoring on a statistically sound basis of processes systems and operations.
SYSTEM	A group of sub-systems united by some interaction or interdependence performing many duties but functioning as a single unit.
TESTING	The determination or verification of the capabilities of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental or operating conditions.
TRACEABILITY	A system that provides the means of identifying the historical evolution of any process of a product or document.
VENDOR	Organisation that provides components or smaller systems.
VERIFICATION	An act of confirming, substantiating and assuring that an activity or condition has been implemented in conformance with the specified requirements.

CHAPTER ONE

QUALITY AND QUALITY ASSURANCE

1. INTRODUCTION

In this chapter, the process of management is described and at the same time, an attempt is made to show the significance of the quality problem to modern management. The development of the modern management approach is discussed, revealing the emergence of a quality management system in management.

The quality function is then defined with a strong emphasis on the economics of quality. The reader is introduced to a management situation when management is either in control or out of control, and a process of movement from the former to the latter states exists, called "breakthrough". This process is described and is followed by a discussion on the concept of quality assurance.

A description of quality costs, their categories and their optimisation then follows, concluding with a brief discussion of the company wide quality control concept and quality circles (both Japanese in origin).

The reader is requested to bear in mind that this chapter is intended for the layman to quality management and the author advises that such a reader be adequately introduced to its principles contained in this chapter, so that he may follow, more easily, the discussion and arguments that follow. Specialists in quality management, need not therefore, dwell upon this chapter.

1.2 QUALITY MANAGEMENT

All human institutions are engaged in providing products or services to human beings[3]. These goods and services are designed to respond

to the overall needs of the users. In order to meet these needs and the goals of the producing organisation, an efficient production system has to be developed, i.e.: an effective employment of the appropriate available resources (input) for a given unit of output. Elwood S. Buffa of the University of California, Los Angeles, says: "In a given production system, successful management depends on plans, an information system concerning what is actually happening, and how we react (make decisions) to changes in demand, inventory position, schedules, quality level, and product and equipment innovation. In forming plans for the operation or management of a particular system, we are adjusting to allocate the available resources in the most effective way for a given forecast of demand. The resources are units of productive capacity"(4). The units of productive capacity spoken of here are units such as number of man-hours available at a regular time and overtime, available inventories, sub-contracting, as well as negative capacity such as shortages and backorders, rejects and reworked items. The construction of a production plan recognises the costs of these capacities and attempts to minimise the sum of all costs over some future time span. Buffa adds: "In attempting to meet the objectives of the plan, certain realities interfere, such as equipment failure, human error, discrepancies in the timing of order flow, quality variation and so on. Therefore, systems for scheduling maintenance, quality control and cost control are invented to help retain order where otherwise the system would naturally tend towards chaos"(4). Buffa describes here how as a logical progression of the development of production management systems, the control of quality has emerged as an important control alongside that of cost.

Over the years as needs change and available resources dwindle, more sophisticated methods of production are devised with the aid of rapidly advancing technological breakthrough and innovation. Managers are faced with the increasingly difficult task of coordinating, planning, controlling and organising the complex activities of their organisation. It is required of them to look closer at and examine more deeply the processes and controls of management and develop more of them. Their aims will be to achieve systems of greater efficiency, cut costs, increase turnover and market share, carefully select products designed to meet users needs

and result in the maintenance of a good image of one's name in the market place. The results - new techniques and processes of management and the development of new technical management systems.

"Management has been popularly defined as 'getting things done through people', and for thousands of years, this has been the key to success for individuals and civilisations alike"(5).
From the dawn of civilisation to the Industrial Revolution, civilisations such as the Sumerians, in business and taxation; the Babylonians, in the managerial guidelines provided by Hammurabi's Code - and construction projects such as the Hanging Gardens of Babylon under Nebuchadnezzar's rule, and production control; The Chinese civilisations being strong on military management and the Romans, in Diocletian's streamlining and re-organisation of the Roman Empire in A.D. 284, were all examples of the development of managerial systems in early civilisations. The Roman Catholic Church made significant contributions to management theory in the areas of the hierarchy of authority, specialisation of activities along functional lines and the staff concept. In the early 16th century, Niccolo Machiavelli established four principles of leadership and by the time the Industrial Revolution was underway, production economics was recognised by Adam Smith, followed by the emergence of the factory system in the mid 1700's. Charles Babbage augmented Smith's observations round about the 1830's, then Frederick W. Taylor introduced a new philosophy, having a direct influence upon the development of production management. "He stated that the scientific method could and should be applied to all managerial problems and that the methods by which work was accomplished should be determined by management through scientific investigation"(4). Taylor's followers were numerous: Carl Barth, Henry L. Gantt, Harrington Emerson, Frank & Lillian Gilbreth - all working within Taylor's general framework and philosophy.

Buffa identifies the development that followed as: " The present upsurge in activity in the general field of production was preceded by two developments in the 1930's, which helped lay the groundwork and point the way for the future. These were the development and introduction to industry of statistical quality control by Walter Shewhart in 1931 and the development in 1934 of work sampling theory (a sampling procedure to

determine standards for delays, work, time etc.,) by L.H.C. Tippet, working in England. Statistical Quality Control concepts grew rapidly and application of these probability concepts to the control of product quality became fairly general, especially with the onset of the Second World War"[4] (Refer to Fig. 1). Mathematical and computational techniques, developed to meet wartime production operations, trickled over into industrial use after the war. The computer appeared as a powerful tool in its own right and with it, simulated production systems and models were developed.

Buffa continues: "Only in the last twenty years have we begun to evolve principles that make it possible to design facilities and control systems with some degree of predictability as to their performance. Where we stand today in terms of production management as an applied science, is at the threshold of the rapid development phase. Increased knowledge about some particular field is often related to a growth and saturation curve, where initial developments are slow and difficult. As bits of knowledge fall into place, the rate of growth accelerates to the rapid developmental phase and finally levels off as it approaches saturation level. In the years to come the scope of the problems for which we can find provable optimal solutions will increase. The theory of production systems will be pervasive and will embrace integrated systems as a whole, not just segments of a system; our ability to design facilities and control systems with predictable characteristics will increase"[4]. Refer fo Fig. 2. "The basic principles of production economics and facility design and control are as applicable to the small organisation as to the large. Implementation of these principles, however, must change with the size and financial strength of the organisation. Production management is a set of general principles for production economics, facility design, job design, schedule design, quality control, inventory control, work measurement, and cost and budgetary control"[4].

J.M. Juran, author, lecturer and consultant in management[3] says the term "Quality Control" began to be used as a synonym for defect prevention in the early 20th Century. In the 1940's and 1950's, he says, there was a wave of enthusiasm for the use of statistical methods in quality control. Juran continues to say that as a result of the limiting approach

statistics had for the quality control regulatory process, new terms such as 'Total Quality Control' were coined to de-emphasise this limiting approach, restoring the concept that a broad collection of tools is needed for regulation, not purely statistics. This occurred in the late '50's, to be followed by additional confusion in the '60's when a trend to quantify reliability and related concepts developed. Motivational programmes, often called "Zero-Defects", implying that sufficient motivation would lead to zero defects, also developed and gained widespread publicity. At this point, the term Quality Control is used to mean broadly, a regulatory process.

Up to this point in this first phase of the study, it has been shown that one of the management systems that have been developed during Elwood S. Buffa's 'rapid developmental stage' is the Quality Management System. It is one of the general principles developed for production economics that deals with the control of quality. The principal universals of this quality function are defined next.

1.2.1 Quality - Fitness for Use

The relationship of human institutions to human beings through the provision of products and services by the former to the latter, is only constructive if the goods and services respond to the overall needs of the user in price, delivery date and fitness for use. If the goods and services do respond to these needs, they are said to possess marketability or salability. This fitness for use, according to Juran, is one of the most vital and far reaching concepts in the quality function: "Among these overall needs, the extent to which the product successfully serves the purposes of the user during usage, is called "fitness for use". This concept of fitness for use, popularly called by such names as 'quality', is a universal concept, applicable to all goods and services"(3). Notwithstanding the characteristics of fitness for use, there exists a common misconception amongst managers today, of the meaning of the word "quality". Philip B. Crosby, an American Corporate Vice President(5), lists five erroneous assumptions made by managers in general, of quality:

1. Quality means goodness, or luxury, or shininess or weight.
2. Quality is intangible and therefore not measurable.
3. There is an "economics" of quality.
4. Quality problems are originated by the workers, particularly those on the manufacturing area.
5. Quality originates in the quality department.

Crosby goes on to provide the correct interpretations for each of the erroneous assumptions.(5):

1. Quality is defined as being "Conformance to requirements". "Requirements must be clearly stated so that they cannot be misunderstood. Measurements are then taken continually to determine conformance to these requirements. The non-conformance detected is the absence of quality."
2. "Quality is precisely measurable by the oldest and most respected of measurements - cold, hard cash." Quality is thought of by management as "goodness" and is regarded with much emotion, without the pursuance of logical actions to attain real quality. "Quality is measured by the cost of quality, which is the expense of non-conformance - the cost of doing things wrong. These costs are divided into prevention, appraisal and failure categories. But they are all a result of not doing things right the first time."
3. "Economics of Quality" has no meaning. This is the argument that managers might put across saying that they cannot afford to make their product or service 'that good', indicates that they do not understand quality. "It is always cheaper to do things right the first time."
4. "People in the shops work as well as they ever did and much more productively than in the past." Crosby infers that the greater number of quality problems originate from management. He claims that it is easy to create a situation where workers contribute to problems, but the planning and creation of this situation or problematic environment is done by management, and it is this area that requires attention.
5. Crosby elaborates on the effects of the involvement in the creation, production, marketing and managing of a company's product or service, by modern professional quality managers as one that will destroy the vital objectivity of their work. To become involved, one tends to

overlook problems; to become objective, one tends to look for potential problems.

A.V. Feigenbaum, President of the A.S.Q.C. and Manager of Manufacturing Operations and Quality Control for General Electric, New York, defines the meaning of the word "Quality" in industry, as "best for certain customer conditions"(6). He describes the two most important of these customer conditions as: 1) The actual end use, and 2) The selling price of the product. Additional customer conditions are: 1. the specification of dimensions and of operating characteristics, 2. the life and reliability objectives, 3. the manufacturing and engineering costs, 4. the production conditions under which the article is manufactured, and 5. the field installation and maintenance objectives. Feigenbaum states, "It is neither practical nor economical for these conditions to have perfection as their aim. The aim is rather the level of quality that establishes the proper balance between the cost of the product and the service that it renders." Feigenbaum's definition of Product Quality is; "The composite product characteristics of engineering and manufacturing that determine the degree to which the product in use will meet the expectations of the customer"(6). It may therefore be reasoned that the customer's expectations are that the product will be fit for use and in being so, will conform to the conditions that he has laid down. One could then conclude that such a product could be regarded as a 'quality product'. This conclusion would only be satisfactory if the customer was fully aware of the quality parameters and quality characteristics associated with the use of his product. Should the customer be enlightened as to these concepts, he would then be able to recognise and select his own conditions, emphasising some more than others, so that he would achieve the satisfaction of knowing that he has attained a quality 'optimisation'. Should the customer be ignorant of these concepts, it would be incumbent upon the producing organisation or its marketing department, to ascertain the relevant quality characteristics and levels of quality associated with their product, during its end use.

1.2.1.2 Characteristics of Quality. The foundation upon which fitness for use rests is the 'Quality Characteristic'. Any feature, property or attribute of the products, materials or processes which is needed to achieve fitness for use, is a "Quality Characteristic":

1. Technological characteristics, eg: hardness, inductance, acidity
2. Psychological characteristics, eg: taste, beauty, status
3. Time-orientated characteristics, eg: reliability, maintainability
4. Contractual characteristics, eg: guarantee provisions, warranties
5. Ethical characteristics, eg: courtesy of sales personnel, honesty of service shops.

These quality characteristics may be further sub-classified into useful categories called parameters of fitness for use: Quality of Design. Quality of Conformance. The 'abilities" (such as reliability, maintainability, producibility). Field Service.

1.2.1.2.1 Quality of Design. J.M.Juran(3) says that because of the imbalance between the high level of human needs and the variable level of human affluence, different levels of excellence of products and services have been created and recognised. Each of these levels of excellence is called a grade, where the difference in grade is a difference in quality of design - design to meet a human need. "Grade is a non-technical term meaning a certain level of quality relating also to a level of fitness for use and a level of affluence. Quality of design is a technical term, being a composite of three separate steps in a common progression of activities: 1) Identification of what constitutes fitness for use - (the result of market research), 2) Choice of a concept of product or service to be responsive to the identified needs of the user - (quality concept), 3) Translation of the chosen product concept into a detailed set of specifications, which, if faithfully executed, will then meet the users needs." Juran calls the total progression composed of these three activities - the quality of design - (Quality of Market Research + Quality of Concept + Quality of Specification).

1.2.1.2.2 Quality of Conformance. Since the design must meet the requirement of fitness for use, and the product must conform to design, Juran calls the extent to which the product quality conforms to the design - 'quality of conformance'. Quality of conformance is the result of numerous variables such as machines, tools, supervision, workmanship etcetera.

1.2.1.2.3 The Abilities. For products with a long life span, time orientated factors such as availability, reliability and maintainability need consideration:

1) Availability concerns continuity in the industrial process, continuity of service from sources of energy, communication, transport, water etcetera, minimising failure rates of products and prompt restoration of service in the event of failure. Continuity of service as Juran says, is recognised as a parameter of fitness for use, and is time related and measured by the extent to which the user can secure service when he wants it. Juran expressed availability mathematically, by the ratio[3]:

$$\frac{\text{uptime}}{\text{UPTIME + DOWNTIME}}$$

and in equivalent terminology:

$$\frac{\text{mean time between failures (MTBF)}}{\text{MTBF + mean time to repair (MTTR)}}$$

2. Reliability can be defined as being 'the probability of a product performing without failure a specified function under given conditions for a specified period of time.' If products never failed, availability would be 100%. Juran terms 'freedom from failure', which is a sub-parameter of availability - reliability. Reliability is determined largely by the quality of design.

3. Maintainability concerns the need for continuity of service, especially for long-life products. It takes place in two ways:

a) Preventive or scheduled maintenance consisting of checks to detect potential failures, scheduled servicing (eg. lubrication) and planned overhauls plus replacement of worn or failure-prone parts.

b) Unscheduled maintenance consisting of restoring service in the event of failure.

1.2.1.2.4 Field Service. The user's ability to secure continuity of service after the sale/purchase of the product, depends largely on some service organisation which should provide clear unequivocal service contracts, establish adequate repair equipment capacity and supplies of spare parts, recruit and train a service force competent to diagnose and remedy failures, provide prompt response to service calls and conduct its affairs with courtesy and integrity. Juran calls this 'Field Service'. It

may also be referred to as after-sales service, sales service, customer service or just service. Field service relates to activities carried on after the sale and is performed by organisations regarded as service industries rather than manufacturing. (Refer to Fig. 3, for J.M. Juran's Tree of Interrelationship amongst Parameters[3]).

1.2.2 The Quality Function

It is important to note that quality of design differs from quality of conformance in the respect that "higher quality of design can be attained only at an increase in costs, whereas, higher quality of conformance can often be attained with an accompanying reduction in costs"[7].
Furthermore, when a purchased product turns out to be not fit for use, this knowledge is communicated (most often) from the consumer to the producer. A keen producer invites this feedback since it provides him with the knowledge needed to achieve fitness for use. However, in today's industrial societies, for any one product, the activities of design, production, sale, use etcetera, are carried out by numerous people, many of them from different organisations, often widely dispersed geographically. Few of these people may be conscious of the effect that their contribution has on the real goal of fitness for use. These people are consequently provided with a 'substitute goal' as Juran calls it - which is the specification. For materials, processes, products, tests, maintenance etc., and associated activities which contribute to fitness for use, specifications do exist and are used to assist these people in the achievement of this real goal. In order to attain this goal, a number of activities are to take place in a logical progression. J.M. Juran has put these into diagrammatic form which he calls his Spiral of Progress in Quality:
[3] (See fig. 4). The increase in the height of the spiral reflects an increase in quality (progress of quality). Each turn of the spiral represents a closed-loop system (one that utilises feedback for improvement), but because of the positive feedback, successive loops are on higher levels, indicating progress in quality. The spiral indicates the wide range of individuals or organisations involved in the cause, albeit that because they are concerned with multiple functions they have multiple

goals as well - they nevertheless fall under the collective title - The Quality Function.

In paragraph 1.2.1, Feigenbaum regards "perfection" as an aim of manufacturers to meet customer conditions as impractical and not economic and recommends that the aim should rather be setting a level of quality that establishes the proper balance between the cost of the product and the service that it renders. Bearing this in mind, it is necessary to consider the two main aspects of quality in order to understand the concept of quality economics better. The two main aspects of Quality are Quality of Design and Quality of Conformance. In paragraph 1.2.1.2.1, the quality of design is described as defined by Juran, who refers to it as a 'grade' meaning a variation in specification for the same functional use eg, 'Cadillac' vs. 'Volkswagen'. The basic functional purpose of a product is usually very clear, but the additional requirements normally imposed on the products are what ultimately determine the grade and therefore the quality of design. In consequence, quality of design is seen to be the degree to which the design meets the requirements.
Once having chosen the level of quality, or having selected a design to meet requirements, the large task of managing the operation so that the quality levels are achieved or the specifications are adhered to, is then to be undertaken. This is the business of keeping the standards and meeting the specifications and is called quality of conformance. The important aspect to consider here is that quality of conformance costs nothing even though at times it might be difficult to achieve, but that non-conformance is costly.
In conclusion, to set too high a level of quality - that is: setting the 'Cadillac' levels on products aimed at consumers who require only 'Volkswagen' levels, is costly in terms of money wasted. It is far better to have a 'Volkswagen' without any defects than to have a 'Cadillac' riddled with them.

1.2.2.1 The Economics of Quality. When a manufacturer or producer enters a particular market, he has to achieve what Juran calls "the basic quality mission", which is to meet the requirements of the market (his customers' requirements). Furthermore, in order to achieve this mission and to stay in business, the producer or manufacturer has to meet the

price requirements while making a profit. The manufacturer consequently reconciles the value of quality with its cost in order to achieve an optimum quality cost/value relationship. (Refer to "Economics of Quality of Design " Fig. 5).

From this figure, it can be seen that perfection can never be reached; that the closer we get toward perfection, the higher will be the cost of achieving that level of quality; that at a particular point nearing perfection, the cost of quality will become higher than the value of quality - at which point quality becomes uneconomical. It becomes the task of the quality conscious manufacturer to find the optimum quality level within this framework of requirements imposed upon him by the market. The optimum quality level is, as can be seen in the figure, the position where the difference between the value of quality and the cost of quality is at its greatest in a positive direction. J.R. Bruneau, quality consultant in South Africa, says of this position, that "this is a balance which taxes the ability of even the best and greatest business minds. The difficulty is in the intangible facets which affect both the value of quality and the cost of quality".

Bruneau continues, describing how 'Quality of Design' addresses the problems of "getting into the correct 'ball-park' area" and how 'Quality of Conformance' addresses the problems of "Staying in it". The value of a given product may be seriously affected by poor conformance to design, however, the value is affected primarily by the design itself. The cost of quality and the optimum difference between value and cost, is determined firstly by the design. Bruneau says that the level of quality of design is aimed not so much at the basic function, but more at the specification. He cites the example of a Mini and a Rolls Royce, in the same way as Juran analogised using a Volkswagen and a Cadillac - that perform the same basic function of transporting people from A to B, but that by specification and hence by design, they are vastly different and, accordingly, the cost of quality bears no comparison. The economics of quality in this example are simply that if we wish to enter the mini market, we should not design a Rolls Royce and vice versa, and having designed the product, we should then conform to the design.

Because of the human element, the fallibility of human beings, the cost of failure also has to be considered. Failure costs money and to minimise this expense, money has to be spent in order to save on failure costs,

and to implement a quality management system to do this saving. This immediately brings to light the economics of conformance in that the cost of failure and the cost of implementing a quality management system, may be juggled to achieve an optimum total quality cost. Figure 6 "Economics of Quality of Conformance" indicates that total quality cost is at its lowest where the curve of failure cost and the curve of quality management system cost cross each other. As with the delicate balance of the value and cost of quality, so also is the delicate balance arriving at an optimum total quality cost very hard to achieve.

1.2.2.2 Control of Quality

J.M. Juran[3] defines control as: "The process through which we establish and meet standards - ie. observing our actual performance, comparing this performance with some standard, and then taking action if the observed performance is significantly different than the standard". The essence of control is the feedback loop and the process of control consists of a series of steps in sequence, which for quality, is as follows:

1. Choosing the control subject ie. selecting what is to be regulated.
2. Choosing a unit of measure.
3. Setting standards ie. setting a standard value or goal for the control subject such as determining the required cost-quality, performance quality and reliability quality standards for the product.
4. Choosing a sensing device which can measure the control subject in terms of unit of measure.
5. Conducting the actual measurement of performance.
6. Interpreting the difference between actual and standard or appraising conformance.
7. Decision making and acting on the difference, (if any).
8. Planning for improvements - developing a continuing effort to improve cost, performance and reliability standards.

Quality Control may now be seen as Juran defines it - "the regulatory process through which we measure actual quality performance, compare it with standards and act on the difference ". Quality improvement, (finding ways to do better than the standard), and quality planning, (launching

new products, processes etc.), are activities that may be followed in order to prevent quality problems from happening.

A.V. Feigenbaum[6] defines quality control as being "the broad administrative area of developing, maintaining and improving product quality" and continues to list benefits that may be expected from an overall quality programme:

1. Improvement in product quality
2. Improvement in product design
3. Reduction in operating costs
4. Reduction in operating losses
5. Reduction in production-line bottlenecks
6. Improvement in employee morale.

From this, it may be concluded that to implement a system of quality control in one's organisation, is sound management practice. Managers are generally required to work within budgeted profit margins, time schedules and to meet specification requirements. Being aware of what the manager is required to do is a small part of his 'problem'. Knowing what he is doing is another, in other words, measuring the results of his actions. One of the most important aspects of management follows in being able to regulate what he is doing so that he meets his goals. Juran says that the manager who meets all the management parameters listed above, is in a state of 'self-control'. Realistic goals are usually set based upon accepted standards. Through streamlining operations, technological changes and advancements and sheer determination, standard levels that were established as goals, may be surpassed. Juran calls this 'new superior level of performance' a "breakthrough": 1. A superior level of performance has been reached and is one that has never previously been attained.

2. The change is a result of human determination to set a new record, and is not the result of luck or chance.

(See Fig. 7).

Juran lists a sequence to be followed for this breakthrough - the universal series of steps to be followed are:

1. Proving that breakthrough is needed and creating an attitude which is favourable for embarking on a programme to attain this breakthrough.
2. Identifying the vital few projects which justify the effort for improvement.

3. Organising to secure the knowledge needed to take effective action through providing the means for:
   a. guiding and coordinating work on the projects
   b. conducting the detailed study and analysis
4. Actual conduct of the analysis or diagnosis
5. Dealing with the cultural resistance to the indicated technological changes
6. Taking action to institute the improvement
7. Instituting the necessary controls to hold the new level of performance.

What bearing does this have on Quality Control? Well, the difference between the old standard and the new standard is regarded by Juran as a chronic ailment which can economically be cured. In the quality function, a chronic disease may be a number of defects, nature of defects or, plainly, degree of quality conformance. Improvement to today's quality performance may be made by 1) troubleshooting to eliminate today's sporadic problems in order to restore the normal state of control or 'status quo' - as Juran calls it, 2) Seeking a breakthrough in which a superior level of performance is reached by the elimination of chronic causes of poor performance and non-conformance to quality, or plainly, achieving improved quality, 3) Planning in a way which minimises the appearance of sporadic problems affecting quality. This would involve launching new products, utilising new processes etcetera. Throughout the management process, control has to be exercised in all aspects of performance, and achieved quality is the result of the performance of activities under the scope and responsibility of management. Juran states that in quality control, the bulk of the field failures downtime, shop scrap, rework, sorting and other quality costs are traceable to a vital few field failure modes, shop defects, product components, processes, vendors, designs, operators etcetera. This phenomenon of "the vital few and the trivial many" as Juran put it, was given the name "the Pareto Principle" during the late 1940's. Juran says that a major use of the Pareto Principle is in the design of quality improvement programmes, where it has such a wide application that no intelligent approach to quality improvement is possible without it. He says that improvement can be justified only for the vital few projects - those which contain the bulk of the opportunity

for improvement in failure rates, quality costs, downtime, process yields etcetera. These vital few projects may be identified through a "Pareto Analysis". (See figures 8 and 9).

1.2.2.3 Quality Assurance. "Quality Assurance is the activity of providing, to all concerned, the evidence needed to establish confidence that the quality function is being performed adequately"(3). "Quality Assurance (Q.A.) is all those planned and systematic actions necessary to provide adequate confidence that a structure, system or component will perform satisfactorily in service". (A.N.S.I. / A.S.M.E. NQA-1; 1979 Definitions).

The upper management of an organisation is vested with the ultimate responsibility for product fitness for use. Activities which make up the quality function are in most cases delegated to subordinate managers however, the accountability for quality rests with the top managers, who are themselves accountable to the directors, owners, regulators, public, etcetera, for the performance of the company. With a recent emphasis upon the importance of the quality function, top managers have at their disposal methods which provide them with confidence in the conduct of the quality function. These methods rely upon the concept of formal independent evidence that the quality function is performing soundly. An analogy may be made here with the finance function, where top managers make use of the independent financial audit, which is a source of confidence providing assurance that the accounting system correctly reflects the financial conditions of the company and that the system is being followed. In the quality function, the same activity is followed, where the quality audit provides the assurance that the quality system is being followed correctly and accurately reflects the quality levels and performance of the organisation.

The confidence that is sought is derived from objective evidence and such evidence through which assurance that the quality function is being well conducted, is gained, may take many different forms. These may be simple sensory tests such as visual examinations or measurements for size and tolerances; feel for texture; smell for freshness; or elaborate tests for more complex products requiring special facilities. It is not always possible for a merchant or user to make these elaborate tests due to his lack of facilities required for this purpose, so the manufacturer's qual-

ity reputation, tests by independent laboratories or warranties are preferred. The more complex a product, the more difficult it is to provide full quality assurance to users. To meet all the needs of quality assurance, a concept has evolved where the manufacturer producing the product must also prepare and make available to the customer the proof that the product is fit for use. J.M. Juran[3] states that in complex products, this proof usually consists of;

1. A formal plan, which spells out, for all phases of product progression, how fitness for use will be achieved.
2. A system of reviews to verify that the plan, if followed, will result in fitness for use.
3. A system of audits to verify that the plan is actually being followed.

There has been a tendency to confuse the term "Quality Assurance" with the term "Quality Control". The distiction stated in the American ASQC (American Society for Quality Control) Standard A3-1971 and also ANSI (American National Standards Institute) Z1.7 1971 is helpful: "Broadly, quality control has to do with making quality what is should be, and quality assurance has to do with making sure quality is what it should be.".

1.2.3 Quality Costs

In achieving fitness for use, certain costs are involved. Most organisations use financial controls which include a comparison of actual costs incurred with budgeted costs, and associated action on the variance is taken. Each department in an organisation has an assigned task to perform, including making a contribution towards quality.

Juran & Gryna,[7] in their book state "Beginning in the 1950's, various forces converged to urge companies to evaluate the costs associated with the quality function. These forces included:

1. Growth of quality costs due to growth in volume of complex products, which demanded higher precision, greater reliability etc.
2. The influence of the great growth of long-life products with resulting high costs due to field failures, maintenance labour, spare

parts, etc. (The costs of keeping such products in service often exceeded the original purchase price).

3. The pressure arising from the phenomenon of "life behind the quality dikes". (This phrase was coined to describe the dependence on quality, being similar to the Dutch way of like - about a third of whose land lies below sea level. The land confers great benefits, but to use it requires that dikes be built and maintained so as to keep the sea out. In a like manner, the modern products and services confer great benefits but also demand protective 'dikes' in the form of adequate quality controls).
4. The need for quality specialists to express their findings and recommendations in the language of upper management - the language of money.

What has emerged is a concept of defining and measuring quality costs and then using the resulting figures for two different but interrelated purposes:

1. To provide a new scoreboard as an added form of cost control.
2. To identify opportunities for reducing quality costs. Here the emphasis is not on meeting some historical standard but on challenging the validity of that standard.

Note that the term "quality costs" is associated solely with defective product - the costs of making, finding, repairing, or avoiding defects. The costs of making good products are not part of quality costs. Lee Blank and Jorge Solorzano(8) define a quality cost system as "the business of assigning monetary value to things that go wrong. That is, a quality cost analysis is done to determine how much it costs to maintain a certain level of quality in the manufactured items or services of the company". Quality costs may be categorised so that specific purposes for which the costs are incurred, can be determined and analysed. But as Blank and Solarzano say, "there will undoubtedly be costs that originate in departments other than quality", which is reinforced by Phillip B. Crosby (5) when he says "the cost of quality has little to do with the operation of the quality department". To reiterate what Juran & Gryna (7) say - "the costs of making a good product are not a part of quality costs" - it is clear then that quality costs are costs incurred by doing things wrong.

1.2.3.1 Quality Cost Categories. Blank and Solorzano[8] list two main quality cost categories as being:

1. Discretionary Costs, and 2. Consequential Costs:

1. Discretionary Costs: Discretionary costs are sums of money that must be spent to assure that a desired level of quality is present in the service or finished product. The two types of quality cost that may be incurred at the discretion of management are: a. Prevention costs, which result from the decision management must make concerning how much to spend to prevent quality problems from occurring - problems that degrade product quality below a minimum acceptable level.

   b. Appraisal costs, which are incurred to determine the actual quality level of the finished product prior to its placement on the market.

2. Consequential Costs: Consequential costs are sums of money which must be spent to correct the service or product because the quality level has turned out to be lower than expected. Consequential costs often occur because management failed to avoid them by incurring a discretionay cost.

Discretionary costs are qualtiy costs that must be incurred to improve the quality of the product prior to the delivery to the customer (called Internal Failure Costs) and those costs that are incurred to correct all the products found to be below some minimum quality level after delivery to a user, (called External Failure Costs). Juran & Gryna[7] define these 'core categories' as follows:

Internal Failure Costs: - costs which would disappear if no defects existed in the product prior to shipment to the customer:

Scrap; the loss of investment in labour and material on defectives which cannot economically be repaired or used.

Rework; the cost of correcting defectives to make them fit for use.

Retest; the cost of reinspection and retest of products which have undergone rework or other revision.

Downtime; the cost of process yields lower than might be attainable by improved controls.

Yield Losses; the cost of process yields lower than might be attainable by improved controls.

Disposition; the investment in effort required to determine whether non-conforming products are usable and to make final disposition.

External Failure Costs: Costs which would disappear if there were no defects (defects found after shipment to the customer):

Complaint Adjustment; Costs of investigation and adjustment of justified complaints attributable to defective product or installation.

Returned Material; costs associated with receipt and replacement of defective products returned from the field.

Warranty Charges; costs involved in services to customers under warranty contracts.

Allowances; costs of concessions made to customers due to sub-standard products being accepted by the customer 'as-is'. This includes the loss of income due to downgrading products for sale as seconds.

Appraisal Costs: Costs incurred in attempting to discover the conditon of the product.

Incoming Material Inspection; the cost of determining the quality of supplier made products, whether by inspection upon receipt, or by source inspection or surveillance.

Inspection and Test; the costs of checking the conformance of the product throughout its progression during manufacture, including final acceptance and check of packing and shipping and environmental and reliability tests.

Maintaining Accuracy of Test Equipment; costs of operating the system that keep the measuring instruments and equipment in calibration.

Materials and Services Consumed; the costs of products consumed through destruct-

ive tests; materials consumed and services performing tests.

Evaluation of Stocks; the costs of testing products in field storage or stock to evaluate degradation.

Prevention Costs: Costs incurred to keep failure and appraisal costs to a minimum

Quality Planning; the costs of the broad array of the quality plan, such as the inspection plan, the reliability plan, the data system and specialised plans, including the preparation of manuals and procedures needed to communicate these plans to all concerned.

New Product Review; costs of preparing bid proposals, new design evaluations, preparation of test and experimental programmes and other quality activities associated with the launching of new designs.

Training; the cost of preparing training programmes for attaining and improving quality performance, no matter which department is to be the recipient of the training.

Process Control; costs of that part of process control which is conducted to achieve fitness for use, distinguished from achieving productivity, safety , etc.

Quality Data Acquisition and Analysis; the cost of running the quality data system to acquire continuing data on quality performance.

Quality Reporting; the cost of summarising and publishing quality information to middle and upper management.

Improvement Projects; the cost of structuring and carrying out programmes for breakthrough to new levels of performance.

1.2.3.2 Optimising Quality Costs. The level of optimum quality costs may be found using the following methods:

1) Market Data method, where it is attempted to determine the quality costs of other similar or competing industries. This information is hard to get and the written industry survey must be relied upon heavily.

2) Budgetary Process, where standards are based upon some sound foundation, such as previous performance and a quality cost budget is established (which may be divided into the various cost categories) and variances are measured and control effected.

3) Ratios for Quality Cost Categories, where it is attempted to establish an interrelationship amongst cost categories (See figure 10).

The Total Quality Cost Curve (see figure 11) may be divided into three zones:

1) The Quality Improvement Zone; where failure costs constitute over 70% of the total quality costs, while prevention costs are under 10% of total. This position means that there are most likely profitable improvement projects waiting to be pursued.

2) The Perfectionism Zone; where appraisal costs exceed failure costs and where improvement projects will comprise discovering and removing the undue costs of perfectionism, i.e. optimising costs of detecting defects compared to the cost of damages if defects are not detected, or, reviewing the quality standards to see if they are realistic in relation to fitness for use, or, seeing if it is feasible to reduce inspection through use of process capability and preserving order, or, considering the feasibility of auditing decisions in order to bring about a reduction of inspection costs.

3) Indifference Zone; where the optimum may be reached and the problem is one merely of control, i.e. to stay at this approximated optimum. Juran & Gryna say that the indifference zone is characterised by the fact that about half the quarterly costs are failure costs while prevention costs are about 10% of all quality costs.

Juran & Gryna continue, saying that Quality Costs are always "maldistributed" ... "relatively few of the contributors (divisions, plants, products, defects etc.) account for the bulk of the costs". The principle of "the vital few and trivial many", commonly known as the Pareto Principle, is very much in evidence here.

1.2.3.3 Optimisation of Cost of Conformance. Total quality costs are strongly influenced by the interplay amongst the various categories of

quality cost; Juran & Gryna have drawn up a table showing a model with interplay amongst quality categories and a graphical representation of this model - see Table 1. (Fig 10) shows the area of minimum total quality costs. When failure costs dominate (left-hand zone), the main opportunities for quality cost improvement lie in reducing failure costs through attack in the main defect concentration areas. When the appraisal costs dominate, (right-hand zone), the main opportunities for profitable projects lie in reduction of perfectionism in standards, more effective inspection and test procedures, more efficient sampling etc. If no profitable projects can be identified, the total quality costs are probably optimal, and the need is to control them and hold them at that optimal level.

1.2.4 Quality Control Circles (QC Circles)

1.2.4.1 Birth of the QC Circle Movement. Quality control originated in Japan in 1949 according to Kaoru Ishikawa - President of Musashi Institute of Technology[9]. Japan has almost no natural resources and imports 100% of its petroleum, coking coal and most of its iron ore requirements. Japan is smaller than California but its population is five times greater - almost half as many people than in the entire United States.

In order to survive, Japan's export income must exceed import costs. Following World War Two, the Japanese undertook to revolutionise their product quality in order to make their products saleable in the World Market and to compete with products from other countries which supply Japan with raw materials.

The Japanese realised that besides using a minimum of raw materials and mass producing to reduce costs, their products must be of good quality and high reliability. Before W.W. II, the image of Japanese products was "cheap and of poor quality" according to Mititaka Yamamoto of Omron Research Institute - California[10]. After W.W. II, the Japanese government wanted to promote foreign trade and to recover from its poor image. The result was a massive training programme for directors, managers, supervisors and technological specialists[10]. Many companies succeeded in enforcing tight quality control and in a short while Japanese technology "grew up". By 1960, large volume Japanese exports developed

as well as a new image of "inexpensive and good". Mititika Yamamoto [10] says "Generally, the Japanese are not good at thinking as individuals, they prefer group thinking. They pay attention to keeping order as a group. Once a group is established, its members are likely to believe that their group alone is right. To think a group is right means the moral justification of the group. It is easier to justify the group than it is to justify an individual. This is group thinking".

Professor Stephan Konz of the Department of Industrial Engineering at Kansas State University[11] recognises that the Japanese success stems from high quality rather than low price. The massive quality training programme undertaken in the early 50's led to training programmes being given also to the workforce, but on a voluntary basis. The response to this by Japanese workers was extensive and the type of programme that evolved, is based upon the group thinking concept. The training form featured inter-departmental groups of ten or so workers seated around a table, and became known as the QC Circle. Since 1962, about seven million workers have undergone this training, and the QC Circle has proved to be self-sustaining. Workers did not stop working on projects because the training course was over, they continued to work on projects much as people generally continue with hobbies that interest them.

And so, by 1970, "Japan reached a quality level equal to the best in the world" claims Kaoru Ishikawa[9].

1.2.4.2 Company Wide Quality Control (CWQC). Company wide quality control (CWQC) is the revolution in Japanese management philosophy that has recently been experienced here. It is a new way of thinking for the Japanese, which embraces amongst other systems, the QC Circle concept, and is very much akin to Feigenbaum's Total Quality Control concept. CWQC features are shown in Table 2.

All departments in a CWQC organisation participate and execute QC functions under the CWQC system. All departments are involved in developing and executing quality procedures, including the purchasing, design, production and sales departments. Western countries differ from this Japanese approach in that only quality specialists are involved in the introduction of quality procedures. Every employee in a company wide quality control organisation from chairman through president, directors,

middle managers, engineers and clerks, foremen to the workers must be involved[9]. The whole control system has also to be integrated so that the quality cost and quantity are not considered in isolation.
Another difference between the Japanese and Western systems is, that Japanese presidents and top managers carry out the quality audit. In the western world, presidents often do not understand what is meant by quality control. Kaoru Ishikawa[9] claims that it is impossible to improve quality when short term thinking prevails. He believes that quality progress as a long term policy should be concentrated upon. This is a fundamental of the CWQC philosophy. Furthermore, Ishikawa claims that product quality should be consumer orientated and that QC should consequently be directed to satisfy consumer requirements. It is up to the designer to determine the exact consumer requirements and the conditions under which the product will be used. This marketing function is another fundamental of the CWQC philosophy. The strong attitude of sectionalism or development of inter-departmental enemies, is not tolerated in the CWQC philosophy. The concept of the next process being 'the consumer' is followed so that when the product or component being produced leaves one department on its way for process to the next, it goes with the same quality confidence as it would if it were leaving the factory to the customer. It is important to collect data, the correct data, or facts, and analyse them by statistical or other methods. Although it is very difficult to obtain correct and factual data, such facts, once collected, can help to indicate areas requiring improvement. Above all, both favourable and unfavourable data inform top managers of what is really happening - a realistic state of affairs. This fact-control concept is a further fundamental of the CWQC philosophy.
The concept of industrial democracy is another fundamental, where management is not restricted to the top-down type, but includes the bottom-up type, creating a system whereby workers' suggestions are passed on to upper management. Each worker has the ability to think, and humanity, as claimed by Ishikawa, "is the recognition of each human being as something different to a machine". This is where the QC Circle concept plays an important role - another fundamental of the CWQC philosophy.

1.2.4.3 The Mechanics of Quality circles. "The QC Circle is a small group to perform quality control activities voluntarily within the same

workshop" - as defined by Kaoru Ishikawa[9]. "This small group carries on continuously as part of the company wide quality control activities self development and mental development control and improvement within the workshop, utilizing quality control techniques with all the members participating". The group performs quality control activities voluntarily and concerns itself not only with quality improvement, but also with increase in productivity and cost reduction. See figure 12.

It is mandatory that QC Circles are applied as part of CWQC and not on their own, says Ishikawa, as without the umbrella philosophy, QC Circles will fail. QC Circles undertake projects for control or improvement of quality. J.M. Juran describes the QC Circle way of operating as one which "separates problems into 'vital few and trivial many' elements; propounding, criticising and defending theories of causes of defects; collecting and analysing data to validate or invalidate competing theories; proposing remedies and testing their effectiveness; overcoming cultural resistance to change; preparing reports to management and for publication and defending these reports under challenge".

Improvement projects undertaken by QC Circles save enormous sums of money and in Japan, have significantly improved the saleability of the Japanese product by removing numerous sources of customer dissatisfaction. The resulting success in greater saleability leads to greater success against competing companies and ultimately greater security for the workers in their jobs.

QC Circles has resulted in improvements in worker motivation by providing a source of job interest not present in routine day to day work. Project work provides workers with a sence of participation, planning and decision making. The QC Circle movement once applied in Japan, led to the realisation that the concept of training workers to solve problems need not be restricted to quality control. Asbjorn Aune, Professor of Production Engineering Laboratory NTH-SINTEF, Trondheim Norway, lays down rules for the implementation of QC Circles in organisations, as being;

1) Participation must be voluntary and open to all.
2) There must be a systematic training of participants in problem solving.
3) Problems must be analysed and solutions should be recommended to management.

4) Meeting must be done on a regular basis and on paid time.

Juran concludes saying "the broader significance of the QC Circle movement is one of utilising the education, experience and creativity of the workforce to help in work planning and improvement, as well as to improve worker morale". At the same time .. "it aids in improving company performance. This improvement is not restricted to quality and extends to other parameters such as safety, cost, productivity, etc".

CONCLUSION

From the discussion in this chapter, it is concluded that quality assurance is a management philosophy well worth considering, and that to employ it in one's overall management system would simply be sound management practice. The reader should now understand the important concepts of Quality of Design and Quality of Conformance. He should also be aware of the economics of quality, the control of quality and, as described in the section on quality costs, the process of reaching a quality optimisation. The philosophies of C.W.Q.C. and Q.C. circles show how successful quality management can be, if applied carefully and with due regard to the situation.

The reader should now be 'primed' in the principles of quality and when reading chapter two, he ought to bear in mind that the South African Building Industry has as yet had no formal quality assurance applied to it.

CHAPTER TWO

THE BUILDING INDUSTRY IN SOUTH AFRICA

2. INTRODUCTION

This chapter commences with a brief description of early Cape building history and the influence people of that time had on building techniques. The emergence of an officially recognised controlling body within the South African Building Industry - the Building Industries Federation - South Africa and a widely accepted form of building contract, is discussed. The Master Builder Associations are also discussed briefly in order to indicate to the reader the degree of control these bodies have within the building industry. The characteristic divisions within the building industry and roles of the members of the building team are discussed with the idea of forming a basis upon which to apply, in a later chapter, the philosophy of Quality Assurance. Similarly, the types of building contract are described with a view to discussing the application of quality assurance principles to the different contract types. The chapter reveals the complexity of the building industry, its contracting procedure and the roles and interface of its team members. A discussion of project management in the building industry is also made.

Due to the complexity of the building industry, this chapter is somewhat lengthy. Here, again, the reader who is familiar with the industry need not dwell upon this chapter. It serves, however, as a necessary basis upon which to found further arguments for the application of quality management in the building industry.

2.1 THE STRUCTURE OF THE BUILDING INDUSTRY

Building in South Africa has its roots in the 17th century when the Dutch East India Company constructed its first official company buildings to

house its personnel concerned with the establishment and management of the company's victualling station in Cape Town.

E.A. Walker[12], in the book "A History of South Africa" tells us how the commander of the 'Indiaman', "Haarlem", which was wrecked in Table Bay in March 1647 - Leendert Janssen, wrote a report entitled "Remonstratie" in which he described his twelve months forced soujourn "in the style of Necho's mariners" till they were rescued by a return fleet twelve months later. As a result of this report, the Chamber of Amsterdam was instructed to make the Cape a strongly held rendezvous, in place of St. Helena, to be used as a stop-over or half-way house to India. The task of founding the refreshment station was entrusted to Jan van Riebeeck, a ships surgeon in St. Helena in 1650, with precise instructions to build a fort "to bear the name of "Good Hope" capable of housing some 80 men, to plant a garden in the best and fattest land and to keep on good terms with the natives for the sake of the cattle trade"[12].

Walker continues describing how after arriving in Table Bay on 6 April, 1652 and setting foot ashore a day later, Jan van Riebeeck set about building the fort of Good Hope, "a humble erection of earth and timber" - on the site of the present General Post Office. In 1685, it was decided by the Dutch 'heeren majores' to transform the refreshment station into a real colony. By 1657, the commander had built a supplement to the fort called "Duynhoop". This was later followed by the construction of a series of forts demarcating the colony's boundaries and by 1665, when war broke out between the English and the Dutch, Pieter Dombar was commissioned to design 'The Castle' - a scheme of defence. Convicts and prisoners were used to collect timber from Hout Bay and shells for lime from Robben Island. With peacetime interruptions to building progress the Castle was finally completed in 1677, by Governor Bax[12].

And so the building industry in Southern Africa was set off to a fine start, the first real project of importance being the Castle - a sound design based on the most approved model of Louis XIV's great military engineer - Vauban[12].

In these early days, many building materials were imported from Europe, as were building methods and skilled artisans. Relatively few materials came from the areas surrounding the building site. The skilled artisans and architects were imported for the more sophisticated company buildings and many of them stayed on and settled in the Cape. The architect was usually the designer, builder and manager of the project, aptly illustrating the derivation of the word 'architect' - "chief builder" - indicative also of the architect's early 'project management' role.

The nature of building was very dependent upon the people involved in the building activity and consequently, as time progressed, included many different types of buildings as immigrants from countries other than the Netherlands, such as the French Huguenots and later the British during the British occupation of the Cape, came to the Cape to settle. As a result of the importance of building ideas for a particular nationality of people settled in South Africa, the methods of building and management thereof that were adopted by those peoples, was naturally from their country of origin. This ultimately led to the emergence in the 1930's of a system of building in South Africa that closely followed the system in Great Britain at the time. When the Union of South Africa became the Republic of South Africa in 1961, the building industry found itself with a system closely aligned with that in Great Britain. In the present day, this basic system has changed little, and where it has changed, it has done so to accommodate itself to those factors influenced by the South African economy that do not manifest themselves in the British economy.

2.1.1 B.I.F.S.A. (The Building Industries Federation S.A.) and Conditions of Building Contract in South Africa

Conditions of Building Contract in South Africa have been founded largely on British conditions and as a consequence, the South African system is seen to be highly analogous to and compatible with the English system[13].

In 1904, shortly after its inception, the National Federation of Building Trade Employers in South Africa (now known as the Building Industries Federation of South Africa - 'B.I.F.S.A.') introduced a Standard Conditions of Contract in Natal and the Cape Western Province. This form

was closely related to the Royal Institute of British Architects 'R.I.B.A.' contract form used in Britain, and it was only in the late 1920's that serious attempts were initiated to prepare and enforce standard conditions of contract on a national basis in the private sector in South Africa. The first standard form of building contract was published in 1932[13]. The Institute of South African Architects ('I.S.A.A.') took the initiative and brought about the establishment of the Joint Council for the Building Industry in the early '50's. Besides the I.S.A.A., other constituents were the Chapter of South African Quantity Surveyors, now known as the Association of South African Quantity Surveyors ('A.S.A.Q.S.') and the N.F.B.T.E. now known as the B.I.F.S.A.. The councils aims and objects broadly covered all matters of mutual interest or concern to the constituents as well as embracing conditions of contract. It however dissolved after a four year association. A Joint Study Committee came into being and still continues to exist, to assist the industry with interpretation of new concepts and provisions and also to rectify, if and when necessary, anomalies which might arise in practice out of the amended provisions of the revised 1960 edition of the Standard Conditions of Contract Form.

The B.I.F.S.A. ever since its formation in 1904 as one of the first national industrial organisations in South Africa, has maintained a close association with the National Federation of Building Trades Employers in Britain. The British influence in this association as well as that of the Institute of South African Architects with the R.I.B.A. is markedly pronounced. This is seen in the modelling of the B.I.F.S.A. constitution on the British pattern[13].

J.A. Barrow Jun., President of BIFSA[14] 1981, describes the aims and objects of the B.I.F.S.A. as laid down in its constitution as follows;

i To watch over, promote and protect the interests of employers in all branches of the building and allied industries.

ii To regulate business and trade relations between members and in relation to manufacturers and suppliers of building materials.

iii To regulate and promote good relations with the Government, all public and quasi-public bodies, the Institute of South African Architects, the Association of South African Architects, the

Association of South African Quantity Surveyors and other professional bodies.

iv To obtain for the Industry fair and equitable conditions of employment, and to promote good relations with trade unions in the Building and Allied Industries.

v To promote the interests of members individually or collectively, according to the dictates of circumstances.

B.I.F.S.A. was formed in 1904 to represent the national interests of employers in the building and allied industries. It is described in the B.I.F.S.A. Handbook[15] how B.I.F.S.A. was born out of local organisation and is an instrument created by affiliated organisations in order to ensure that the individual efforts of these organisations would not be defeated through lack of coordination, or, on the part of the group as a whole, a lack of appreciation of the significance of local or sectional issues, which may have a bearing on national affairs. BIFSA therefore serves as a mouthpiece of the organised building and allied trades in all matters of national consequence, and pursues that which is desired by the majority as being in the best interests of all. BIFSA policies are formulated by affiliated associations through their own executive committees and by virtue of their representation on the national executive. The constitutional aims of BIFSA are the same as those of its affiliated associations. The logical division of functional authority is the main difference between the national organisation and the affiliated bodies. The "affiliated organisations" and "affiliated associations" referred to in the Building Industries Federation (S.A.) Handbook, are;

i Master Builders and Allied Trades Associations.

ii Electrical Contracting & Allied Trades Associations.

iii Master Masons & Quarry Owners Association (S.A.).

iv Industrialised Building and Components Manufacturers' Association (S.A.).

v Guild of Joinery and Furniture Manufacturers of South West Africa.

vi Ceilings and Interior Systems Contractors' Association S.A.

vii S.A. Reinforced Concrete Engineers' Association.

viii S.A. Industrial Refrigeration & Air Conditioning Contractors' Assoc.

ix Metal Window & Doorframe Manufacturers' Association.

x Special Members.

BIFSA aims to maintain trading conditions on an even keel and facilitate the smooth functioning of the Industry, both as an economic entity and in so far as the business transactions of individual members are concerned. BIFSA gives due regard to the long term needs of the Industry and its dependence upon harmonious relations with organised labour, the professions, government departments and other public bodies, as well as with kindred employer groups. This embraces the recruitment, education and training of labour, advanced technical and academic education, the regulation of labour relations, accident prevention, tendering and contractual matters, the promotion of new constructional techniques and methods, the development of new materials, maintenance of material supplies, cooperation with government departments in the drafting and administration of legislation, organisation of the Building Industry, the promotion of industrial prestige and public relations and a variety of other subjects. It must be noted at this juncture, that although BIFSA's handbook does list 'a variety of other subjects' as part of its task or 'primary functions and services', no specific mention is made of the promotion of the quality of products and services, nor of quality in general or the management thereof. It emphasises the needs of the building industry, but does not indicate that it recognises the needs of its life-blood - its employers. BIFSA has a series of by-laws established in recognition of codes of behaviour required to ensure that matters of fundamental importance to BIFSA and its affiliate associations are not undermined by indiscreet action on the part of individuals through lack of foresight. The principles embodied in the by-laws concern considerations of equity as applied to good practice, fair competition, and the securing of justifiable preferential treatment for members to the extent necessary to maintain the numerical membership required for effective organisation. BIFSA maintain that benefits can and do flow from the Federation's organisational activities through by-laws, to non-members.

B.I.F.S.A.'s rules lay down strict conditions pertaining to tendering procedure, the employment and remuneration of labour and membership.

2.1.1.2 The Master Builder's Association (The Master Builders and Allied Trades Association - M.B.A.)

L. Sisson, Director of the Master Builders and Allied Trades Association in the Cape Peninsula, 1981,(16) comments how the first organised body of 'Masters' in the building trade in the Cape Peninsula was brought into being in 1891 which comprised a few local builders and was called "The Association of Masters in the Building Trade". Between 1898 and 1901 the association ceased to exist, but after its revival, grew from strength to strength, until reaching its present status. The prime function of the M.B.A. is to establish and maintain industrial peace in the building industry in the area of its jurisdiction. It does this by negotiating with the trade unions and agreeing upon regulating and controlling conditions of employment of employees in the building industry. The agreements may concern any one or all of the twenty-six provisions as set out in Section 24 of the Industrial Conciliation Act No. 28 of 1956. This might include such matters as minimum wage rates, hours of work and overtime, keeping of records, pension-, sick-, medical-, unemployment-, holiday-, provident- and other insurance fund details, closed-shop agreements and any matter of mutual interest to employers and employees.

The association also plays a very important part in the regulation of business and trade relations between members and the regulation and promotion of good relations with the Government, all public and quasi-public bodies, architects, quantity surveyors, consulting engineers and other professional bodies. Through its affiliation with the BIFSA, the Association plays a direct part in the negotiation of standard conditions of contract and of sub-contract and of standardised procedures for tendering and codes of practice. Through BIFSA the Association has direct access to Central Government and at local level, the association is represented on a considerable number of statutory and non-statutory bodies.

2.1.2 The Nature of the Building Industry

Building in South Africa is a major industry and one of the most important fields of economic activity. Fifty percent of annual Gross Domestic Investment is in the Building Industry and Building Construction. However, the building industry is an extremely volatile industry, subject to periods of economic boom and depression. (See fig. 13[17]). An economic boom started early in 1978, and to indicate the volatile nature of the building industry, the level of activity started to accelerate during 1979 giving rise in mid 1980 to a shortage of bricks and later on of cement as well. Such shortages in materials and a depleted labour force has had the effect of creating a bottleneck to the growth of the building activity which was forecast to be in excess of 10% in 1980 [18].

Building Industry growth is also influenced to a large extent, by monetary and fiscal policies prevailing in the economy. Refer to Table 3 [19] which shows a 4.4% growth rate for the Building Industry in 1980; a 3,5% growth rate for 1979 and a massive negative -13,4% for 1978, leaving an average per annum of -1,8% from 1974 to 1980. The Building Industry does not respond immediately to improved economic circumstances and growth rates are considerably less than those achieved by the economy as a whole[20].

Building costs in South Africa rose on average by 30,7% in 1981. During the first quarter of 1981, the annual rate of increase in building costs was as high as 36,6%. Refer to Fig. 14 which shows that there is a tendency for building costs to increase rapidly during the economic upswing phases. A large proportion of the costs of the building industry were affected by statutory price control over products supplied by other sectors of the economy, such as steel, bricks and cement. The Building Industry cannot control these prices. Although, at the beginning of 1982, price control on such products was abolished, this will not necessarily imply an amelioration of the situation. Cement, for example, an essential commodity to the building industry, is distributed and supplied on a nation wide basis by a monopolistic like system called the Cement Marketing Organisation (C.M.O.). For the case of bricks, however,

substitute systems for brick work might well have the effect of bringing prices down.

The labour situation in the South African Building Industry is characterised by severe shortages in the skilled labour (artisans) ranks, with the higher percentage of total labour employed, being non-artisans. From 1972/73 to 1981 the number of artisans employed has dropped by 34%, while the number of non-artisans has increased by 32% - the ratio of artisan to non-artisan in 1972/73 being 1:4,8, while at present, it is 1:9,5. The effect of this in the labour market is a deterioration in productivity - non-artisans being less skilled than artisans, and the critical shortage of labour having the effect of increasing the cost of labour (which in 1981 was expected to amount to between 15 and 20% for that year) does not paint a pretty picture for the building industry. The artisan shortage in June 1981 = 15,6%; in March 1981 = 17,3%; in January 1981 = 16,4%; in September 1980 = 11,9% and in June 1980 = 10,4%. The increase in the shortage is quite alarming. Employment in the Building Industry follows the business cycle quite closely, as it does investment in the industry. Small changes of investment have a multiple effect upon employment, rendering the labour situation in the building industry very unstable. This too has an adverse effect on productivity in the Building Industry(20). Productivity, however, tends to increase with downswings in the building industry, as the possibility of being retrenched makes such a downward trend a motivating factor for increased productivity. The converse effect occurs during upswing phases, but caused by labour shortage and poor quality of labour employed.

The Building Industries Federation S.A. is South Africa's third largest employer after the Civil Services and the Mining Industry.
The Executive Director of the BIFSA, Mr. Lou Davis, announced in October 1981 that BIFSA is to invest R50m of its own money over the next five years, in a programme aimed specifically at training all ethnic groups to meet the skilled labour demand in the South African Building Industry.

There is, at present, an acute housing shortage in South Africa, for all race groups - (at present the figure stands at 500 000 units and an ongoing demand is estimated at an additional 180 000 per year). The

limited and decreasing availability of capital funds, especially in the private sector does not help the building industry in terms of meeting the housing shortage. In order to achieve economic stability and to assist with the smoothing out of the fluctuations in the business cycle, the government would do well to inject funds into the various sectors during downswing phases, with due regard to the need for funds in the housing market, and especially for the sake of the building industry.

2.1.3 Main Divisions within the Building Industry

The Building Industry is an essentially fragmented industry made out of sub-sections which are functionally independent, but technically dependent.

The sub-sections are;

i Manufacturers and suppliers (builders merchants)

ii Designers

iii Constructors

2.1.3.1 Manufacturers

These organisations produce products in a factory or some production centre for use on a construction site. These products may be bricks, cement, steel products, timber products, etcetera.

Suppliers

Manufactured products are distributed to the building industry by merchants who play a secondary role, in that they finance construction companies through the use of available credit facilities. So construction firms are financed to a certain extent, by builders merchants.

2.1.3.2 Design

Design consultants operate as independent professional firms. They work individually as firms but combine forces and come together on projects. These design consultants fall into the following categories:

The architect, who is responsible for the overall design.

The quantity surveyor, who is another design consultant, dealing with financial and economic consequences of design.

Consulting engineers - these are structural, electrical and mechanical and even plumbing engineers, air-conditioning and lighting engineers too - all grouped together and responsible for specialist design.

2.1.3.3 Construction

Building Contractors are responsible for the erection of the building. The construction industry employs 20% of all the people employed in secondary industry. In the main group or sphere of construction, there is a further subdivision into two groups:

i Main-Contractors - who build the structure.

ii Sub-Contractors - who do the finishing work and specialist work, such as shopfitters, painters, etcetera.

2.2 THE BUILDING TEAM AND THEIR INDIVIDUAL ROLES

The building team may be made up of representatives of firms, partnerships or companies, as applicable, from each of the main sub-sections of the building industry, for any one typical building project. Usually, the representatives from the design and construction sub-sections come together to form the team, with representation also from the client who commissioned the building project. Clearly identifiable roles can be discerned in the procurement of buildings and the building process. The first is that of the building owner, user or client. The second, that of the experienced and skilled multi-disciplinary design team, and thirdly, that of the building contractors. At the same time as defining their roles, a description of the contract process for a hypothetical project will be made, making the roles of the client, design team and contractors, more easily understood.

2.2.1 The Client

There are three basic types of client:

i The private client

ii The commercial client

iii Local Authority and Central Government types of client

2.2.1.1 The Private Client

A private client may be an individual, group of people or organisation which is only concerned with a specific project. The building being erected could be for an investment, for self occupation or for letting and this type of client is normally not experienced in the building field. Briefly, the normal procedure is that the client appoints an architect and outlines the basic requirements to him. From here on, the architect usually takes full responsibility, making outline proposals and preliminary sketch plans and even primary feasibility studies. A Quantity Surveyor's advice might be sought at this stage, however, one is seldom appointed at this stage(21).

2.2.1.2 The Commercial Client

This type of client builds either for speculation, investment or for his own use. These clients are normally insurance companies, property development companies and other large investment type companies. The type of buildings concerned here are mainly shopping complexes, apartment blocks and business accommodation. Of prime importance to these clients is the return on their investment. For this reason, they require very accurate cost advice and consequently, a quantity surveyor is usually appointed at a very early stage. Direct appointment may be made by the client after consultation with the architect or upon his recommendation. It is often found that these types of client have their own property development departments with a team of architects, quantity surveyors, engineers, town-planners and the like. Their function would be to co-ordinate and control the building team, purchase and sell property, let the building, and very often, to manage and maintain it as well(21).

2.2.1 3 Local Authority and Central Government Type of Client

These are provincial administrations, Public Works Departments, Municipalities, Universities and Community Development Departments. These clients will build for their own needs or for public facilities,such as schools, hospitals, housing schemes, etcetera. They do not build for investment and their building activities are limited by available taxes and funds. They normally have strict budgets and a projected building programme. For example, the Cape Provincial Administration will have a budget of R'x' per year of which R'y' is for schools, R'z' for hospitals, at R'A' per pupil and R'B' per bed, respectively. Most government departments have and use their own professional staff and carry out a lot of their own construction work. Because their salary scales are not competitive with those of the private sector, they suffer from staff shortages and therefore hand out a lot of work to private practises. Their own staff may then be used to check on the private consultants to ensure compliance with the brief, and generally, to oversee the project as a whole. A quantity surveyor is generally appointed directly and at the same time as the architect. All practising quantity surveying firms are registered with government bodies on a roster basis(22).

2.2.1.4 The Role of the Client

The building user, owner or entrepreneur who erects a building for leasing to others as an investment, or for ultimate sale, has an important role. Once the basic decision to proceed with a building is made by him, he has four major tasks to undertake:(21)

i Appointment of his Professional Team
ii Definition of the Brief
iii Arrangement of Building Finance
iv Involvement throughout the Development Operation

2.2.1.4.1 The appointment of the professional team is an important primary operation. The ultimate concept, quality and effectiveness of the project is largely dependent on this choice. Traditionally the architect has been assigned the leadership of the team and 'father confessor' role to his client, and is recognised as the kingpin in the procurement hierarchy. Recently, though, this position has been challenged by management

consultants, engineers and others. The process of selection of an architectural firm will involve a certain degree of research where proven professional track records in the concept, technical and management divisions, becomes paramount. It is necessary to appoint all the applicable disciplines and if the architectural firm selected is multi-disciplinary, embodying the required skills, then this selection is complete. If, however, the architectural firm is not multi-disciplinary, then the architect should be invited to make his recommendations as to a proven running partner favoured through much experience. Such additional disciplines as might be involved in addition to the controlling architect, are urban planners, quantity surveyors, structural, mechanical and electrical engin- eers, interior designers, landscapers and project managers. Larger architectural firms are multi-disciplinary in nature(21).

2.2.1.4.2 The client may prepare the brief, which can be a very exacting procedure often requiring specialised knowledge, and will have brought all necessary expertise to bear on the problem in establishing the brief. On the other hand, architects may be instructed to research and establish the brief in conjunction with specific people within the commissioning organisation. The finally approved brief should have detailed unambiguous terms that cover entirely the requirements to be satisfied by the project.

2.2.1.4.3 Arranging building finance is a highly specialised undertaking, particularly if loan finance is involved. Generally, the client examines the sources of necessary expertise but is often advised and aided by the architectural firm's internal and external financial operatives.

2.2.1.4.4 Involvement in the building process is a continuous task. A good way to establish interaction with the development process, is to attend monthly management meetings where the owner's representatives are present at meetings of all the firms involved, where problems are discussed, decisions are made and information is passed on. The client may appoint an executive individual or small committee who are able to liaise with the architects at short notice and to give urgent decisions that need to be taken during the intervals between management meetings.

2.2.2 The Professional Team

The professional team provides a most important 'powerhouse' of design, technical, scientific and managerial skills[21]. Their duties, as led by the architect, are:

i appraisal and definition of the project
ii concept of design
iii development of design
iv documentation
v contract administration and supervision

During each of these stages, cost control plays an important part. A budget figure is established either by the client or quantity surveying component of the team, at the project definition stage, or after the initial design concept. At the design development stage, a detailed cost re-assessment takes place to ensure compliance with the established budget. If there is a cost over-run, the team effects cuts in the project to return cost to the budget. Where a number of cost cutting possibilities present themselves, the architect submits these to the client for an expression of preference. Final documentation then follows, which, in measured contracts, will include a bill of quantities. The quantity surveyors price the bill of quantities to establish a likely price. It might be found, due to changed circumstances in the industry, that prices turn out to be higher than that of the budget figure. The architect in consultation with his client, may then prepare a schedule of omission or variations in order to reduce the cost over-run. Usually an escalation sum is included in the budget figure to take care of rising costs during the construction period. This sum should be able to absorb a small cost over-run. A contingency sum is also built in to this budget figure to allow for unseen technical complications.

Cost monitoring and manipulation during the contract administration period is an important phase which is achieved by the architect, quantity surveyor and engineering disciplines jointly, using regular, periodic cost status schedules for all cost components of the building contract. Omissions and additions are clearly identified so that at specific times, the cost position of the contract may be identified. Steps to control cost may be instituted by means of omissions and/or variations of

material, allowing for constant adjustments against the established budget[23].

2.2.2.1 The Architect

In the execution of his every day work, a practising architect has a responsibility, primarily, towards his client, but also towards posterity and the community as a whole, as well as to his profession and fellow practitioners. He is a responsible citizen and a professional man. Due to his endowed gifts and background of training, he has the accepted status of a professional - a person set apart from others by statute. The Architects Act No. 35 of 1970 and common law, the building regulations and Standard Conditions of Contract forms, all recognise the Architect as one who meets the following description, by virtue of his responsibilities, duties and powers. To comply with the definition of architect, an architect must be registered with the South African Institute of Architects[24]. Registration in this manner has a two-way effect of protecting both the public and the architect. An architect has copyright on his design work. The plans he draws up for a building, become the property of the client, but no-one is allowed to copy his work, by Common Law.

2.2.2.1.1 Stages of Relationship the Architect has with the Building Team on a Hypothetical Project[25].

1. Preliminary relationship with client. In his preliminary relationship with clients, the architect will point out to them the conditions under which he may accept a commission. This process of accepting a commission is the same as a contract of agency with an employer - the employer or architects client being the principal and the architect being the agent with a mandate. The scope of this mandate may be: a direct commission for full services; acting as a consultant; performing surveys and inspections for valuations and reporting thereon; acting in litigation; partial services; acting as an assessor in competitions and competing in competitions.

The architect will discuss the mutual commitments with regard to fees and when they are due. The minimum charges that the architect may claim for his service, are laid down in the Architect Act. This is to protect his fellow members by avoiding unfair and unethical competition. Similarly, there are certain conditions under which the architect may not accept a commission. It is expected of the architect to protect his clients interests by being independent of the building trades. For example, he should not have any fixed interests in building product concerns, manufacturers or suppliers.
The architect is to be able to prepare and discuss estimates and preliminary drawings to enable the client to decide upon a procedure.
He is required to act generally as an adviser to the client and in a responsible manner.
The architect is required to advise his client on the selection and employment of consultants, quantity surveyors and the methods of contract and procedure and general matters of building finance. In so doing, he is required to give the best possible advice, bearing in mind the clients interests at all times. He is required to explain the general commitments under the various types of contract and details pertaining to the financing of buildings, loans and required cash flows. He is required to know and be able to refer to and discuss with the client, all relevant legislation and regulations which may affect the project. He is required, before proceeding further, to gain the clients approval of sketch plans for the project, which will have embodied all possible designs(25).

2. Working Up Stage. The architect will now have to clarify the commitments and responsibilities of his and the client's relationships with the consultants. He is required on behalf of the client, to agree to the terms of the various commissions to consultants other than his own. He is required to keep consultants supplied with information in good time and to check on the manner in which the work is being carried out. The architect is required to have a full knowledge of materials used and to have investigated and tested materials contemplated for use. He is to ensure that the client is kept informed of progress and that all amendments are in

the clients interests, and necessary. He must assure the clients approval with full understanding as to the nature of the design. He will then submit the drawings and necessary documentation to the local authorities. He must deal with, and if necessary, consult with the authority to ensure compliance with the regulations. The architect is required to approach adjoining owners, where necessary, and ensure that their rights are known and taken into account, to safeguard the client against possible claims being made against him.

The architect should assist in the updating of preliminary estimates to arrive at a final estimate based on the working drawings. From this, a schedule of financial returns on the building may be made.

3. Tendering Procedure and Framing of Contract. The architect should advise the client of the different types of contract and their respective suitabilities to the particular project concerned. The architect is required to have a good working knowledge of architectural law, both statute and common law, the law of contract and be able to advise the client on contracts with companies, partnerships, public bodies and others. The architect should be able to effect all necessary correspondence in this regard. The architect should be able to assist with the checking of the bills of quantities in its development stage, in the pricing stage and when the priced bills are returned by contractors. He is required to keep the quantity surveyor supplied with information in the bills of quantities preparation stage. He is also required to prepare tender documents on behalf of the client, to advise, direct and prepare a tender list and to advise on the acceptance of tenders. In doing so, he will investigate the quality, standing and general suitability of tenders and advise on surety requirements. He will ensure an equitable and legally sound method of procedure in this regard. He will prepare the contract documents and ensure that both contracting parties understand their commitments made under the terms of the contract. He will assist in the signing of the contract documents and ensure that the client has a full understanding of the financial implications - including the payment by certificates system(25).

4. Administration of the Contract. The architect is required to understand fully and to carry out his duties in administering the contract. His powers and duties as defined by the contract, during this stage, are:

As agent to the client, to give instructions and see that they are carried out, including variations and their financial implications and compliance thereof by the client.

To ensure that drawings and instructions are clear and issued in good time.

To keep adequate records of all items affecting the contract.

To carry out inspections reasonably and to ensure that the contract is being carried out in accordance with the contract requirements.

To assess with the advice of the quantity surveyor, where applicable, and issue certificates for instalment payments.

To take the necessary action, or advise the client accordingly, where the contract is not being carried out.

To ensure that nominated sub-contractors are appointed with due consideration, in good time and with the clients approval.

To prepare, with the approval of the quantity surveyor, where applicable, the final account and obtain agreement thereupon.

To carry out the final inspection and ensure that work is handed over in a proper fashion.

As a quasi-arbitrator where the architect's decision is applied for, to ensure that the contract is carried out in fairness to both parties.(25)

5. Disputes and Termination. Where one of the contracting parties resorts to litigation, or disputes are referred to arbitration, the architect is required to advise the client on the procedure to be followed and to take the necessary steps laid down in the conditions of contract.

He is required to act as a witness, submit evidence and arrange for the completion of the work when the contract is terminated.(25)

2.2.2.2. The Quantity Surveyor.

Historically, the quantity surveyor originated from the old measurer of building work. Today, his role is much more comprehensive and varied, with a different emphasis. The registered quantity surveyor is a specialist professional, whose training and experience are directed towards the planning and control of expenditure on construction of all kinds, including effective means of accounting for it. As a professional, the quantity surveyor is protected by the Quantity Surveyors Act No. 36 of 1970, and both he and the Architect, as professionals, share common areas of behaviour.

The quantity surveyor is a more scientifically orientated professional than the architect - who is a creative artistic type of professional. Quantity surveyors are required to be systematic, precise and accurate. His main responsibility is to provide an economical way of producing a document that can be used to price a job accurately. This document provides a basis for adjusting for variations and assists the client in the financial control of his project on a monthly basis, and also enables some advance cash flow cater-ability. His knowledge of construction economics enables the quantity surveyor to:
Advise on what a project would cost a client.
Advise on the size and standard of the structure that can be erected for any given expenditure.
Advise on the economics of a project and the preparation of a budget.
Cooperate with the designers to ensure that a building can be erected with an approved expenditure.
Advise on tendering procedures and contractual arrangements.
Prepare documents for obtaining tenders and arranging a contract.
Exercise financial control during the construction so that the budget is not exceeded without authority.
Act with the architect and engineer to ensure that the financial provisions of the contract are properly interpreted and applied so that the clients financial interest is safeguarded and that the contractor is paid a proper price for the work(22).

The services a registered quantity surveyor would normally provide to a client are as follows:
Preliminary cost advice and cost planning

Advice on type of contract
Advice on obtaining tenders
Preparation of tender documents
Negotiation with contractor
Cost control and preparation of financial statements
Valuation of work in progress
Settlement of the final cost with the contractor and sub-contractors[23].

2.2.2.2.1 Cost Advice. It is generally recommended that preliminary cost advice be given by the quantity surveyor at the very outset of a project. The probable region of cost of a proposed project may be indicated by him or he may assess the type and size of structure that can be erected for any given expenditure. With this information and with the estimates of maintenance and running costs, the quantity surveyor assists his client in the preparation of the budget for the project[23].

2.2.2.2.2 Cost Planning. The Quantity Surveyor uses a technique known as cost-planning, which enables his cost advice to be used objectively during the design process on every aspect of the structure, enabling the price for each constituent to be valued against its performance requirement and aesthetic considerations. After the initial feasibility studies and preliminary estimates have been prepared, the quantity surveyor prepares the cost plan from the architect's preliminary drawings. The cost plan divides a building into its various functional elements and allocates costs to these elements. In this way it is possible to ensure a proper apportionment of expenditure over the various elements. Proposals for alternative materials and designs are costed as the design progresses and the cost implications are presented to the client and other consultations are made with a knowledge of the overall costs involved[23].

2.2.2.2.3 Tendering Documents. The most often used forms of contract in building works are based on the bills of quantities used as a contract document. The bills of quantities is a quantified statement of the architect's drawings including the specification. Each contractor that tenders for the contract is able to estimate his price for the contract

on exactly the same basis as his competitors. Bills or schedules are prepared in accordance with standard methods of measurement in use throughout the building industry in South Africa. These bills or schedules are later used during the construction of a project to provide a basis for the financial management of the contract. Where other forms of tendering procedure are used, the quantity surveyor ensures that similar documents are drafted in the form most suited to the circumstances(23).

2.2.2.2.4 Obtaining Tenders. Tenders for building work may be obtained either in competition or by negotiation. Choosing the most suitable procedure is one of the most important decisions to be taken at an early stage and one of the matters where the quantity surveyor's advice is most valuable. The quantity surveyor may advise on the selection of suitable building firms to be invited to tender, according to the type and size of the job and the general standard of workmanship and skill that may be required. When tenders have been obtained, the quantity surveyor checks them to see that no substantial errors have been made, ensuring that no contract is entered into on the basis of a seriously incorrect quotation. He then submits a detailed report on the tenders to the client. The advice the quantity surveyor gives in the selection of contractors and obtaining tenders is also applied to the choice of nominated sub-contractors and suppliers, and obtaining quotations from them(23).

2.2.2.2.5 Cost Control. Cost control during the construction phase will be effected by the quantity surveyor, by using the cost plan (where it has been prepared in the design stages). Variations in the work, whether they take into account the client's changing needs, or to overcome unforeseen site conditions, may be necessary during the construction process. The quantity surveyor then estimates the cost of the proposed variations and reports on their impact on the probable final cost. Corrective measures may be taken elsewhere in the job should the client so require, in order to keep the cost within the budget. The quantity surveyor will also prepare financial statements at regular intervals, which keep the client and designers fully informed of the up-to-date financial position and anticipated final cost of the work(23).

2.2.2.2.6 Valuation of Work in Progress. The contractor is generally paid each month for the work he has completed during the preceding month. The quantity surveyor has the responsibility of measuring and valuing this work, together with the value of any variations which may have been authorised by the architect during the period in question. The quantity surveyor then submits to the architect, a recommendation regarding a payment on account. At the architect's satisfaction that the work involved has been carried out in accordance with the terms of the contract, the amount due to the contractor will then be certified by the architect. This certification will be in accordance with the quantity surveyor's valuation(23).

2.2.2.2.7 The Final Account. The calculation of the final cost of the contract is the last responsibility of the quantity surveyor. He prepares the final account, adjusting the contract sum according to the terms of the contract, taking into account variations, adjustments to the accounts of the nominated sub-contractors and suppliers, and any other matters for which the contract allows. The quantity surveyor then obtains the contractor's concurrence with the final account, providing a fair and equitable settlement in accordance with contract conditions. Should the client require an analysis of the final account, the quantity surveyor will prepare this accordingly(23).

2.2.3 The Contractor

Building contracting organisations tend to be located at the main centres of South Africa. There is a relatively low number of large organisations active throughout the country and many smaller organisations that operate from one centre only. As a result of the volatile nature of the building industry, which is so because the degree of building activity is very dependent upon the availability of money, many smaller building organisations have come into being in boom periods, only to turn insolvent in subsequent periods of depression. The building contractors that have weathered South Africas most recent depression, in the late seventies, considered also the worst for thirty-five years, have generally been those that have been in existence for quite some time. As

a further consequence of their longevity, their reputation has become firmly established within the vision of building clients and the professional teams.

The legal responsibilities of the contractor in the common measured, or lump-sum contracts, are contained in the standard form of conditions for those forms of contract. The contractors legal or contractual responsibilities come into play at the time he is awarded the tender and accepts it by signing the contract. He has, however, certain tasks and duties that he must perform to ensure that he has the best chance of being awarded the contract. These will normally commence at the time he is invited to tender for the contract.

2.2.3.1 Tendering Procedure

A formal invitation to tender for a contract will be sent to contractors on a short list, after the client has approved the list of contractors recommended to him by the quantity surveyor and the architect. A contractor being invited to tender for the project, will examine the details of the project in order to decide whether his organisation's resources can meet the requirements of the design drawings, specification and contract. Some of the aspects that will be examined closely are:(26)

i The tenderer must interpret the drawings and have a clear picture in his mind of the requirements of the contract and the final product. This understanding will enable him to decide whether the skills of his construction team will be adequate in the construction of what has been specified. Other resources, besides the skills required, will also have to be examined with a view to satisfactory fulfilment of the contract. The tenderer should make a thorough inspection of the site to familiarise himself with its nature in order to facilitate his approach to pricing the bill of quantities and pre-contract planning.

ii The bill of quantities should be read thoroughly making sure that all usual clauses are contained therein and to pick out and examine any odd clauses not usually contained in bills of quantities. The different parts of the bill of quantities should then be split up into those activities that will be handled by the tendering

organisation and those that will be handled by nominated sub-contractors.

iii The tenderers purchasing department, which will have kept itself abreast of current prices, will provide an input to the working out of the rates for the bill items. At the same time, the purchasing department should ensure availability of the materials specified.

iv The individual or department whose responsibility it is to work out the rates, will usually have kept a record of rates used on previous contracts or tenders. This record will be a useful check against rates worked out, taking into consideration the market price structure. The rates used for the tender will also be recorded for future reference and updating at a later stage.

v The profit mark-up on nominated sub-contractor's prices will be worked out and his prices will be compared, if possible, with his prices of other jobs prior to this one, on which the tenderer had been the contractor.

vi The preliminary and General Clause/Bill would be broken down into items of cost and cost components (up to as much as 100 different items or more) that could then be priced as early as possible.

vii A detailed and thorough overall examination must be made in an attempt to foresee any problems that the job might present. The economic climate and conditions exerting pressure on the building industry such as: shortages of materials and difficulty of suppliers to deliver goods; credit factors and interest rates; availability of labour and associated problems that would affect the project and its required resources.

viii An examination of the building techniques and construction methods required by the job will have to be made and the standards required with a view to the tenderer's capabilities will have to be considered.

ix An examination will have to be made of all the factors that could affect the price, such as: 1) Nature of the work. 2) Site location. 3) Site details such as water and power supply, security, stormwater and sewerage details. 4) Availability of labour and materials. 5) Time factor; are hand over dates realistic? are some sections to be handed over prior to others? what are the damages for non-completion on schedule if any? 6) Special features. 7) Consultants - who are

they? have they been dealt with before? 8) Technical problems. 9) Schedule of Prime Cost items and Provisional Sums. 10) Information about local authorities. 11) Schedule of drawings.

The tenderer should then complete the following prior to finalising and submitting the actual tender:(26)

1) Method Statement. 2) Plant Requirements. 3) Labour Requirements
4) Site Layout. 5) Programme.

2.2.3.1.1 Method Statement. This is a detailed study and supply of information on how one will go about constructing the building, organising the plant, labour and materials and the roles that each will play during the construction phase. It will contain a consideration of the implications of each of these such as their protection, access to the site, accommodation and storage. Decisions will be made to sub-contract various activities, based on whether the tenderer has plant for the activity and whether it could be done more cheaply by a sub-contractor. An example would be the activity of excavation or even the supply of concrete; the decision to use ready-mixed concrete would involve considerations of plant available, available space, proximity to a source of ready-mixed concrete; price and type of concrete required; whatever is decided, the factors affecting the decision should be recorded, providing the basis upon which the prices for that item or activity had been submitted.

2.2.3.1.2 Plant Requirements. The most important consideration here, is that the ultimate decision on plant to be used will be based not solely upon cost, but cost effectiveness too. The plant to be used must be the most efficient for the specific job that is required to be done. The type of material to be handled or produced by the plant, must be considered; the working area in which the plant will have to be operated, and the speed at which the plant is required to handle or produce the material in question, must be considered. The availability of the plant either from the tenderer's yard, or a hiring supply company, or sub-contractor; the owning and operating costs of the plant, if supplied by the tenderer; and the rate of hire from a plant, if supplied by the tenderer; and the rate of hire from a plant hire company, and the rate per unit item charged by the sub-contractor, will all have to be considered. Again, a full list of

factors affecting the final decision should be recorded for future reference. Where decisions relating to plant have been made, a plant schedule for the contract should be devised.

2.2.3.1.3 Labour Requirements. The project may be broken down into parts of the total amount of work to be done. In order not to strain the resources of the tenderer's organisation too much, the bill is analysed into materials, labour, overheads, profit and plant. As regards the activities involving labour, the amount of labour required for each will be measureable, given performance figures. These performance figures will have been recorded from productivity studies on previous jobs, or will have been computed by work-study specialists. A rough total number of labourers, tradesmen, and artisans will be calculated, providing an idea of how many men will be required on the project. This, coupled with the programme of the job, or a fairly detailed method statement, will provide a labour schedule as a guide to the labour requirements the tenderer will have to meet.

The tenderer will also have to consider the requirements of transport, accommodation, source of supply, statutory regulations, trade union requirements, industrial council requirements and other factors affecting cost.

2.2.3.1.4 Layout. The tenderer will have to establish the extent of available space at the site. He will have to take into account the terrain, its topography, vegetation, access and points of power and water supply and sewerage details. The nature and structure of the building will dictate to a great degree, the position that will have to be adopted for the crane, if one is to be used. The space required by the crane will be dictated by the type of crane, whether it be stationary or travelling, and this in turn will affect the location of the concrete production plant, steel storage and formwork manufacture areas. The site offices will normally serve to accommodate the general foreman or site agent, as a venue for site meetings of the building team; the clerk of works accomodation, building contractors site staff and other contract required facilities or items requiring accommodation. The tenderer will have to consider these requirements and fit them into his site layout and price

accordingly. Again, the tenderer would record the bases upon which his decisions have been made inasmuch as they affect the price tendered.

2.2.3.1.5 Programme. It is becoming increasingly more common for the contract to require a contractor to provide and maintain a P.E.R.T. (Programme Evaluation Review Technique) or C.P.M. (Critical Path Method) programme for the contract. While the requirement of such a control mechanism is of particular value during the construction phase, the tenderer will nevertheless find it a valuable tool during the tendering stage. Based upon the method statement, the programme is developed to the degree where items or activities of cost consequence may be identified such that the cost magnitude and timing are known and taken into account when pricing and determining projected cash flows and working capital requirements. The tendency is, these days, for contractors to convert their manual tasks to computerised operation. The C.P.M. or P.E.R.T. programmes are ideally suited for computerising,the ease and speed with which calculations and data may be made or recalled, allows for easy updating as frequently as on a daily basis if so required. This facility may prove to be invaluable for use on modern and more complex projects, both before and after the award of the contract.
In addition to the abovementioned uses, the programme will provide a statement of what parts of the building should be constructed before others, so that the resources of the firm would not be strained too much. This would be planned strictly in accordance with contract requirements, should certain sections of the works require handing over prior to others, and it will also consider bonuses for the completion ahead of schedule, as well as the damage that might arise from completion behind schedule.

2.2.3.2 Post Contract Award

The duties and responsibilities and mere diversity of tasks to be performed by the contractor once he has been awarded the contract, amount to some great magnitude. The manner and sequence in which these tasks will be performed will vary from contractor to contractor and will also depend upon the particular nature of the project in question. In broad terms, the contractor has the responsibility of procuring materials for

and the construction of the designed building, and to hand over the finished product in such a manner as may be described in the contract, such that it complies with the design or working drawings and the applicable specification. The most fundamental obligation the contractor has in a building contract is the obligation to complete the works.
The construction techniques the contractor employs and his methods of planning, organising and controlling are largely determined by the individual contracting organisation, the contractor's project team or even a single contracts manager. There are, however, certain contractual requirements with which the builder will have to comply. These are embodied in the standard conditions of building contract which is called the "White Form"(27). There are also other non-standard conditions that will be specific to each individual project, and will be listed in the Bill of Quantities for that project.

2.2.3.2.1 The Standard Conditions of Building Contract. The standard conditions of building contract are contained in the "Agreement and Schedule of Conditions of Building Contract (between the contracting parties) ..." a standard form known as the "White Form"(27) which is approved and recommended by the Institute of South African architects, the Association of South African Quantity Surveyors, and the Building Industries Federation (South Africa). This "White Form" is applicable only where bills of quantities form part of the contract documents, which is normally the case when the contract value exceeds R100 000(16). Where the contract value falls short of this figure, it is common practice to employ the Lump-Sum (Fixed Price) contract form, the conditions of which are also standard and are embodied in the "Blue Form". This is entitled the "Agreement and Schedule of Conditions of building contract between (the contracting parties)", a standard form of contract which is approved and recommended by the I.S.A.A., the A.S.A.Q.S. and B.I.F.S.A., and is applicable only where bills of quantities are <u>not</u> used as part of the contract documents. In the building industry in South Africa, there is more than one form of agreement where a builder agrees to perform building or engineering work for another party - the building owner. The government has a form of its own for use, as has the S.A.R.&H. Administration. This applies also to some of the provincial works departments, municipalities and even some of the larger property developing companies. An estimated

60% of the national building programme falls within the private sector and is largely carried out under the conditions contained in the "White Form". Consequently, this study will concentrate on those conditions of the "White Form" as revised in July 1974[28].See appendix 1 for a summary of some relevant conditions.

The standard conditions in the contract form prescribe further obligations of the contractor which flow from certain events that might occur during the contract duration. An example of these include obligations concerning cases where disputes arise; defaults of various parties to the contract and sub-contracts; determination of the contract by the employer or the contractor himself; arbitration and other events not normally considered as usual during a smoothly run contract. It is purposefully intended in this study not to explore these obligations for reasons of brevity and non-applicability to the object of this study.

2.2.4 Other Parties

2.2.4.1 Engineers

A person duly registered as an engineer may describe himself as a professional engineer and use the title (Pr.Eng.) after his name. Those who design engineering works and supervise their erection are often called consulting engineers and carry out duties analogous to those performed by the architect in pure building works. Where the term 'engineer' is used, it will generally refer to a person acting in this capacity[29].

2.2.4.2 Resident Engineer.

In larger engineering contracts, a designee of the engineer responsible for the design of the works, appointed by the engineer to supervise the

works, is known as the resident engineer. He is normally available to handle the daily problems of detailed planning and supervision[29].

2.2.4.3 Clerk of Works

The employer may appoint a clerk of works to act solely as an inspector on his behalf or under the directions of the architect. The object of his appointment is to ensure that there is someone permanently on the site to see that work is being properly carried out. He does not relieve the architect of his responsibilities[29].

2.2.4.4 The Sub-Contractor

It is usual for the contractor to employ whatever specialist contractors he may deem desireable in the circumstances. These specialist contractors who are thus employed by the main contractor are referred to as 'sub-contractors'. In most building contracts the employer reserves the right of selecting through his architect, the various specialist contractors normally referred to as nominated sub-contractors. The main contractor is normally given the right to object to the appointment of a sub-contractor on reasonable grounds[29].

2.3 TYPES OF BUILDING CONTRACT IN SOUTH AFRICA

The building industry in South Africa has the following types of contract:
Lump-Sum Contract
Quantities Form or Measurement Contract
Negotiated form of contract, subdivided into managed contracts and package contracts.

Under each of these types of contract, the effects of each type on the determination of the contract sum; the control required during the administration and the determination of the final cost will be discussed.

2.3.1 The Lump-Sum Form of Contract

This form of contract is a widely used form, where an agreement is entered into for a specific amount. The amount established is entirely the responsibility of the contractor, but is subject to the measurements provided to the client or owner by the quantity surveyor. These measurements may be adjusted on behalf of the owner by the quantity surveyor, but this adjustment will remain the responsibility of the owner. The Standard Conditions to the contract and contract agreement come in the form of the "White Form", previously mentioned, which is a recognised orthodox form of contract. It makes reference to drawings and the specification and is used for smaller types of contract as a rule. Members of the Master Builders Associations may not tender for a job of over a certain value without a Bills of Quantities, (R100 000 in 1981). A few builders are selected with the lowest tenderer entering into a lump-sum contract with the client. The architect and client should have a knowledge of current building costs and keep in mind the cost limit. Each tenderer has to quantify the work in order to arrive at a tender price, leading to duplication of work amongst tenderers[22].

2.3.1.1 Determination of Contract Sum

When setting up a lump-sum contract, tenders are called for, inviting competition. Each tenderer or builder is required to do his own measuring and submit the tender figure. A certain degree of approximation results in this method, affecting the accuracy of measuring. Over measurement often results in this method. There is also the possibility of not achieving uniformity of interpretation of the contract and related documents - (specification and drawings), which often tends towards a higher pricing rather than a lower one with, perhaps, a safeguard built

in by the tenderer. This lack of uniformity in interpretation could adversely affect the anticipated tender figure.
There are certain aspects involved in entering into a lump-sum contract where total responsibility is 'shoved' onto the builder. One might have a built-in increase to the tenderer's figure tendered to cover this responsibility(30).

2.3.1.2 Control during the Administration of the Contract

For this aspect, there is a distinct disadvantage over the normal measurement contract. Here, there are no breakdowns as to the amounts which have to be paid to the contractor from time to time. There are no unit rates to refer to when dealing with variation orders(30).

2.3.1.3 Determination of Final Cost

The lump-sum tendered figure is the final cost, excepting for variation orders that might have been made during the contract duration. The only means of rating a variation to a lump-sum contract is the Fair Valuation, which, is difficult to ascertain. One method of dealing with variations, which do and will invariably occur, is to attach to the lump-sum contract, a schedule of rates which cover the main items in the contract. The lump-sum may be adjusted to incorporate variations using this schedule of rates. A problem often presented in this area, is when the true relationship between the schedule of rates and the contract sum is questioned. This, arising in the case of variations, might cause the cost of building to be placed out of gear. Emphasis should be placed on relating the schedule of rates directly to the lump-sum figure(30).

2.3.2 Quantities Form or Measurement Contract

This is the most common form of contract and is used especially for contracts with members of the Master Builder Associations, that exceed the value of R 100 000 (in 1981). Here, maximum efficiency is attained when the number of tenderers is restricted to between six and eight. Inviting

too many tenders leads to price-cutting and shoddy workmanship. Too few tenders means that the opportunity of receiving favourable tenders is lost. Nevertheless, selection of tenders invited should be made carefully. The contract figure may be based upon;
a bill of quantities
provisional or approximate quantities, or
a schedule of rates[22].

2.3.2.1 Bill of Quantities Base

For a traditional building, the standard form of contract, based upon a bill of quantities, will probably give the lowest price. Here, the bill of quantities forms part of the contract documents and provides a set of rates for the valuation of monthly payment certificates and variations to the contract. It provides the opportunity for fairly tight and effective control right throughout the contract period, enabling the final cost of the contract to be known at all stages. The bill of quantities is used in its traditional form together with the specification, drawings, standard conditions of contract form and the Standard System of Measuring Builders Work. The ability of determining how much the monthly payment certificates will be, enables the employer or client to organise his cash flows[30].

2.3.2.2 Approximate or Provisional Bill of Quantities Base

If time is of the essence or the scheme has not been fully designed, but a competitive tender with fixed rates is required, the approximate or provisional bill of quantities may be used or preferred. It does not prove to be as satisfactory as the standard bill of quantities, however, a fair forecast of the final cost may be made, depending upon the degree of approximation. Here, work is measured as executed and a final price is agreed upon using the items and rates in the bill. It requires constant updating in order to be a helpful guide to the final cost[30].

2.3.2.3 Schedule of Rates Base

Here, the contractors are asked to price competitively, a schedule or typical bill of quantities with NO quantities provided. That is, just to give a rate for each description. The disadvantage of this method is the difficulty of selecting the tenderer and the uncertainty in forecasting the final cost. It is therefore a relatively unhelpful basis for administering the contract and only slightly helpful in determining the value of variations, although variations that are not on the schedule very often occur(30).

2.3.3 Negotiated Type of Contract

This type of contract has not found favour with the quantity surveyor or architect professions. The negotiated contract is almost invariably advocated by certain large building contracting firms who seek to secure major contracts without having to compete in the open market. These contracts may take many forms, but the most usual are the 'Managed Contracts' and the 'Package Contracts'(30).

2.3.3.1 Managed Contracts

Generally, under managed contracts, the owner appoints an architect and other professionals are appointed, as required. A committee is formed comprising the owner, architect, consulting engineers of applicable disciplines and a general contractor. This type of contract is normally used where cost is an important factor, or where complicated construction techniques require the early selection of the builder, before the design of the building is finalised. A good case for this type of contract is one where speed is of the essence, but at the same time, caution against improper planning due to haste, must be exercised.

2.3.3.1.1 Determination of Contract Sum. The determination of the initial contract sum for a cost-plus type, is done by adding the net cost

and a) a percentage or, b) a fixed fee, or c) a target cost and a fixed fee together. There is no initial contract sum, and no tendering as a rule. The owner does not know what the final cost will be and there is no set contract form describing special areas of responsibility. It is often used for messy alteration jobs. It is essential to draw up a contract form in each case, making quite clear what is meant by the terms of the agreement made. An attempt should be made, as far as is possible, to determine the final contract sum. Tricky areas in determining the net cost would be the cost of supervision (foremen), the discount on materials, plant, tool and equipment costs, small tools and scaffolding - whether hired or owned by the contractor, credit for materials, formwork for concrete, controlling items used for and expended during the course of the work and remedial work (cost of materials to be pulled down) where separation of bad work from efficient work should be made.

a) Cost Plus Percentage. This is a very simple method, once the definition of 'cost' and 'percentage profit' have been agreed upon. The biggest disadvantage here is that there is a very real incentive for the contractor to be wasteful, since any increase in cost will increase the contractors profits. It is also very difficult to forecast the final cost to the client, since it is an open-ended type of contract. This often leads to the client setting a cost-plus with a ceiling figure contract, similar to a target cost.

b) Cost plus Fixed Fee. This is a variation of the cost-plus percentage type, where an attempt is made to reduce the incentive for the contractor to be wasteful. The fixed fee is agreed upon by the contracting parties, but otherwise, this form has the same disadvantages as the cost-plus percentage type of contract.

c) Target Cost. A further refinement of the above two types of contract, is one where a bill of quantities, or detailed estimate is prepared and priced by negotiation, to arrive at a net target cost, to which is added a fixed fee for the contractor. If the actual cost is lower than the target cost, the client and the contractor split the difference at a previously agreed ratio. If the actual cost is higher than the target figure, the extra cost is to the contractor's account. The contractor therefore has the incentive to do the job

as cheaply as possible. A problem is the arrival at a realistic target figure and the definition of cost. A guarantee as to the maximum the owner will have to pay is an important attempt to eliminate the dangerous part of the cost-plus type of contract. Any ceiling figure established is only meaningful when carefuliy and accurately derived in the first instance. When the specification is changed and the contract grows, in other words, variations are made, there must be a mechanism for the adjustment of this ceiling figure to accommodate variations. Where a ceiling figure has been set, it is customary to use a bill of quantities to enable easy revision of the ceiling figure, when and where necessary.

2.3.3.1.2 Advantages. Complete drawings and detailed bills of quantities are not required resulting in a considerable saving of time. If no independent quantity surveyor is employed, his fees are saved. The 'know-how' of the general contractor is available at an early stage, resulting in better pre-planning of the actual building operations and the organisation of plant, labour and materials. A major part of the work is usually done by sub-contractors on a competitive basis. The cooperation from an early stage of all members of the committee as a team, results in increased efficiency and time saving.

2.3.3.1.3 Disadvantages. The necessary task of pre-planning is often regarded too lightly. Where a quantity surveyor is not employed by the owner, the checking of all documents on which payments are based will be in the contractor's and sub-contractor's hands. These functions will then be done preserving the contractors' interests and not those of the client. In most cases, the most advantageous prices will not be obtained. Competition is largely eliminated. At the time the target figure is agreed upon, the information upon which it is based is in a very sketchy stage and only a rough estimate can possibly be made. The only accurate way of arriving at a reliable figure would be to prepare detailed bills of quantities, which might as well be used as the basis for the contract. In the absence of a bill of quantities, it is very difficult to adjust the target price for variations in order to make the 'sharing of savings' calculations - which might lead to disputes. Financial control is very difficult in the absence of a bill of quantities. There exists a

practical difficulty in defining accurately and precisely the meaning of 'cost' and what items fall under it, in the conditions of contract. Disputes could arise concerning what comes under 'cost' and what under the 'management fee'.

2.3.3.2 Package Contracts

This type of contract is fairly common in the civil and mechanical engineering fields. It is not very prevalent in the architectural field, except in the case of domestic housing. The package contract is a form in which the contracting firm is responsible for the design and construction of the building. The design and drawing work may be undertaken by men in the employ of the contracting firm, or may be let out by the firm to a private architectural practitioner, paid by and responsible to the contractor. Tenderers are usually called upon to quote a lump-sum price for the whole project, that is, design and construction. Drawings and specifications of the proposed scheme are submitted with the tender. The most suitable scheme is selected, usually on the basis of design and cost. A building team or committee is formed, but without a quantity surveyor and with an agent of the employer, usually an architect, performing somewhat different functions than in a normal contract. The contractor produces all necessary drawings, schedules and specificaitons and controls and coordinates the work on the site, while the architect acts in a supervisory capacity on behalf of the owner. The architect may be required to handle such matters as interim payment and final account settlement. In some package contracts, there may be no consulting architects or professionals at all.

2.3.3.2.1 Advantages. Better coordination of the work usually results from the design and the construction being in the hands of a single party. As the contracting firm does the design and estimating, cost is generally lower, since costs of design and estimating by architects and quantity surveyors are high. When the project is let competitively, the owner has a wide scope of choice.

2.3.3.2.2 Disadvantages. Proper pre-planning is often jeopardised due to the limited time and vast amount of work required before a tender can be submitted. There might not necessarily be a saving in professional fees as contracting firms employ quantity surveyors and architects, and their cost is included in the price quoted. The competitive element can be introduced into this form of contract by considering a larger selection of tenderers. The work done by unsuccessful tenderers, however, forms part of their overhead expenses and must ultimately and inevitably be passed on to the building public.

2.4 PROJECT MANAGEMENT IN THE BUILDING INDUSTRY

2.4.1 Definition of Project Management

The definition of Project Management is taken from D.H. Scott's article entitled "An Analysis of Critical Elements in Project Management"[31]. "True project management is the orchestration of all the skills necessary to define the problem and to devise and implement the solution which optimally meets the objectives".

2.4.2 Reasons for the Emergence of Project Management in the Building Industry

The traditional arrangements and relationships between clients, consultants and building contractors engaged in development have, in the recent past, become strained due to the increasing complexity of building, the greater degree of financial discipline demanded and the continually increasing desire for reductions in the planning, design and construction periods. This has necessitated a more intimate understanding and interpretation of a client's requirements in terms of the building required, finance and time, improved communicaiton and much closer coordination of the work of the consultants and the building contractor. The development of buildings is a complex procedure made all the more so

by unstable economic conditions and changing technology, legislation and practice. In addition, financial commitments can be considerable and therefore, great expertise is required to avoid mistakes and to minimise delays throughout the many stages of development.

In the traditional system in South Africa, it is often a blatant error, or lack of judgement, or both, that leads to a particular contractor emerging as the lowest tenderer(31). Because the selecting of the building contractor for a project is invariably based upon competitive tendering, this system may virtually be relied upon to ensure the appointment of a contracting organisation least qualified in terms of the actual or hidden requirements of the owner. It is also a strong factor influencing the fragmentation of the building industry, separating the design phase from the construction phase. This fragmentation has led over the years to the 'arms length' type of contract that exists today, between the design team and the contractor. The contract is "ingeniously arranged"(31) between the owner and the contractor with the design team acting as the agent of the owner and the contract is worded in such a way that the contractor is "sure to have to take a responsibility for almost any setback"(31).

It is often claimed that this is the reason for the emergence of the package deal type of contract where the builder in turn, attempts to bypass the design team authority by direct negotiation with the client. This would then lead to the emergence, either of a contractor in-house design team or to the contractor's control on the employment of design teams. A new situation arises where the owner or client deals directly with the organisation carrying the responsibility for the project - but, unfortunately, has no way of knowing if he is getting a fair deal.

Protagonists of project management claim that the success of the package-deal type of contract is evidence of the degree of disillusionment with the design profession, notwithstanding the advantage of the professional approach. Such protagonists also feel that a firmer commitment to and responsibility for the quality of the end product should have been taken by the design profession in order to deal with the

threat to their profession by the package deal type of contract. Had this been achieved, there would then be a straight choice between the professional consultants and the profit orientated contractor, each with the same project motive of commitment to and responsibility for the end product.

The fragmentation of the design team is seen as a vital issue in the history of the building industry. One reason for this is put down as professional jealousies over who is best qualified to lead the design team. Another is that a group of organisations, each representing different skills in the industry, but little else in common, are brought together for a project. A tremendous task or effort is required to effectively coordinate a design effort when team members are in separate organisations, each with separate identities and possibly remote locations. Project management has therefore developed to meet the need that has arisen to coordinate this fragmented industry.

2.4.3 Project Management in Operation

Project management binds the whole project together and eliminates the conventional 'arms length' relationship which often makes adversaries of those who should be partners. It schedules, directs and coordinates the flow of information between all parties and thereby minimizes the time spent in searching or waiting, promotes cooperation and encourages people to be self-starters. It eradicates the 'ivory-tower' attitudes to costs and their controls and stimulates the search for economies without compromising quality. It focuses attention on the calendar and ensures that each participant is committed to the schedule and is aware of the effect which delays in his work will have upon the work of others in the programme as a whole.

A recent development has been the separate appointment of professional project managers by owners, with the object of ensuring satisfactory coordination and control of the entire project from inception through to commissioning. Thus a separate discipline has emerged with the very object of transforming the fragmented use of operations into a coordinated team effort under the control of a leader who knows what

needs to be done and who is able and determined to do it. The overall objective of project management is to establish the management and control of a project from inception to completion within the parameters of the client's brief. The client's physical and financial objectives should be clearly identified and then procedures established and implemented to ensure that these objectives are updated and modified as necessary, and achieved within the time scale.

Project management emphasises teamwork with the project manager's first priority being the selection of the team, in the absence of the client's preferred consultants. This emphasis on teamwork has given rise to a multi-disciplinary organisation, having developed as a result of being assembled for particular projects and having had the experience of benefits resulting from this team approach to the design and detailing of work. The team would include agents, legal advisers, architects, engineers, quantity surveyors, etcetera, as required. Project management is therefore, a fundamental part of the multi-disciplinary approach. The decision to work as a team means that there must be a team leader, and the role of the project manager of Project coordinator is created.
Project management may include the widest aspects of the project from conception and feasibility through to final commissioning - requiring a logical team commitment to the ultimate success of the project. Commitment to the project, emphasis on teamwork and good project management form the cornerstone of the multi-disciplinary approach[31].

2.4.4 Sources of Project Managers

The client might select the project manager from within his own organisation, or from an outside consulting service. Project managers appointed both internally, from the client's organisation, and from an outside agency, should be carefully scrutinised for their ability to assume this position and manage efficiently. An outside management service may be able to offer wider experience and give the client greater flexibility in the project than an "in-house" (internally appointed) manager. The latter may, however, have a sounder knowledge of the client's detailed requirements and greater experience from the practical

results of earlier schemes, particularly from a maintenance and management viewpoint.

The project manager can be drawn from any of the participating disciplines. Where a project is dominated by a particular discipline, it is therefore logical to select from the team, a project manager with a background in that discipline. He would need to be mature and authoritative, with broadly based experience and knowledge of building development. In the end, however, the decision on the best manager for the particular project, is based more on managerial and leadership qualities than on the discipline and background of the individual(32).

2.4.5 Project Management Services

The extension of project management services to cover the construction phase is a natural evolution of the role of the project manager. It is accepted practice in some countries that professional organisations offering this comprehensive management service, include total responsibility for the construction phase. This can be either in the form of a 'managed contract' when all the physical construction work is subcontracted, or else a construction agent can be appointed to act as the representative of the owner in employing the separate contractors required.

The degree of involvement of an outside management service and the specific duties to be included from the range of services offered, should be clearly set down for the client. The associated fee will vary according to the depth of involvement and size of the project. The average range of fee as an example taken in 1977 is .75% to 3% with 1% to 2.5% being more common(32). These figures are quoted to provide a rough guide and idea of the cost of this service, however, fees are better negotiated on a lump-sum basis rather than using a percentage of the total contract value.

Project managers will need to insure for professional indemnity. They should give due consideration to any additional insurance that might under differing circumstances prove necessary.

The following is a list of services likely to form part of project management, depending upon the requirements of the client:

1. Assessment of client's requirements.
2. Advice on site acquisition, assessment of planning potential, and advice on general viability including the efforts of taxation and legislation.
3. Preparation of the brief in conjunction with the client.
4. Advice on the appointment of the consultants and their fees; the establishment of communications; instruction and coordination of the professional team; establishing of reporting systems and procedures.
5. Advice on financing the project.
6. Establish that all statutory and local consents are obtained.
7. Critical appraisal and monitoring of all stages.
8. Financial planning and cost control.
9. Approval of the final design.
10. Advice on type of building contract and method of appointment of building contractor.
11. Overseeing contract progress including: control of variations and costs; monitoring of reports and progress on site; monitoring of availability of labour, materials and services; chairing meetings of the professional team and on site attendance as necessary.
12. Client liaison during the contract on progress cost and cash-flow; taking further instructions and translating these into coordinated instructions for the professional team.
13. Control of handover of the building and advice generally on such matters as insurance, defects and maintenance together with the provision of as-built drawings, instruction manuals, test certificates, maintenance recommendations and contracts etcetera.
14. The commissioning of the building for habitation or the coordination of the letting or sales programmes, including recommendations on the form of lease to suit the client's requirements or to maximise investment value.
15. Disposal of the completed investment where appropriate.

The project management service would exclude the professional services of, for example, the estate agent, architect, engineers and quantity surveyor.

Refer to Fig. 15[32] for a diagram entitled "RELATIONSHIP CHART FOR PROJECT MANAGEMENT".

CONCLUSION

It can be seen that project management has been developed because of certain needs that have arisen in the building industry. This need for project management has accelerated in recent times as a result of the increase in complexity of projects, and controls required such as those on cost, time and quality. Whilst the role of the project manager is, to varying degrees, fulfilled at the present time by other professionals, generally to the exclusion of their normal roles as consultants, project management is evolving as a profession in its own right. Although this evolution may be long and arduous on account of the many and varied disciplines involved, and especially the staid traditional nature of the South African building industry, the trend is nevertheless indicative of a separate professional entity in its embryonic stage. Its emergence is seen as inevitable and necessary for reasons already mentioned as well as for the healthy development of the building industry within the national economy.

Quality Assurance has a natural affinity to Project Management in South Africa because the project is run by one team which will require one project-wide QA programme covering design and construction and not separate ones as would be required by the different contract types listed in Chapter 2 paragraph 3 ibid.

CHAPTER THREE

A NATIONAL QUALITY AWARENESS

3. INTRODUCTION

In Chapter 1, Section 1.2.4 on Quality Control Circles, Company Wide Quality Control and QC Circles are seen to be the "child" or "invention" of "mother necessity". One only needs to look around one in every-day life to see the degree of success that has resulted from the Japanese effort to survive. There is hardly a home, factory or office in this country that does not sport a host of Japanese manufactured products. After learning how the Japanese achieved this, it is not difficult to understand that the pursuit of excellence in quality - fitness for use was a prime ingredient.

This chapter serves to indicate that like Japan, South Africa also has to compete on the World Market to increase and maintain a favourable balance of payments situation. The Japanese are frequently quoted as the fore-runners of successful application of quality management principles that result in success on the World Market. The quality/productivity relationship is discussed . The current awareness of quality management in South Africa is discussed, as is the development of S.A.B.S. 0157, Code of Practice for Quality Management Systems. Recent quality assurance events in the South African Construction Industry are mentioned, indicating the existing awareness and a trend of increasing quality awareness in South Africa. A discussion on the need for a National Quality Strategy, with suggestions concerning the implementation of the strategy, are put forward.

3.1 THE WORLD ECONOMY - PRODUCTIVITY AND QUALITY

The Finniston Report entitled "Engineering our Future" recently presented to the British Parliament by a committee of inquiry into the engineering profession, discusses the trends in World Trade. It highlights the fact that between 1964 and 1976, the world market share of British cars, ships, steel making and electrical machinery were halved. Deneys Zeederberg, former Director of Quality at ARMSCOR, provided figures from the German Economic Institute as follows:(33)
Japan has boosted her share of world exports from 1,3% in 1950 to 7,5% in 1978. "It is likely to become the world's largest exporter of manufactures. Japan already dominates exports in several fields, accounting for 75% of motor-cycle exports, 70% of radios and 40% to 50% of ships, tape recorders and calculators".

It is not surprising how Japan achieves this. Zeederberg provides information about South Africa's share of the world market. He says that South Africa's share of the world market has dropped from 0,6% in 1971 to 0,5% in 1976, for all commodities excluding gold. As far as South Africa's share in the market to developing Africa is concerned, it has dropped from 3% in 1971 to 1% in 1976. Dr. Basie Kleu, chairman of the Board of Trade and Industries, said recently that South Africa's Manufacturing Industry is a net consumer of foreign exchange, providing the example of a negative R740 million net foreign exchange earnings in 1975(33).

The success of the Japanese is being felt heavily in the United States also, especially in the motor industry, where between the end of 1979 and April of 1980, the Japanese had boosted their share of the U.S. car market from 21,5% to 29%. Dr. T. Hodgson, Director of Technical Services Department, C.S.I.R., says(34)"The standard of living can be assumed to be directly related to the level of growth in the Gross Domestic Product (GDP) per man-hour (Labour Productivity). For the relative difference between the respective GDP's per man-hour of the United States of America and South Africa to decrease with time, South Africa's GDP per man-hour will have to grow at a rate exceeding 6,2% (which corresponds to some extent to the present rate of increase in Japan's GDP per man-hour) and for South Africa's real GDP per man-hour to equal that of the U.S.A. by the end of the decade, it will have to grow by more than 16% per annum".

Dr. Hodgson predicts that in order to survive, South Africa has to look to the future and sort out her priorities. South Africa has all the ingredients for success: raw materials, energy, labour resources, a stable government, yet in specific areas, its products are often out-priced by others and the quality is inadequate.

Zeederberg has realised that besides South Africa's loss in product value, there is also a loss in labour productivity. (See Fig. 16)[33]. He says: "our labour productivity is now so low that labour is too expensive to use, despite the surplus (unemployment)". Zeederberg quotes Joseph H. Kehlbeck, who was concerned about the performance of the U.S.: "Every major country is engaged in a productivity battle with all the other major countries of the world. This battle is going on every day. It is not being fought with cannons, airplanes and warships; it is being fought in every factory every day as the factory competes in the world market. The winners of this battle are going to generate jobs, improve their standard of living, and reduce taxes. At the same time, the losers in this all important battle are going to see high unemployment, become a welfare state similar to what exists in England, and the standard of living will be lower than in other nations throughout the free world". It is easy to identify how well Japan is faring in this battle. In South Africa, we have slid from a situation in 1960 where the average industrial worker enjoyed a higher standard of living than the average Japanese industrial worker, to today, where our man's standard of living is about one third of his Japanese counterpart. From the above, we conclude that the Japanese seem to have all the answers. They certainly are going better in most sectors of the world market than both the USA and U.K. In comparison to the USA, South Africa is not performing well at all. We see too, that poor productivity is one of the reasons for this shortcoming.

But what relation does productivity have with quality, if any at all? H.J. Bajaria[35] of the Lawrence Institute of Technology, Southfield, Michigan, explains the relationship between quality and productivity:

"When management talks about productivity improvement, they generally refer to the rise in quantity produced per unit of effort. This definition can be made explicit in the sense that it should really say '<u>usable</u> quantity in <u>customers' hands</u> per unit of effort'".

Bajaria provides an example with three cases - See Figure 17 for the

relationship between Quality and Productivity for three production processes. Case A - for a given quantity level, if quality is increased, the productivity index will improve. (i.e. expenditure for a quality function will be justified). Case B - for a given quantity level, if quality is improved, the productivity index will remain a constant, (i.e. the lowest extreme to which the expenditure for quality effort will be justified). Case C - for a given quantity level, productivity index will go down, (i.e. quality efforts expended here will be in much higher a proportion than the productivity raise they will produce). The reasons why B and C behave in the way that they do, could be that:

there is either no or a very poor quality planning system.

Incompetent people are involved.

Product design is inconsistent with the state of the art.

There is no emphasis being placed on defect prevention, but emphasis is being placed on defect detection.

The quality department is being used by management as a "window dressing" effort, i.e. quality motivation is absent.

Repair and rework are more expensive than the original production piece due to inherent characteristics of product.

A conventional approach to improving productivity would be to install a new process, maintaining the same quality level, while another approach would be to increase the quality level from A to B (See Fig. 18). Not all situations will be as in Fig. 18 and it is important therefore, to identify whether situations described in Figs. 19 and 20 exist.

The sort of productivity indexes that can be influenced by a quality function are:

Scrap costs / total sales

Rework costs / total sales

Warranty costs / total sales

Product liability costs / total sales

Lost production costs due to unscheduled downtime / total sales

Quality department costs / total sales

Number of design changes / total sales

Testing costs / total sales

Other indexes such as:

Percent Market share

Profit per employee
Maintenance cost per unit of product
and other indexes such as
Worklife quality indexes
Hours spent in prevention activities / total hours
Proportion of absenteeism
Number of employees terminating jobs per year.

Peter F. Drucker states that making work productive has four requirements: Analysis to identify the specific operations, their sequence and relationships, and defining the end product: Synthesis into a process of production, which is the application of logic to work: Building into the process, the control of direction, quality and quantity, standards and exception; and Providing the appropriate tools(33). Zeederberg recognises the basic theme of Drucker's statement as being one of self-control, which coincides with the basic theme of the quality management discipline. He says "it is quality assurance which requires that work analysis begins with defining the desired end product. Quality Assurance is the only management and engineering discipline which seeks the establishment of a system of self-control which in its 'ultimate form' will give each participant in the productive effort, the ability to act independently, and an interest and a say in the planning and control of that effort, in effect, making him a partner rather than an employee in that effort"(33). Japan has succeeded in establishing this 'ultimate form' as seen in their CWQC philosophy.

3.2 QUALITY IN SOUTH AFRICA

With Messrs. Zeederberg (Director of Quality at South Africa's large ARMSCOR organisation) and Hodgson, (Director of Technical Services Department of the C.S.I.R.) both propounding quality assurance to the South African Industry, because they recognise the need that exists in South Africa for Q.A. implementation, it can be seen that a National Quality Awareness is slowly but surely developing in South Africa. Dr. Hodgson emphasises the need to train more QA personnel, while Mr. Zeederberg emphasises the effects of quality on productivity. Both have a common factor in their quality drive, and that is survival of the South

African economy in the World Market. In the last five years, South Africa has experienced a vast spread in the QA mission, and the Construction Industry has not escaped its influence. The South African Bureau of Standards (S.A.B.S.) has established a code of practice to meet the needs of purchasers, that the products and services they require give them in-use satisfaction. The S.A.B.S. has recognised the need for management to integrate effectively, their objectives in design, development, production and marketing to assure the quality of a service or product desired by the purchaser. To meet this need, the S.A.B.S. established in 1979 the 'Code of Practice for Quality Management Systems' S.A.B.S. 0157.

This came about as a result of the recommendations of the Exploratory Committee on Quality Assessment Systems, in 1979, when the S.A.B.S. formed a Quality Management Advisory Committee (QMAC) with aims and objects being:

1) Regular review of the Code of Practice on Quality Management.
2) Regular review of the Quality Assurance Assessment System and its implementation.
3) Regular review of the education and training and examination of Quality Assurance personnel and assessors.
4) Consideration of the promotion of QA and related matters. The QMAC has two sub-committees with the following terms of reference:

SUB-COMMITTEE ONE:
1) To recommend a common QA Standard for supplier assessment.
2) To recommend means whereby the establishment of a quality assurance standard can be implemented.

SUB-COMMITTEE TWO:
1) To recommend education and training and certification systems for management and other quality assurance personnel in South Africa.

Sub-committee one has been concerned with the preparation of S.A.B.S. 0157 (Code of Practice for Quality Management Systems) and a glossary of terms for quality control and quality assurance (S.A.B.S. 0158), as well as a code of practice for Measurement and Calibration Requirements for Industry.

Sub-committee two has been involved with a general questionnaire aimed at obtaining information that would assist with the structuring of courses in quality management and assessing the needs of industry in that regard.

S.A.B.S. 0157 is freely available now, upon request from the S.A.B.S. To provide an indication of the Quality awareness and degree of quality involvement in organisations in South African Industry, the reader is urged to study Dr. T. Hodgson's paper - "Education and Training in Quality Assurance".

Furthermore, the Electricity Supply Commission (ESCOM) has been required by the Atomic Energy Board (AEB) to implement a Q.A. programme on the design, construction, commissioning and operation of its first Nuclear Power Station - Koeberg, in order to receive a licence to run the power station. Subsequently, ESCOM has introduced the requirement of S.A.B.S. 0157 in all contracts for power stations. The vast power station construction programme that ESCOM has planned to meet South Africa's future energy needs means that henceforth, the construction industry will become very much involved in quality management systems(36).

A major South African Building Contractor, L.T.A. has also recognised Q.A. and has appointed a Q.A. Manager to meet these requirements. Another large Building Contractor, Murray and Roberts, publishes a monthly house journal called "Robust". In the August 1981 edition, "Robust" contains an article by J.E.D. Bramwell, deputy chairman of the Murray & Roberts Group, on the subject of Quality Assurance. The article is entitled: "IT'S NO GIMMICK", and announces that 1981 is Quality Assurance Year at Murray & Roberts. Bramwell says that the Group-wide Q.A. Programme initiated recently, is to be taken one hundred percent seriously by all concerned. To quote Bramwell on Quality Assurance, "It is necessary, it is desirable, and in many instances we don't have any option but to apply it anyway". M & R recognise that there are very few areas where their products have "no defects" and have adopted that as their QA goal. M & R are being guided by the Japanese experience and are striving for the Japanese reputation of highly competitive pricing, high quality and high technology in their products. M & R too, are feeling the demands of

their clients to adhere to S.A.B.S. and other "Q.A. Manuals". M & R have already embarked upon a Q.A. Training Programme.

At this juncture, it is interesting to note the difference in the manner in which Quality Assurance or Company Wide Quality Control has been adopted in South Africa and Japan. In Japan it was a case of "necessity is the mother of invention" and in order to survive, Japanese companies and organisations have tried to and succeeded in 'eating' the proverbial carrot placed before them. In South Africa, although this has been attempted, accepting Quality Assurance has developed more along the lines of: "In order to get our stamp of approval, you will have to implement our code of practice for quality management systems!" or: "If you want to be considered for this contract, you will be required to show us your Quality Assurance Programme!"

3.3 A NATIONAL QUALITY STRATEGY

There is mounting evidence that purchasers of industrial and consumer goods in this country are becoming more aware of the importance of quality and total life-costs. This is to some extent surprising, for South African consumers especially, are known for their apathy towards exercising their rights as consumers, which is shown by the lack of a consumerism movement here. There is also evidence, that retailers, led by large chain stores such as "Pick 'n Pay's Hypermarkets" and "Woolworths" who, if not already, are becoming increasingly conscious of the importance of quality.

As South Africa continuously urges its industries to secure export markets for goods manufactured here so that a positive foreign exchange flow can be generated, more and more manufacturers are feeling the strong competition on quality from overseas manufacturers - of course, especially from Japan. Yet in comparison to the whole, there are but a few that have recognised the importance of quality. Clearly, there is a responsibility for all manufacturers of products and services in South Africa, be they domestic producers or exporters, to contribute in his own way to the overall quality drive in South Africa. This is a pre-requisite so that South Africa's standards and levels of quality may be elevated to

compete favourably with other major producing and exporting countries on the world market. Consequently this is a goal that will have to be adopted by all providers of goods and services in South Africa before such competition commences. In fulfilling this responsibility, it will not necessarily mean that results will be seen immediately. In order to 'survive' over the longer term, in the face of successful countries like Japan, South African industries will have to work together in 'sorting out her priorities' as advised by Dr. T. Hodgson, in order to commence proceeding toward the goal. How do we go about this tremendous task? Do we set about it as individuals with limited coordination of effort and a virtual non- existent impact on a nation-wide basis due to fragmentation of effort? No. There is a need for effective coordination on a national level, with strong cross-fertilisation taking place between different sectors of industry about quality techniques and pratices. A National Strategy has to be developed as one of South Africa's priorities in order to reach its quality goals. The strategy should in particular seek to combine the resources of South Africa to ensure that goods are designed to meet world market needs in function, appearance and price, and that goods are manufactured consistently to conform to the design specifications at minimum cost. It should also consider the importance of product integrity and quality after the point of sale.

A strong theme flowing right throughout the very successful Japanese CWQC system is one of voluntary participation. It could well be that the characteristic of participation in quality being voluntary, has been a major contributing factor to Japanese success. Much can be learned from countries such as Japan, the United States and others who have already developed their national quality strategies. For some industries that implicate the safety of communities and the public at large, such as nuclear power generating stations, airlines and other public transport industries, construction and building industries (accommodation), food, and a host of other industries, already require quality programmes as a contractual obligation. Besides the importance of quality in safety orientated industries such as these, there are all the other industries where aspects such as function, appearance, price, conformance to design specifications and cost, all go together through varying degrees of soundness

of management, to determine just how fit-for-use the products result in being. Without contractual obligations or forced compliance to quality requirements in these industries, there exists only the proverbial 'carrot', a promise of fewer rejects lowering costs, higher productivity, greater product quality leading to a greater market share, and a host of others, to motivate these industries at all levels in the direction of quality. Consequently, a strategy is required to meet the quality objectives. This strategy should be formulated and developed through the voluntary co-operation of industry, commerce, consumers and the Government. This strategy should include the promotion of a greater awareness of the importance of quality in meeting market needs; facilitation of the implementation and assessment of modern quality management systems and an attempt to ensure that national arrangements are made for specifications, testing, and certification of goods to meet overseas market needs.

The promotion of quality in order to build up and sustain the growing national awareness of the importance of quality at all levels of industry and commerce and by the public at large, should include the following actions:

1) Promotional campaigns that will aim to develop this greater quality awareness and that will also be organised in collaboration with national organisations such as the South African Board of Trade and Industries; National Productivity Institute; Council for Scientific and Industrial Research; the South African Federated Chamber of Industries; the South African Design Institute; the South African Society for Quality Control, and the professional institutions.
2) An ongoing review of training and educational facilities and courses to examine whether they meet the nation's quality needs, and, if not, to formulate with institutions and educational establishments - proposals to enable them to do so.
3) Provision of assistance through quality consulting; providing advice, case studies seminars and similar means, in order to help smaller and medium sized firms in the development of quality techniques and practices in their organisations.

Modern quality management systems that operate from the design stage right on through to after-sales service, are required to ensure that the

quality of manufactured products meets customers' quality requirements. While the responsibility for introducing and implementing such systems rests with individual firms, more and more customers and upper-tier contractors are assessing their suppliers and sub-contractors to establish whether they have the capability of producing products and services of the required quality.

As many different upper-tier contractors and manufacturers might subject the lower-tier sub-contractors or suppliers to quality assessments in selected areas, it would be necessary to consider the reduction of the level of unnecessary multiple assessments through national coordination, or, perhaps, have such assessments undertaken by bodies of acknowledged competence, for example, where overseas market requirements are to be met. Some firms may need advice and help in improving their systems and should a body of acknowledged competence be established, this body would be in a position to provide this service.

Customers would feel it necessary to assess contractors' or suppliers' quality systems in order to increase their level of confidence in the contractor or supplier. If certain existing organisations like the S.A.B.S. or the B.I.F.S.A. were to undertake this function of contractor/supplier assessment, great reduction in the level of multiple assessments would be made. Such a system would be required to take into full account the legal implications of assessment as part of the terms of contract. Suppliers, contractors and sub-contractors on the quality-approved assessment list, would expect an enhanced status in the domestic, and where applicable, overseas market. The assessment scheme should strive to be authoritative and impartial and should be effected by a recognised organisation in order to gain nation-wide and overseas acceptance.

It is essential to have suitable product standards and specifications with testing and quality assurance provisions. There should also be some standards and guides, or as South Africa already has, a code of practice, needed for the development, implementation and assessment of quality management systems. This national responsibility has already been undertaken by the South African Bureau of Standards. Certification of various

testing institutions or organisations that have competent and well equipped facilities, should be made so that such institutions may receive national quality recognition.

The task of initiating and sustaining a national quality drive should be vested in a single focal body, in which all interests would have confidence. In South Africa at present, this has been undertaken by the South African Bureau of Standards, as seen in their publications such as SABS 0157, however, the S.A.S.Q.C. would also have a very important and meaningful role in this direction. While the S.A.B.S. could accept the task of formulating and coordinating a detailed strategy for re-asserting the Quality of South African goods and reducing the industry's quality costs, the S.A.S.Q.C. could well be the organisation to accept the responsibility for promoting a better understanding among all sectors of the community of the importance of quality, but with strong backing and liaison with the S.A.B.S. This task, however, could also be entrusted to a new body altogether, set up specifically for this purpose, with as much work as possible being done through existing organisations. This new body could be called the South African Board of Quality, and its terms of reference could be precisely tailored to the task envisaged, demonstrating at the same time, a clear commitment to the importance of quality.

As a result of series of interviews with building clients i.e. those organisations that have building projects commissioned for them as an investment, such as insurance companies, it has been identified that there is a general recognition by such clients that the building industry in South Africa is a relatively unsophisticated industry, yet a very complex one. Accordingly, it is felt by these interviewees, that the initiation and direction for a quality strategy in the South African building industry, should be undertaken at Government level. Whatever the vehicle chosen to develop, implement and support the national quality strategy, it would necessarily have to be funded to a large extent, by the Government. This having been done would render the status and commitment of the country to the strategy, unequivocal.

CONCLUSION

It is clearly desirable that quality becomes a well understood concept in the minds of all South Africans. The need for this awareness stems from the fact that South Africa is a competitor in the World Market - but only just! Her glorious days of the past are not likely to continue if she does not succeed in the world market 'rat-race' for a slice of the 'world market pie'! There might be many ways to put South Africa on the path to success, but one tried and trusted way, as Japan has shown the world, is the pursuit of a National Quality Strategy. South Africa is not self-sufficient as the balance of payments continuously shows, so in order to fund her imports, her exports have to be worthy of marketing. The importance and significance to the country's economy of such export successes on the World Market demands government attention. Who can be more effective in the support and guidance of a new movement designed to improve the health of the economy - a national quality strategy, than the government itself. The strategy should not only affect the country's export clients, but should also have the effect of raising the standards and quality of life for each and every South African, domestically.

This need has been discussed on a national basis for all industries effectively. The reader is taken into a discussion of the need for quality awareness in the Building Industry in South Africa, in Chapter 4.

CHAPTER FOUR

THE NEED FOR QUALITY ASSURANCE IN THE SOUTH AFRICAN BUILDING INDUSTRY

4. INTRODUCTION

The author undertook to compile a series of questionnaires that were to be sent out to members of the Building Industry in South Africa, in order to assess the degree of quality awareness in the industry. The survey was planned to include clients, design consultants and building contractors and was to be effected in two main parts; the first part being a pilot study in the Cape Peninsula area and the second, a nation-wide study. It was considered that the pilot study would provide feedback to the author on the effectiveness of the questionnaire method of research in this industry. Initially, two questionnaires were drafted, one for architects and the other for building contractors. The sample of questionees was taken from the Architects Directory of the Institute of South African Architects (Cape Provincial Institute) and the members list of the Master Builders Association - Cape Peninsula area of jurisdiction - which appears in the Building and Allied Industries Handbook 1980/81.

Approximately fifty of the initial questionnaires were sent to Architects and Builders. The response to these questionnaires was re-evaluated through the means of:

1) telephonic discussion with an architect and a building contractor, both of whom had been sent a questionnaire.
2) discussion with the Professional Communications Unit at the University of Cape Town.
3) discussion with a senior lecturer of the Department of Building Science at the University of Cape Town.
4) discussion with the author's supervisors
5) discussion with a quality assurance consultant.

The questionnaires were then revised and re-drafted, with a slightly different layout and approach, with respect to the manner in which members of the building industry were invited to participate in the pilot

study. The pilot study involved the posting of the questionnaires to the questionnees, expecting, in good faith, that a forty percent response would be achieved. The percent response that was received led the author to adopt the new approach in the interests of achieving a better percentage response besides attempting to be cost efficient. The new approach was to involve an initial brief letter inviting members to participate and to respond indicating their willingness to do so. The Institute of South African Architects had advised that the author could expect a 45% response from their members, however, in the light of the responses received from the pilot study, the author expected a response of approximately thirty percent.

The author intended distributing approximately 1 000 'letters of request' to the design consultants and building contractors and consequently expected the response to these letters to number approximately three hundred per vocation. The questionnaires for these vocations would then be distributed and a response was expected to be in the region of sixty percent, bearing in mind that an undertaking to complete the questionnaires had already been received by the questionnees concerned. Based upon these figures, a feasibility study concentrating on the cost of printing and mailing was made and the author concluded that even with co-operation in the line of physical mailing assistance from the institutes concerned, the lack of interest from organisations approached for sponsorship in this regard forced the nation-wide survey to be shelved. The author concludes that this lack of interest really indicates a lack of interest in and knowledge of Q.A.

In lieu of this survey, a series of interviews were then held with building clients, design consultants and building contractors, but purely on a local basis.

The results of the pilot study and the interviews held are discussed in this chapter. The questionnaires are also discussed in some detail, providing reasons why the questions asked were felt necessary. In order to find objective evidence of a need for quality awareness in the building industry, it was felt necessary to address each member of the building team - the client, design consultant and contractor. There are more in-

dividuals whom it might be deemed could provide additional and valuable input to the study, such as builders merchants, sub-contractors and other specialist trades and consultants, however, the resources available to the author limited the exploitation of these additional avenues. For the purpose of this study, the information gleaned was sufficient to provide the sought-after objective evidence of the need for quality awareness in the building industry.

4.2 THE QUESTIONNAIRE

The motive behind the questionnaire was to determine the degree of quality awareness in the building industry. The structure of the questionnaire was chosen with a view to being easy to complete but at the same time being comprehensive. The main quality criteria, listed alphabetically in the second part of the 'pilot study' (initial) questionnaire (Refer Appendix 2 and 3 for master copies) formed the backbone of the questionnaire. The multiple answers provided the questionee with a choice of: 1) declaring that he implemented the requirements of a formal QA programme in respect of each question asked, demonstrating that he is fully aware of and follows QA principles, 2) that he 'goes through the motions' of implementing a QA Programme but is not aware of formal quality management systems, or 3) that he has no particular concern for quality problems and their efficient solution - or that he has some other way of dealing with such problems.

The purpose of the general section of the questionnaire was to determine and categorise the type of questionee organisation and the services provided by it. This was included to determine whether certain types of organisation tend to adopt quality assurance while others remain simply quality conscious or not quality conscious at all.

The questionnaires were sent to architects and Building Contractors in the Cape Town area and differed from each other to cater for vocational differences - the emphasis being placed on quality of design in the architects' questionnaires, but on quality of conformance in the builders' questionnaires. Refer to Table 4 in the Appendix section for the results of the questionnaires.

4.2.1 Questionnaire for the Architects

The Architects' questionnaire was completed by only two organisations, respondent "A" an respondent "B". Three other organisations responded indicating that they were unable to complete the questionnaire. Fifty questionnaires were mailed to architectural professions. The response achieved can hardly be indicative of how aware of QA the architectural profession is, however, the results are discussed, showing differences between respondents "A" and "B".

Both respondents are large partnerships (4 or more partners with supporting draftsmen and site supervisors) and have been in business in excess of 30 years. Both of them have more than five projects running simultaneously. Of the projects on which they have been involved over the past ten years, by far the larger percentage are of the design, administration and final account type of involvement. There is no specific type of building in which either of them specialize. Partnership B sticks to conventional "Bills of Quantities" types of contract while partnership "A", although this type of contract forms the largest percentage of his total, also enters into negotiable type of contracts as well as other unspecified types. Both respondents serve a wide range of client types.

4.2.1.1 Evaluation of Results

a. Organisation. Neither of the two respondents have an independent department, section or group to deal with quality problems. When the production side is faced with quality problems, the independent group performing quality assurance functions should report to a management level that has the required authority and organisational freedom, including independence from cost and schedules. The purpose behind this is to achieve the resolutions of these problems with the objectives of quality uppermost in the mind and without bias or pressure from the production side. The evaluators of quality problems must have sufficient management support to assure that detected non-conformities and deficiencies are corrected. (See Fig. 21 for an example of a typical organisation chart showing this relationship).

The independent quality organisation or department is fundamental to the successful implementation of quality management principles. The results achieved from respondents A and B indicate that neither of them understand the philosophy of quality assurance.

b. 1, 2 & 3 Programme. Both respondents "A" and "B" claim to have a written quality policy endorsed by top management. Respondent "A" has a 'practice manual' which is undoubtedly an in-house office procedure, which, as he indicates, deals in general terms with and controls quality. Respondent "B" indicates that he has nothing of the sort.

The quality manual is an essential document in a properly organised establishment because quality assurance can only operate effectively if the aims, objectives and procedures of the function are clearly understood. It contains the official quality objectives of the firm, communicating them to all functional groups in the organisation as well as identifying relationships between each of these groups and the quality function. It provides a basis for training quality personnel and others whose work affects quality. It serves also to formalize a quality organisational plan in relation to other functions so that the organisation may be kept under continuous review. It gives assessmet teams (in this case designers) the opportunity to compare the company's organisation and attitude towards product quality with their own requirements. In short, it is a statement by top management of the firm's quality policy which, like a firm's good reputation, is to be respected and adhered to at all times.

Respondent "A" has what he calls a 'Policy Statement' which contains procedures for implementing quality activities and which, together with his practice manual are updated on a regularly scheduled basis. Respondent "B" has no such document. The quality manual should describe in detail the quality management functions during design and development, listing responsibilities for each, including design review, value engineering, value analysis and product review. Furthermore, the manual should contain a description of quality control methods and all procedures for activities affecting quality. It appears that respondent "A" does have something that would fit the bill as far as this 'orgnisation' section for

the questionnaire is concerned, but it is not evident that it carries the full quality assurance conviction.

c. Control of the Designs. Respondent "A" does require the designers to state the assumptions and references used as the basis for his designs in written standardised form, while respondent "B" does not have this requirement at all. Respondent "A" also requires his specifications to be submitted for a second or independent review, but this is usually a formal discussion at a meeting, where if changes to the specification are made, modifications are included in the "Master Specification" using a control register. Respondent "B" does not require specifications to undergo a second or independent review, but simply notes revisions on plans and dates them when design modifications are made. Further than this, respondent "B"'s design control is non-existent. Respondent "A" also requires drawings to undergo a second independent review which is documented using a standard format and procedure. If design changes are initiated at or through the design office, or in the field, these are controlled by respondent "A", by using formal documentation and a register, following a formal procedure.

Defective design may be manifested in many ways: incorrect materials specified, vague or ambiguous specifications for materials, methods and treatments, incorrect specification for corrosion, inadequate user and installation instructions and many others. The design function is a highly complex task and the preparation of design specifications extremely important. The independent design review where specialists from all relevant functions bring together their expertise with a view to optimising design in terms of satisfaction of client requirements, reliability, ease of manufacture or construction, ease of maintenance and service, appearance and safety, is yet another important aspect. Should designs change during the initial or secondary reviews, the required efforts should be taken to assure that the specifications and drawings are modified to reflect the changes, eliminating the possibility of superseded specifications being included in the final product.

d. Document Control. As far as drawings and specifications are concerned, both respondents require the identification of those to whom these

documents are issued and both of them in a reasonably formal manner. This practice however, does not extend to purchase orders, where the author has concluded that architects think in terms of this responsibility as being one vested with the contractor. It is apparent from this conclusion that architects do not show interest in the control of purchase order documents to ensure that revisions, which might have originated from their own design change order or instruction affecting quality, are in fact conveyed to the contractors, sub-contractors or suppliers.

All documents prescribing activities affecting quality need to be controlled to assure that the documents themselves and changes thereto, are reviewed for adequacy and approved for release by authorised personnel and distributed to the locations where the prescribed activity is performed. A change to the document should be reviewed and approved by the same individuals or organisations that performed the original review.

Here, both respondents indicate that they are performing a quality management function reasonably efficiently but without any association to and coordination of this function with a formal quality management system.

e. Procurement Control. Respondent "A" keeps a record of his clients' tenderers' capabilities and performance, but does not require the use of a qualified tenderers list for each project. Respondent "B" does not do either of the two. Both respondents "A" and "B" do not evaluate and visit the premises of tenderers before the contract is awarded. This would be a difficult requirement to fulfill, as with manufacturers, a contractor seldom carries on work at his own premises. It would therefore be difficult for an architect to gain access to a site where construction works were underway and the architect wishing to do an appraisal, not being the agent of the client erecting the building. This aspect of quality assurance is commonly known as vendor appraisal or evaluation and aims at providing confidence that quality products and workmanship will be provided. The appraisal is normally carried out by a team comprising design, purchasing, production, finance and quality personnel. In the case of the building industry, because of the nature of contract-

ing, the requirement would be for a designer (architect) to evaluate a contractor, and then the two of them together, as a team, to evaluate sub-contractors and material and product suppliers, in order to adequately satisfy the requirements of vendor appraisal.

f. Inspection. Both respondents perform inspections during the construction phase, which are formally documented and both maintain a qualification level for those performing inspections. Respondent "A"'s quality policy lays down the requirement of the maintenance of qualification levels, while respondent "B" simply has informal requirements based on the inspectors experience and performance record. There will always be a need for a considerable amount of inspection both during and after construction and manufacture, and even throughout the building's life. Inspection should be as efficient as possible to prevent expensive recall programmes at a later stage. While the contractor himself should be implementing an inspection programme on his own work, the objective approach from the quality conscious architect will assure the client that quality is being achieved on the project. Here, both respondents are diligently performing one of the prime management or administration functions of the architect and inspector, but again, without a full quality assurance conviction.

g. Testing. Both respondents "A" and "B" require tests to be performed on materials, parts, components and systems, however, respondent "A" does not require tests to be performed on <u>all</u> materials. He does have these tests performed in accordance with written test procedures incorporating requirements and acceptance limits, while respondent "B" allows the testing individual to set his own requirements as he may see fit. Both respondents make use of a formal document instructing corrective action to be taken by the contractor when test results are not satisfactory. Respondent "B" does not follow the requirements pertaining to measuring and test equipment, while respondent "A" does this fully.

In order to demonstrate that structures, systems and components will perform satisfactorily in service, a test programme needs to be established. Tests should then be performed in accordance with written procedures which incorporate requirements <u>and</u> acceptance limits <u>as inferred by the</u>

applicable design documents. All test results should then be documented and evaluated with adequate feedback to the design originator, where applicable.

h. Handling. Both respondents "A" and "B" require that their contractors observe the requirements of lifting, moving, cleaning, coating, environmental conditions and where applicable codes, standards, regulations, specifications and design documents pertaining to material and equipment. Both respondents document these requirements in their contractual documents and check to see that the requirements are being carried out. It is most important to ensure that, right from their origins, materials and products are carefuly handled, so that their characteristics affecting quality are not destroyed. This ensures that the materials and products will not be rejected, or responsible for inferior quality when incorporated into the works. Both respondents indicate that this requirement is being met, yet it is debatable whether it is being done thoroughly.

i. Deviations from Requirements. Respondent "A" does require that materials, parts or components which do not conform to requirements are to be controlled in order to prevent their inadvertent use, and he documents these nonconformances formally, providing all the required details. Respondent "B" indicates that he does not tackle deviations from requirements in this manner at all. Respondent "A" however, does not require the marking of items identified as being nonconforming, while respondent "B" now indicates that this is in fact done in his organisaton, but left up to the individual. Both respondents require that the cause of all conditions adverse to quality are properly identified and corrected with the cause of such conditions being determined as well as the corrective action being taken to prevent repetitions all being listed in a special document. It is important that the cause of the conditions adverse to quality are properly identified and communicated to all concerned in the design and construction divisions. Such conditions may then be 'designed-out' of the system in the future. Few design consultants actually go as far as purposefully taking the corrective action report right to the root of the cause, especially when the root is "bedded" in a material

supplier or product manufacturer's organisation (Refer also interviews para. 4.3 ibid).

j. Records. Both respondents "A" and "B" follow the requirements concerning the preparation and maintenance of quality records. For respondent "A", these requirements are laid down in a procedure and used on all contracts, while for respondent "B", the requirements are observed informally. Documentary evidence of the quality of items and the activities affecting quality are provided and maintained for the benefit of the designers and contractors after the completion of a contract and for the purposes of a quality reference. However, they exist to provide the objective evidence of the maintenance of quality in all aspects of the project and during audits on any aspect of the project. Distinction ought to be made by the architect between records pertaining to activities affecting quality, and those that are simply run-of-the-mill office documents.

4.2.1.1 Conclusion. From the results above, it is difficult to place either one or both of the two architects into one of the categories listed in para. 4.2. In some aspects, both respondents "A" and "B" have demonstrated that they fit into category 3, i.e. that they have no particular concern for quality problems, and their efficient solution (e.g. using quality management). By far the majority of answers indicated that both respondents would fit best into category 2 ("going through the motions" of QA implementation) although respondent "A" would fit into this category far better than would respondent "B". This would indicate clearly, as far as this small sample goes, that only a "formalising" of their present management, incorporating a few modifications, would render acceptable quality management systems. Without a system that can be properly identified as quality management, the benefits of quality assurance as laid down in Chapter One, cannot be realised.

4.2.2 Questionnaire for the Building Contractors

The Builders' questionnaire was completed by six contractors; another four responded saying that they were unable to complete the questionnaire. Fifty questionnaires were mailed out to building contractors in the Cape Town area. The response received can hardly be regarded as re-

presentative of the local industry, however, it is a larger response than that received from the architectural profession. The results will be discussed showing details of contractors management.

Of the six contractors, two are involved exclusively in housing construction and three in large project type construction, incorporating hospitals, schools, office blocks, factories, appartment blocks, shopping complexes, sporting facilities, etcetera. One of these is involved quite entensively in large-scale housing schemes. The sixth contractor performs both housing construction and large construction-type projects, mentioned earlier, as well as some civil work. The two contractors involved exclusively in housing have been in business for not longer than twelve years. The 'average age' of the other organisations is 39 years. The average number of directors in the contracting organisations is three. Most of the contractors pursue the traditionally recognised forms of contract. ("Conventional" is the term used in the questionnaire.) Apart from the domestic builders, client-types are varied.

4.2.2.1 Evaluation of Results

A. Organisation. None of the contractors have an independent department section or group to deal with quality problems excepting for one housing contractor. He calls this a maintenance department and the author makes the assumption that quality problems are fed back to the construction department by the maintenance department to prevent their recurrence. These results lead the author to conclude that these contractors do not appreciate that behind most of their problems lies something related to quality, or the lack thereof.

B. Programme. Three contractors do not have a written quality policy endorsed by top management, while the remaining three do. One of them, a housing contractor, refers to this as a five year written guarantee. The presence of a written quality policy is perhaps the best indication that a quality conscious mangement exists, however whether the policy is cosmetic or sincere needs yet to be determined. None of these contractors have a written QA/QC Inspection Manual, although one housing contractor claims to have a QC Manual which contains QC procedures and is updated on a regularly scheduled basis. It is doubtful whether his manual is com

prehensive or implemented in a manner proper enough to be considered QA. With the exception of this house builder, all of these contractors do not have a modicum of quality programme, reinforcing their lack of appreciation of sound quality management.

C. Control of the Designs. Three of the contractors do design work; the balance do not. None of the contractors appreciate and follow design control requirements excepting a house-builder who has a written requirement that the architect is to state his assumptions and references used as the basis for his design. Two contractors require design calculations to be subjected to an independent or second review. One of these is a housing contractor and the other a large general building concern who requires the review to be made by a professional engineer.

Three of the contractors draw up specifications; the others do not. Two of those that do, require the specifications to be subjected to a second independent review. All of the contractors require that changes to specifications be communicated to the job site on a standard document and controlled transmittal system. Four contractors initiate working drawings, the other two do not. Three of them require the drawings to undergo a second independent review; one of them informally and the other, only a group discussion on preliminary sketch plans. Two contractors will include modifications to drawings at this stage through the use of a drawing control procedure, or a simple update of the master original.
Only one contractor does not require the control of design changes initiated at the design office, most likely because he does not originate working drawings. All the other contractors have this requirement which is either documented formally or effected via telephone or other consultation. Verification of implementation of the design change is done by some unspecified in-house procedure. All contractors require design changes made in the field to be controlled and either documented formally on a standard format or in an informal in-house but standard manner. Follow up on implementation is made in the same way as for design changes made in the design office. As far as concerns the control of design changes, all of the contractors exhibit a firm control. It is assumed that the contractors regard the design review as an architects function, although it is done by two contractors who themselves initiate designs.

D. Document Control. Four of the six contractors require that those to whom specifications have been issued are identified using a formally documented control log containing all relevant details. All of the contractors require that changes to specifications are conveyed to the individuals who have been issued with the initial or superseded specification; either by using a formal control log or an informal control system. The same applies in the case of drawings and for purchase orders, although, for the latter, one contractor does not have this requirement. All contractors require that details of the revisions to purchase orders are conveyed to the individuals issued with superseded purchase orders. There is a tight control on documentation as far as drawings, specifications and purchase orders are concerned, with almost all of the contractors concerned. There ought not, therefore, to be any breakdown affecting quality through the inadvertent use of a superseded specification, purchase order or drawing. This constitutes a large area to where the root cause of quality problems are often traced.

E. Procurement Control. Only, three contractors keep sub-contractor and supplier performance history files. All excepting one contractor uses a qualified sub-contractor list for each new contract, based mostly upon the contractors financial and performance reputations (not on quality, excepting of course if option 10 of question 9 of the questionnaire was ignored by the respondent, placing quality with performance).

The evaluation of the subcontractor's quality considerations is done informally by all excepting two of the contractors. In their opinion, contractors indicate that a qualified subcontractor would be one who performs acceptable inspections on his work, excepting for one, who says it would be a subcontractor that has an acceptable Q.C. Manual. This contractor claims to have a Q.C. Manual himself.

None of the contractors visit and evaluate subcontractor organisations for each contract, prior to the contract award. During the course of the contract, all contractors require an inspection and examination of subcontractors organisation and behaviour during performance of work.

The results of these inspections are noted informally in four of the six cases; formally in one case. These results are generally included in the subcontract general correspondence file.

F. Inspection. All the contractors perform inspections during the construction phase; only three of them require those performing inspections to be qualified. When performing inspections, it is important for the inspectors to have a training in quality inspection procedures and to be able to identify areas affecting quality of the work that they inspect in order to be effective. This questionnaire does not identify whether these individuals comply with quality inspection requirements, however, the fact that inspections are being performed does show a positive approach.

G. Testing. Only three contractors require tests on materials, parts, components and systems to be performed and all three have this requirement extended to cover their subcontractors. Two of these contractors have written test procedures incorporating requirements and acceptance limits, while the balance leave it up to the individual, as he may see fit. If test results are negative, a formal corrective action document will be used by two of the contractors, while only one will mark the defective item and reject it. Three contractors indicated that they follow the requirements of calibration and control of measuring and testing equipment. Tests can only give a true reflection of the quality of material, product or component if the equipment with which the test is being made is properly calibrated and sound in all other respects. Destructive tests necessitate employing sampling techniques while nondestructive testing would enable tested products to be used. There can be no better verification of the quality of a material or product than by submitting it to a properly designed and executed test. The contractors demonstrate a lack of understanding of the full significance of testing, seen by their answers to this section.

H. Handling. Three contractors require that the handling of materials components, parts and equipment be performed in accordance with the requirements of environmental conditions, codes, standards and regulations. Only one contractor documents these requirements, another leaving it up

to the individual to document. These two contractors follow through with on and off site inspections to verify compliance to requirements.

I. Deviations from Requirements. Only three contractors require that nonconforming materials be controlled to prevent their inadvertent use. Two of these document the nonconformances formally, providing comprehensive information pertaining to the case. Only two contractors mark and identify items. All but two contractors require, that the cause of such nonconforming conditions be properly identified and corrected, the cause and corrective action to be taken to prevent repetition being identified separately.

It is imperative for effective quality management that the true system breakdown that caused an item, part, component, material or product to be nonconforming, be properly identified. This cause would be "designed out" of the management system and would be monitored more closely in the future. Should it have been a design related problem, it would be picked up by the designers from the resulting documentation that is generated. The reason behind this is to prevent its recurrence and is simply a feedback system for so doing. Few of the contractors actually do this "all the way", some do not do it at all. There is thus a clear need for a greater awareness of the benefits of inspection identified here.

4.2.2.1 Conclusion. As with the architects, none of these contractors can be categorised into either of the three intended categories. None of them exhibit all the requirements for categoy three, nor for category one. This means that they would best fit into category two, but this must be qualified. Many contractors, probably without knowing, implement sections of Q.A. programmes in their operations. Without the formalised quality organisation to support and coordinate these activities, much of the goal of quality assurance is being lost. The author concludes that there is a need for an explanation to contractors in general, of the extra measures that would have to be added to their present practice, in order to establish a Q.A. programme.

4.3 THE INTERVIEWS

In evaluating the interviews, the author addresses the clients; Architects and Quantity Surveyors including an input from a member of the Portland Cement Institute - as Design Consultants; and Contractors, including input from the Master Builders Association and the Building Industries Federation of South Africa: all separately. The interview comments are analysed according to a sub-division into eighteen quality criteria listed below, including comments on quality strategy, quality costs and others, as and where applicable. The eighteen quality criteria are: 1. Organisation, 2. Quality Assurance Programme. 3. Design Control. 4. Procurement Document Control, 5. Instructions Procedures and Drawings. 6. Document Control, 7. Control of Purchased Material, Equipment and Services. 8. Identification and Control of Materials, Parts and Components. 9. Control of Special Processes. 10. Inspection, 11. Test Control, 12. Control of Measuring and Test Equipment, 13. Handling Storage and Shipping. 14. Inspection, Test and Operating Status. 15. Nonconforming Materials, Parts or Components, 16. Corrective Action, 17. Q.A. Records, 18. Audits.

4.3.1 Clients

The clients interviewed are all private: three large insurance companies and a university. Their comments (in inverted commas) and discussion follow:

1. Organisation

"Few contractors have a polished management team ..".

This implies the need for improved management in the ranks of the contractors in the industry and in the context of quality, it would indicate a need for quality assurance there. In criticism of the nature of the contract between the architect and client - "Once signed by the client, he (the client) has signed away all his rights excepting to pay money as directed by the architect. The architect is left to be the sole judge."

"The contractual side of the professions needs to be looked into in great depth".

It would be in the clients best interests to maintain a link to a part of the architect's (agent of the client) organisational structure, especially during the design stage, to ensure that details concerning quality

levels and the achievement of these levels can be communicated to and from the client effectively. The author identifies a need to change the nature of contracts between the different building team members if the requirements of the eighteen quality criteria were to be rigidly enforced in the building industry.

"Changes to everything in the "White Form" need to receive a unanimous decision from BIFSA."
"We have a project management team and follow conventional contracting procedures as well as negotiated and managed types of contract. The reason for this is that in recent times of high escalation, negotiated contracts, based upon 'fast track' systems of building are opted for. A little premium is paid, however overall savings are made on escalation."

This demonstrates the client's need to cut costs by avoiding the 'White Form' and involving his project management team in a negotiated contract. Without having to effect changes to legislation, the client now has the ability to control some of his costs directly, including the opportunity to effect savings on quality costs, in the negotiated contract. This indicates a need for his organisational structure to incorporate quality management in his overall project management team.

2. Programme
"It is company policy to set standards of quality. Our principal agent is the architect whom we feel is very insensitive to our requirements. We believe this is due to their being too used to dealing with laymen and so we prepare a technical brief for our design consultants to follow".

Besides the design aspect, this client demonstrates that he does have quality requirements but that amongst others, the architects are insensitive to them. In order for the client to assure himself that his quality requirements are being met, he would have to make it a requirement that the architect has a quality policy and a programme. This implies that the contract between architect and client should list a quality programme as a contractual obligation. If, however, both client and architect were aware of the benefits flowing from a quality assurance programme, logic and reason should prevail resulting in the architect voluntarily exploit-

ing this area of management for his own and his client's benefit. Such a client in search for design consultant would think twice about commissioning one that does not have a Q.A. programme.

"If we had to make S.A.B.S. 0157 a contractual requirement for our contractors, it would automatically build up the tender price."
Few clients, architects or contractors interviewed knew what S.A.B.S 0157 contains and even fewer still, were aware of its existence. None of the inteviewed understood the purpose of the code of pratice, until explained to them. As has been explained in chapter 4.3 ibid, an increase in tender price should strictly result from the setting of higher quality levels than those required by municipalities as a minimum. The requirement of a Q.A. programme (for example SABS 0157) to be adopted and implemented, would imply an ultimate cost saving to the contractor.
This cost saving, through the use of a Q.A. programme, should, in all fairness, be shared with the client, to demonstrate the contractor's eagerness to win a contract. A reduction should thus be reflected in the tender figure, not an increase.

"The South African Building Industry is very unsophisticated." Implementation of SABS 0157 or the use of other quality assurance programmes in the Building Industry, would therefore help fulfill the clients' need for a more sophisticated industry.

3. Design Control
"We have found a reluctance from consultants to commit themselves to quality."
As professionals, architects and other design consultants are obliged to take measures to assure that applicable regulations and requirements are correctly translated into specifications, drawings, procedures and instructions, as part of their mandate. The client's brief and other requirements affecting quality are likewise the responsibility of the design consultants. The client clearly expresses his need for his design consultants to become more aware of quality management.

"The design consultants are the ones that must bring their expertise to bear upon the problem of choosing the right materials for the client's use."

The client expresses his need of being able to rely on the design consultant's knowledge and ability to identify the quality levels that are required and to specify materials to meet those levels. Through the employment of quality assurance in design, the design consultants will be able to determine the state of the art and technology pertaining to alternative materials; determine design and reliability test requirements; assess their performance from environmental test results; consider safety, reliability, maintainability, standardisation and perhaps conduct failure mode effect analysis(37). They will provide themselves with the assurance that the client's quality needs will be met in the best way possible.

"One must realise that the level of skills has changed over the years and that in looking for cheaper materials, tricky details often result - affecting quality."

The specification of cheaper materials necessitating tricky details indicates a breakdown in the quality of design. The design consultant and his primary and secondary design reviewers have omitted to assess the performance and resulting effects of the use of the specified material and in the specified manner. In this case, the overall quality of the component is rendered inferior.

"Manufacturers of roof coverings competing heavily against one another are producing roofing sheets to the same profile, but of thinner gauges and therefore of inferior quality - and the design consultants are not aware of these changes. The cheapest type of roof covering is invariably selected."

This demonstrates the client's misgivings of design consultants. Failure in verifying and checking the adequacy of their designs, a fundamental in quality of design, indicates a strong need for quality awareness amongst design consultants.

"Architects are all very much the same - they like to present a creation of theirs, which, most often, results in something the client does not want."

This comment indicates a lack of effective communication between client and architect, and a lack of understanding of quality. The prerequisites for quality in design are not being met and quality is consequently being sacrificed.

"The degree of specialisation in architectural practices is inadequate."

"There is a need for greater quality awareness in the architectural profession. Since they are all designers, they should be aware of quality of design. There should be a higher degree of specialisation in the profession so that they are more intimate with the characteristics of the systems they design."

If a design consultant is not a specialist in a particular area of design and he is approached by a client who requires design consulting in this area, the design consultant ought to decline the commisison. Assuming he had accepted such a commission, it would then be incumbent upon him to ensure that his work undergoes a second and independent review from a specialist in that area of design. For large clients who have their own project management team, the first choice of independent review of the designs, be they specialist or not, would be this team. The specialists that should make up a design review team include at least one of each of the following:(37)

Designers, Quality Engineers, Production Planners, Production Engineers, Specification and Standards Engineers, Purchasing Officers, Safety Officers, Technical Sales Representatives or Market Research, Cost Accountants, After Sales Service People.

These personnel would be selected from between the client and the design consultants (the latter all agents of the client). A form of this review is followed by one client interviewed, who has a 'drawing comment procedure' which questions the design of the consultants.

"Design Consultants (clients agents) and a building economist (clients representative) are involved in feasibility studies for projects in excess of R3 m; below this, it is not worth the project management effort."

This demonstrates that some clients are aware of the 'specialist team' advantage during initial design stage.

"We must recognise the fact that there is a labour and materials shortage."
Design consultants need to be aware of the types of materials that are in short supply and for which a premium is therefore likely to be paid. They ought then to fall back on their market research and ideas and product customer specification to determine whether alternative but available materials or systems will satisfy the client's quality needs.

4. Procurement Document Control

"The problem of availability of manpower and materials affects quality. Long lead times on specified materials means that they have to be ordered in advance, especially in boom periods."
While availability of materials is a prime consideration under design control, once having ascertained availability and having specified a particular material, all requirements necessary to assure adequate quality in that material should be included or referenced in the procurement documents for that material. This applies to products, equipment and services as well and to the extent, if necessary, that contractors and subcontractors might themselves be required to provide a quality assurance programme.

"Today, quality's main enemy is 'time'. As a result of the lack of available time on projects, quality suffers."
The client recognises that pressures of the business cycle and the economy in general exert a profound influence on projects and their duration. He indicates a need for some means of quality management to maintain desired quality levels. The implementation of a quality assurance programme would provide those involved with a means of assuring that quality levels will be maintained on 'fast track' projects. The client needs simply to establish in his procurement documentation, requirements that contractors and subcontractors to the extent necessary, provide quality assurance programmes for the project.

"If the contractor knows that the client is posting a quality supervisor on a contract as his (the client's) representative, then the contractor will bulk up his tender price to cover this 'extra', as it is regarded that the supervisor will incur him extra cost over normal contracts."

As explained in the evaluation of comments pertaining to "Programme" (ibid) and chapter 4.3 (ibid), this argument holds no ground. It would however, be an interesting exercise to monitor the cost saving that would result from a properly implemented contractor quality assurance programme as a contractual requirement, listed in the procurement document. Quality Assurance Programmes usually provide for inspection and audit by the client or his agents.

5. Instructions, Procedures and Drawings

"The quality of the finished product is only as good as the foreman on the job."

This could be interpreted as meaning that the foreman is the sole individual responsible for quality on the job. The foreman is a key person in the link between quality of design and quality of conformance. Instructions, procedures and drawings originate from the design consultants and constitute the 'statement' for quality of design. They consequently include all the appropriate quantitative and qualitative acceptance criteria. Satisfaction of these acceptance criteria is the responsibility of the contractor and is largly left up to the general foreman to pursue. Quality Assurance programmes provide those performing activities affecting quality with the substance necessary for achieving desired quality levels.

"We rely heavily on S.A.B.S. standards for setting levels of quality workmanship etc."

The client recognises the need for levels of quality to be established. While this is a design function, their specification would be meaningless without a means of meeting the acceptance criteria. A quality assurance programme provides this means, but the qualitative and quantitative acceptance criteria remain the important cut-off point for the extent to which Q.A. effort should be applied.

6. Document Control

No comment.

7. Control of Purchased Material, Equipment and Services

"If service is poor, that supplier is not considered the next time round. These things are documented."

Assuming that requirements have been properly referenced in the procurement documents, suppliers will be contractually bound to meet those requirements. If the supplier consistently falls short of those requirements, the client will be left with quality levels, inferior to those he needs. "Next time round" implies on the next project. There is just as much risk, with another supplier on the next project, for the same thing to occur. To avoid this risk, measures should be established to assure that purchased material, equipment and services conform to the requirements. The measures should include provisions for source evaluation and selection, objective evidence of quality furnished by the supplier, inspection at the source and examination of products upon delivery. The effectiveness of the suppliers quality control should be assessed by the client or his agent at intervals consistent with the importance, complexity and quality of the product or service.

8. Identification and Control of Materials, Parts and Components.
No comment.

9. Control of Special Processes.
"Technology is stepping up; new products are coming onto the market and there are not enough people to provide the skills required. Today, with the advent and incorporation of foreign systems new to the R.S.A., applications are made with little knowledge of how they would perform in South African conditions. This led to immigrants working with these systems and importation of the required skills at a cost."
The high technology or foreign systems may be regarded as special processes. The client indicates that this is an area where quality suffers. Measures should, however, be established to assure that such processes are controlled and accomplished by qualified personnel, using qualified procedures in accordance with applicable codes, standards and specifications, criteria and other special requirements. The comment "at extra cost" does not imply that the control of quality will lead to an extra cost, but that the specification of a special process itself is the specification of a higher quality level - which is responsible for the 'extra cost':

10. Inspection

"We expect architects to be their own quality controllers." "There is a lack of supervision (talking of architects) and it is written into the law." "The Clerk of Works is the person the client relies upon to be the quality controller and he must therefore be a good sound knowledgeable individual with plenty of past experience." "The Clerk of Works is seen as someone who should be quality conscious, however, the architect is expected by us to perform QC work, especially on the finishes."

These comments collectively demonstrate the client's strong need for inspection of activities affecting quality. Chapter 2 para. 2.2.2.1.1 Sect. 4, and 2.2.4.3 (Clerk of Works) define the responsibilities of the architect and the Clerk of Works respectively. It is seen that there is a feeling amongst clients that a certain amount of the architect's responsibility is being shunned. A programme for inspection of activities affecting quality should be established and executed by all organisations involved in performing such activities. This would imply that the design consultants, contractors and subcontractors, as well as suppliers should all have an inspection programme. The purpose of inspection is to verify conformance with the documented instructions, procedures and drawings for accomplishing the activities. In order for the evidence of inspection to be objective, it should be performed by individuals other than those performing the activity. The Clerk of Works is purely there to satisfy the clients interests that his requirements are being met. The client is quite entitled to have inspection performed by the Clerk of Works at any level of the project. The architect is required to "carry out inspections reasonably and to ensure that the contract is being carried out in accordance with the contract requirements." (Ref. Chapter 2 para. 2.2.2.1.1 Sect. 4 ibid). This implies that the architect should establish his own inspection programme, consistent with the requirements of the client's Q.A. programme. This would in any event, automatically follow if the client had made it a condition of his commission when entering into the contract of agency. The assurance of quality cannot be reached without adequate inspection at all levels of the project, be it for the organisation of supplier, sub-contractor, main contractor or design consultant. Consequently, all levels should have an inspection programme so that between-tier assurance of quality may prevail.

11. Test Control

No comment

12. Control of Measuring and Test Equipment

No comment

13. Handling, Storage and Shipping

No comment

14. Inspection, Test and Operating Status

No comment.

15. Nonconforming Materials, Parts or Components

No comment.

16. Corrective Action

"The architect must monitor the occurrence of defects. Our maintenance department feeds back information pertaining to defects arising in the post completion stage of the project."

This comment clearly indicates the client's need for the architect to modify his design practice for future projects. This is effected through the evaluation of defects fed back to him. Consequently methods should be established to assure that conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, defective material and equipment and nonconformances are promptly identified and corrected. The cause of the condition should be determined and measures should be taken to assure that repetition will be precluded. The identification and cause of such conditions including the corrective action should be reported to appropriate levels of management. Management will thus be familiar with areas likely to present problems and be able to deal with them accordingly. This includes both the aspects of design and construction.

17. Q.A. Records

No comment.

18. Audit

From the various comments above reflecting the client's lack of faith in quality associated performance for both the design consultants and con-

tractors, the means of verifying all aspects of a quality assurance programme and determining the effectiveness of the programme, does exist. This is called 'the audit'. The results of such audits would be documented and reviewed by the client and follow-up action, including re-audit of deficient areas, would be made. Audits of each contracting tier may be made by the client. It is usual quality assurance practice for upper-tier contractors to audit their subcontractor. The architects and other design consultants would be on the audit tier immediately below that of the client. The client might choose to place his audit responsibility with the arhitect, but if not, a representative of the client, (similar to a Clerk of Works) would audit the design consultants.

19. Quality Strategy

"We believe that the government should do something to protect the public against faulty, bad and improper workmanship and the standard of training. The government should appoint an inspector to look at quality. Quality assurance should be introduced to BIFSA. The first step in the introduction of quality assurance should be at government level with manpower 2000 - where training is done."

Para. 3.3 deals with a national quality strategy and its recomendations are reinforced by the attitudes of the client. BIFSA is perhaps the first controlling organisation that should be approached since it has a collective bargaining credibility with central government. It would be able to work both ways, introducing Q.A. upward to government, and downward to the building industry.

20. Quality Costs

"The training of architects needs to involve an appreciation of costs and economics." On architects: "These 'animals' go out and manage contracts worth millions, yet they do not have the scope of training to cope with this."

These comments clearly indicate the clients' concerns about the effects of inadequate cost control on their projects. Their comments suggest that architects are insensitive to their needs in this regard and are not equipped in the management of quality costs. If architects were to receive an appreciation of quality costs during their training, the concerns of the client ought somewhat to be alleviatd. A consequential im-

provement in the control of costs would help meet the clients set of needs.

"It's penny wise and pound foolish to cut corners at the cost of quality. The results of cutting corners are felt in the long term as maintenance costs increase."
This client demonstrates that he is aware of the extra costs involved by cutting corners, but does not show that he understands quality cost categories (Para. 1.2.3.1 ibid.) He is aware of consequential costs, but not of discretionary costs, which are further subdivided into prevention and appraisal costs. Paragraph 2.2.2.2.5 describes the quantity surveyors cost control role. The quantity surveyor would be the individual from the client's agent group that would benefit most from a knowledge of quality costs. He would be able to regulate the degree of Q.A. and Q.C. applied to the project to ensure the optimisation of quality costs. (See Chapter 1, para. 1.2.3.2).

21. Training
"One of the greatest factors affecting quality in the Building Industry is its volatile nature which has the effect of losing people to other industries; and with them go the good people."
"Unions and trade organisations display a general lack of awareness of quality. Methods of payment affect the workers' attitude towards quality and generally, there exists an animosity between contractors and tradesmen."
"There is a need for further training in all spheres of the Building Industry."
The employment of completely untrainable or untrained people will not provide satisfactory quality(38). Not only should people capable of doing a job be selected, but also those interested in doing it well. When an operator produces scrap or defectual work a quality control system should be in operation to pick it up and provide suitable help and instruction to cure the problem. Every time a man is put on a particular job, his supervisor should ensure that he, the operator; 1) knows how to do the job; 2) knows the key points which must be kept uppermost in his mind; 3) knows the quality standard required. All personnel on a job perform certain activities that have an effect on the ul-

timate quality. They should therefore be trained to assure that the proficiency required in their job is understood, attained and maintained.

22. Miscellaneous.
"Project lengths are extremely short and building is done at speed - we are consequently prepared to accept poorer quality."

"You only get what you pay for."
"There are a minority of people that know what should be expected and do exercise their rights."
"Most people are laymen as regards the accommodation they are getting. Prestige finishes concern them more than other factors. Should anything substandard or defective arise, the commercial man displays general apathy."
These comments serve to indicate the general apathy towards quality and the lack of understanding of the meaning of quality and Q.A.
To accept a "poorer quality" means that the end-result, what the client is left with in terms of the building he wants, will not be "fit-for-use."

"You only get what you pay for displays an attitude along the lines of 'quality costs you more'. This is wrong, as is pointed out countless times in preceeding chapters. The case is, most often, that you are getting less than you pay for.

5.3.2 Design Consultants

Two architects from large, well established local architectural practices and one quantity surveyor from a well known local quantity surveying firm, were interviewed. Their comments follow:

1. Organisation. "There are too many one-man architectural practices in the R.S.A."
"Design professionals are involved in too many things, i.e. in a vast variety of work. There is a lack of specialising. The reason for this is that there is not sufficient a volume of specialised work in the R.S.A."

"The architect should have other consultants to advise in layouts of more complex projects."

The design consultant is aware of the fact that due to all his tasks and responsibilities, he will be hard put to do justice to them all, on his own. From the quality of design aspect there would be no second independent review of his designs. The architect would thus have to be a specialist in every aspect of design on the project if he were on his own. Judging by the clients comments (see para. 5.3.1 ibid) this type of architect no longer exists. The architect, by nature of his profession and his market, is required to be multi-disciplinary in his work. He therefore needs to have specialists from each discipline to optimise his effectiveness.

2. Quality Assurance Programme. "There is a lack of feedback after the completion of the project."

"There is a lack of design interface with actual work being done and the workers."

"There is a lack of communication between designer and client."

"Designers are not familiar enough with available products."
These functions which are lacking in the design professions - from lack of feedback to lack of familiarity, show that the aims, objectives and procedures for their respective design practices have not been established. The assurance in quality of design can only be effectively achieved if the aims, objectives and procedures of the design function are clearly understood by all concerned.(37) These are usually contained in the quality manual or QA Programme. There is a clear need for the establishment of such a document in a properly organised design consulting practice.

3. Design Control.
"With a good brief from the client, the architect can do anything. The client is not aware of what is entailed in a brief."

"Clients do not choose their consultants well. Clients should research. South Africa does not have property advisors - in the U.K. there are chartered surveyors."

"Clients do not select their consultants properly, i.e. for their expertise."

These comments highlight an interface and communication problem during the clients brief. (Refer para. 2.2.2.1.1 Chapter 2). In principle, the client sets the quality standard, but it is the design consultant's responsibility to undertake a design analysis based on this quality standard. The design analysis evaluates the envisaged project in terms of satisfying the given needs. The evaluation is done in terms of the needs of the customer, including those of society as a whole; and in terms of whether it will be possible to actually achieve desired goals in normal construction (i.e. employing available construction techniques). The client is responsible for communicating specific needs to the design consultants. Should the client simply be aware fo the fact that he has a need for accommodation, it would be necessary for an 'analyst' to explore and identify the specific requirements that will satisfy that need. A chartered surveyor or property advisor could be considered as such an analyst. In order for the brief to be effective, the design input requirements should be listed and acknowledged by both design consultant and client. Once this foundation has been achieved, the design consultant may set about pursuing further quality in design by developing a design that will meet the client's true needs.

One of the design input requirements is that available materials be evaluated in terms of satisfying the needs. Should materials available for use in the building industry be of "poor quality" (implying that they are not fit for the use envisaged) then alternative materials, products or systems will have to be specified, even if this requires their importation. The prime consideration here is fitness for use.

The aim of design control is to maximise satisfaction of the client while minimising quality cost. It involves the establishment and specification of the desirable cost-quality, performance-quality and reliability-quality standards for the project, including the elimination or location of

possible sources of quality troubles, before the start of construction.(6)

4. Procurement Control

"The contractor cannot be expected to become intimately involved in the quality of supplied materials."

Procurement documentation usually references measures to be taken by the contractors and sub-contractors to assure that applicable client requirements, design bases and other requirements necessary to assure adequate quality are met. This naturally includes requirements affecting the quality of supplied materials. Should contractors experience material or product application problems during the construction phase, the provisions of their Quality programmes should identify these under the procedures for nonconforming materials, parts or components; and corrective action, and bring the problems to the attention of the designers. The design consultant will need this feedback information for the modification of his design to meet clients' requirements.

5. Instructions, Procedures and Drawings

"Carpenters, in their shutterwork, and joiners, cannot do work correctly - their workmanship is poor."

While this comment implies inadequate training, one common fault is that requirements are inadequately listed. Instructions, procedures and drawings are required to include all appropriate quantitative and qualitative acceptance criteria for the reference of those performing the activities concerned, in order to achieve the desired quality levels. The interpretation of these criteria is a training-associated prerequisite. Where applicable, actual procedures, be they Q.A., Q.C. or works procedures will help to achieve the desired quality levels at the completion of the activity.

6. Document Control

No comment.

7. Control of Purchased Material, Equipment and Services

"Our timber is of inferior quality. S.A. Pine is not good enough to meet SABS standards."

"There are a multiplicity of new products on the market and many clients have been caught short by building product failure, failed warranties and the disappearance of the manufacturer from the market."
The designers' specifications are listed in applicable procurement documents, reflecting the clients' quality needs. Contractors, subcontractors and suppliers will have to conform to those requirements as a contractual obligation. In order to assure that prospective suppliers, subcontractors and contractors are capable of meeting the requirements of the procurement documents, objective evidence of the quality furnished by the contractor or supplier should be sought. The means of finding this objective evidence is usually through source evaluation and selection, followed by inspection and examination of products upon delivery. If the designers are of the opinion that the merchants are trading or vending inferior quality, there is a clear need for them to implement the aforementioned controls.

8. Identification and Control of Materials, Parts and Components
No comment.

9. Control of Special Processes
No comment.

10. Inspection
"Architects supervision is much greater today than previously. The architect now spends more time on preventative supervision."
"We sometimes have a resident architect on projects, monitoring progress and performing a QC function."
Quality cannot be inspected into a product or component - it has to be designed and built into it. In all systems, however, there are attributes that are more critical to product performance than others. These ought to be identified and then incorporated into an inspection programme. By nature of the architects' responsibilities in discharging his mandate (Refer Chapter 2 para. 2.2.2.1.1 ibid) he or his representative will be required to perform inspections. He will as will the contractor, be familiar with the requirements and will determine whether the specified levels of quality have been achieved by the contractor. Likewise, the contractor knowing that the architect has approval rights on the

work completed, and influences the size of his monthly payment, will also inspect during and at completion of the activity to ensure that quality levels have been achieved. Should the contractor not do this, or be unsuccessful in his inspection programme, the architect could condemn or pronouce the work as nonconforming or deficient, which would mean repair, or rework. This disruption causes delays in the project and affects the contractors costing and cash flows adversely. The sooner problems affecting quality are picked up, the greater the effect of minimising extra unwanted costs. These comments, clearly indicate a need for quality inspection programmes.

11. Test Control

No comment.

12. Control of Measuring and Test Equipment

No comment.

13. Handling, Storage and Shipping

No comment.

14. Inspection, Test and Operating Status

No comment.

15. Nonconforming Materials, Parts or Components

No comment.

16. Corrective Action

"There is an 'end-cost' and a 'first-cost'. The difference between the two is the cost of unplanned maintenance and repairs and negative differences in expected rental that the project can command."

"There is informal feedback (of which there is only a little) of performance of products and product failures."

In spite of all the efforts to which the design consultant might have been to administer the contract properly, certain things might not turn out satisfactorily and will cost money to rectify. In order to prevent a recurrence on contracts in the future, the design consultant will look for the cause. Corrective measures will be taken with the object of learning from mistakes. Architects are conscious of the effects on final

cost that failures, malfunctions, deficiencies and defective materials and equipment will have. They do not demonstrate their awareness of how a systematic analysis of the evidence associated with what went wrong can help determine the cause of what went wrong. Likewise, that their quality programme and procedures may then take this into consideration to prevent recurrence and effect quality cost savings. It is this feedback of performance information to the design and construction aspects that is one of the quality assurance fundamentals.

17. Quality Assurance Records

No comment.

18. Audits

No comment.

19. Training and Qualification

"We are twenty years behind other countries with respect to training."
"Workmen and artisans need an understanding of quality and what a quality product is - an educational process required to upgrade persons."
"There should be more seminars for professionals or courses with a limited number of participants - called workshops - groups of 6 to 8."
"Unemployment levels should be maintained in order to maintain the level of skills in the industry - this should be done on a regional basis due to the difference in activity levels from region to region and the differences in building types."

In considering manufacturing requirements, as early as the design stage, an analysis of training elements for all construction activities ought to be made[37]. This is because the personnel performing activities affecting quality need to be of the required calibre to assure that suitable proficiency is achieved and maintained. Consequently, training programmes usually form part of quality assurance programmes. This requirement is not restricted to contractors personnel, but also to the design consultants. Quality control and inspection personnel need to receive training in inspection methods and techniques and be able to interpret results and evaluate what they inspect. Architects and other design consultants require training in quality management to enable them to discharge their mandate more effectively. This is supported by E.A.

Reynolds argument: "If there is to be real progress and advantage of QA concepts and methods in S.A., there must somehow be understanding by the managing directors, the corporate boards and the government ministers, comparable to the high level of understanding (and education) in Japan and the U.S.A." Better education at all levels is the main requirement for effective Q.A. as it is for greater needs and more general problems than quality."(39)

It is up to top management to understand the concepts, potentials and prerequisites of effective Q.A. Once having 'trained' top management, under their direction and with their backing training programmes for upper, middle management, engineers, technicians and artisans will help spread the quality awareness throughout the building industry. There is no other way to ensure that the levels of skill acquired by the industry will be available when required without adequate training. BIFSA realises this and is spending millions on training over a five year period (Refer Chapter 2, para. 2.1.1.2 ibid), and they are to be commended for it - but it would be money wasted if it did not address quality and if it was not run as a function of a Q.A. Programme for the Industry. Neither would this training programme be as successful as it could be if it was not accompanied by a simultaneous 'training' of top management. There is a clear need for training at all levels of the organisation, as the above comments indicate. This is primarily a responsibility of the employer, since it is he that will reap the immediate rewards from his efforts in this regard. By the same token, the employers themselves would benefit from an awareness of new techniques and methods of management, such as quality assurance.

20. Miscellaneous

"The institute researches quality control through on-going programmes." (Architect).

"There is no restriction concerning who can build . The government should institute such control and Building Societies should be more discerning."

If the Institute of Architects does ongoing research and one of its programmes is quality control, it leads to this question - unanswered - "Why is it not they who are promoting Q.A.?"

The architects deem it necessary for builders to be qualified to build, yet as agents for the client, who help in the selection of a contractor for the project, they are in the best position to exercise this restriction. The architect would achieve a great deal if he were to make a Q.A. programme a contractual obligation for tenderers to his clients project: He would have the added assurance that the client's quality levels would be met; his task of administering controls on the project would be made easier and the cost and productivity benefits flowing from an effective Q.A. programme would benefit the contractor, client, and in the long run, the architect. BIFSA and the MBA have certain restrictions on who may tender for certain contracts (Refer Chapter 2 para. 2.1.1. ibid.). It should therefore not be the government who should impose such restrictions concerning the competence of building contractors, but BIFSA and the MBA who are in the best position to do so. A building contractor effectively implementing a QA programme could logically be classified as more competent than one who does not.

As far as building societies are concerned, a contractor pre-qualification prior to the granting of a loan would do much to help raise the overall quality levels in the domestic housing market.

5.3.3 Building Contractors, Building Economist and B.I.F.S.A.

Two building contractors, the President of BIFSA, Executive Director of BIFSA, past director of the MBA and a building economist were interviewed. Some of their comments follow:

1. Organisation

"The contractor is not a manufacturer or an industrialist, as is the common misconception of people generally. A manufacturer or industrialist will conceive of a product; has one place of operating, and is normally concerned with multiple productions of the same product (homogeneity). A contractor is vastly different. He deals with a one-off product which has already been designed for him by an architect, commissioned by the client. The designer prescribes the time duration of the contract period, the materials and the building products to be used, and, to a certain extent the building methods and many others. Consequently SABS 0157 which has been designed for the industrialist cannot and should not be used for the contractor."

SABS 0157 is currently being used in all contracts for ESCOM's power stations(36). ESCOM has a need for Q.A. on its projects and has made the pursuance of this code a contractual obligation and follows-up on contractor implementation through comprehensive auditing programmes based upon the requirements listed in SABS 0157. SABS 0157 contains requirements for the design, manufacture and installation, as appropriate for products and services. The building industry has its sub-divisions; architects and other design consultants; contractors; subcontractors; suppliers and the clients. The thing that binds these divisions together with one common cause, is a project, for which the client has contracted each of these divisions for their services. The project, per se, is no different from the industrialist's where he is manufacturing a product. Everything from the design down to the coordination of activities will be focussed on that product, as will they be on the project in the building industry. Materials might be ordered and brought in from other premises, products will be shipped in and this is true for both the industrialist and the building team. The only difference is the end-product. The industrialist delivers his completed product or article off his premises to his client or customer, while the building project remains in one place and the building team members go their own ways to other projects. Considering a project on this basis, there is every reason why SABS 0157 should be applied to it. The subdivision of responsibilities, flows of communication and building team member interfaces are areas that will differ from the industrialists case purely from the point of view that they are all different business entities. This alone poses a problem of effectively implementing a Q.A. programme on the project and is an area which, besides warranting a study on its own, will require particular attention. This attention will have to come from controlling bodies in the Industry such as the Institute of Architects, Quantity Surveyors and other consultants, BIFSA and the MBA and subcontracting and supplier associations.

While Chapter three shows that very little change to SABS 0157 will have to be made to render it a meaningful document tailored to suit the Building Industry, it is mainly on this section (organisation) that attention will have to be focussed.

2. Programme

"Reputable contractors would not object to implementing a quality assurance programme."

"Architects are lacking in management - it is a problem of management vs. design."

These comments indicate 1) that well known and respectable contractors would be prepared to implement a QA Programme should it be required of them; and 2) there is a recognition amongst contractors that architects' management skills need improvement. The author concludes that a code of practice for quality management systems that has been developed and accepted by general industry in South Africa (SABS 0157) would be the best of the availble panaceas for the building industy's quality shortcomings.

3. Design Control

"The architect would prefer higher quality levels because it would affect his remuneration. Specifying higher levels of quality meant a higher contract price and therefore greater revenue for the architect."

"The architects do not know how to give a client's brief."

"The cost-orientated designs of architects today are not fit for use."

"The architects frankness with clients is lacking."

These comments support the client's need for a Q.A. programme for the design aspects of the project.

4. Procurement Document Control

No comment

5. Instructions, Procedures and Drawings

"The building industry can only concentrate on labour for improved quality, since they are 'assemblers'."

This comment highlights an area where contrators' Q.A. programmes can help to assure that activities affecting quality are accomplished with the desirable results.

6. Procurement Control

No comment

7. Control of Purchased Material, Equipment and Services

No comment

8. Identification and Control of Materials, Parts and Components

No comment

9. Control of Special Processes

No comment

10. Inspection

No comment

11. Test control

No comment.

12. Control of Measuring and Testing Equipment

No comment.

13. Handling, Storage and Shipping

No comment.

14. Inspection, Test and Operating Status

No comment.

15. Nonconforming Materials, Parts or Components

No comment.

16. Corrective Action

No comment.

17. Q.A. Records

No comment.

18. Audits

No comments.

19. Training

"BIFSA is tackling the quality of the labour force with a training programme. It has training centres all round the country. An apprentice now has a three months training course in his trade and then he does three

years of practical with a building contractor, after which he sits his qualifying government examination."
"There is a lack of quality consciousness in training programmes."
These comments show how BIFSA has responded to the industry's need for trained personnel, but how it could be better if it's programmes took cognizance of quality principles.

20. Strategy
"Q.A. should not be seen as a new name for a new set of norms - which is how many will tend to regard it and therefore they shy away from it, but it should be indicated to them that Q.A. is an elastic approach to a problem."
This comment touches on the delicate subject of introducing to the industry the concept and principles of Q.A. It shows the need for it to be done in a proper way so that the industry will understand it and therefore see how it can help them. There is always a danger when introducing a simple concept that because it has been given a sophisticated name, it is avoided. There is consequently a need for tactful introduction of Q.A. to the building industry.

4.3.4 Conclusion

From these interviews, it is concluded that the quality problems of today's building industry are everybody's "fault". The clients have grave misgivings about the architects' abilities to achieve quality and to a lesser extent the contractors. The architects criticize the clients for inadequate briefs and the contractors and suppliers for providing below-quality workmanship and materials. The contractors place a lot of "blame" on architects and the uniqueness of the building industry with its associated problems. There is such great confusion concerning quality and all it stands for, that the need for awareness of quality is very strong.
The author concludes from this evaluation that the building industry needs quality assurance, perhaps more than other industries, because of its uniqueness. Before a Q.A. programme can be used successfully on a project in the building industry involving clients, design consultants,

contractors and if necessary their subcontractors and suppliers, this need for a quality awareness must be satisfied and an industry-wide support for some emphasis to be placed on quality management must be realised. For those that "go-it-alone", there will be a certain amount of opposition, with which will invariably be associated, an increase in costs.

This chapter reinforces the need for a national quality strategy mentioned in Chapter Three. Chapter Five will discuss the differences between establishing quality levels and managing to achieve those levels. It also runs through the requirements of a quality management system demonstrating its applicability to the building industry.

CHAPTER FIVE

THE SETTING AND ATTAINING OF QUALITY LEVELS AND QUALITY MANAGEMENT IN THE SOUTH AFRICAN BUILDING INDUSTRY

5.1 INTRODUCTION

We have seen the importance of recognising that the establishment of desired quality levels is distinct from the ability to achieve these levels. It is also necessary to recognise that an interrelationship between the two does exist. Paragraph 1.2.2, The Quality Function (ibid.) describes how a 'grade' is established. In the Building Industry there are various different sources from which the final grade for the building is specified. These sources are: the manufacturers of products, the design consultants, clients, municipalities and the South African Bureau of Standards. However, a code of practice for the systematic management of the effort in production required to reach the desired or specified grade accurately, confidently and without wasted effort, time, money or materials, has not been fully achieved in South African Building Industry. It might be argued that to achieve the specified grades in the described manner will simply be a case of following sound management principles. But, an understanding of what is meant by sound management principles does not necessarily mean that the holder of this argument is cognizant of quality management principles.

Management theory and practice encompasses planning, organising and controlling people, money, materials and time. These principles are fundamental to personnel management, financial management, material resource management and a host of others - including quality management. Chapter Four discusses the lack of quality management in the Building Industry and how incomplete the attention to quality in the establishment of the design and the codes of practice to meet these requirements really is. Although the South African Bureau of Standards has published many codes of practice for use in the Building Industry, (for example, to name just one: SABS-021, Code of Practice for the Water Proofing of Buildings), which affect the quality of buildings in their various different aspects

there is not yet one code of practice specifically for the Building Industry which encompasses quality management as applied to design, construction, commissioning and operation/use of buildings.

5.2 SABS-0157-1979, CODE OF PRACTICE FOR QUALITY MANAGEMENT SYSTEMS

This code is directed at the party responsible for the supply of goods and services in modern South African Industry in general, and not for any one industry in particular. The code provides an integrated and definitive set of requirements for a practical series of quality management systems. It has been designed to be used in the following three ways:

1) Prior to the establishment of a contract, it can be used by a potential purchaser as a basis for evaluating the competence and effectiveness of a supplier's quality management system, in order to provide assurance to interested parties.

2) It can be specified as a contract requirement whereby the contracting party must have implemented in his organisation and as part of the supply of goods and services on the contract, a quality management system, acceptable to the client, and/or compatible with this code.

3) It can be used in product specifications where reference to a quality management system is appropriate.

NOTE: Where the quality management system is specified as a contract requirement, or is part of a product specification, difficulties can arise from differing interpretations of compliance with the requirements, and it may be necessary for the contract or specification to be supplemented by additional quality assurance documents which state how the requirements of the code will be met, e.g. in contracts, a quality programme; in specifications, a quality plan.

Recognising that the nature of the product or service required will significantly affect the particular system necessary to ensure quality,

SABS-0157 has three parts which are designed to satisfy quality system requirements for products or services of three broad origins:

PART ONE: This part applies to products and services, (usually complex) produced under closely controlled conditions where the supplier may be responsible for design, development, manufacture, and, where appropriate, field trials.

PART TWO: This part applies to products and services where the design is already established and assumed satisfactory, but compliance with the requirements can only be adequately determined by inspection performed throughout all stages of the manufacturing cycle, and when appropriate, installation and field trials.

PART THREE: This part applies to products and services, the quality of which can be satisfactorily determined by inspection and tests conducted on the final article.

From the above, it can be seen that each of these parts of SABS-0157, are to some extent also suited to the Building Industry. The most commonly used form of building contract is one, where a Bill of Quantities is used as part of the contract documents, with the design and specification having been established by the architect and other design consultants. Thus PART THREE of SABS-0157 would find its greatest applicability here.

With a greater choice being made by clients, consultants and contractors to follow negotiated or management type contracts, PART ONE will become more and more applicable in the Building Industry. The trend to follow these forms of contract is largely dependent on type of development, supply and cost of money (the economy, in short) and the market for the type of accommodation being supplied. PART THREE would also be suitable to firms producing or manufacturing components for use in the Building Industry.

Architects, structural engineers, electrical and specialist consultants, are necessarily concerned with the quality of design. (Refer para. 1.2.2 ibid.). The contractor tendering for a contract based on Bills of Quantities, is not concerned with the establishment of the design specifications, his concern is mainly in meeting the requirements set by the de-

sign team. His prime quality objective therefore is to achieve quality of conformance. (Refer para. 1.2.2.ibid.). This important distinction should henceforth, be held firmly in the readers mind.

5.3 ESTABLISHING LEVELS OF QUALITY (QUALITY OF DESIGN)

As mentioned earlier, manufacturers, design consultants, the S.A.B.S., municipalities and the client, himself, all play a part in setting quality standards. Naturally, the level of quality set by each of these individual parties is likely to differ a great deal.

Municipalities set certain standards in keeping with the recommendations of its representatives in the particular aspects of municipal responsibility. These standards will be followed throughout the particular municipal area.

The South African Bureau of Standards sets quality levels to protect consumers in general. It uses a marking system to make known to consumers that certain products comply with certain quality standards. The S.A.B.S. also sets these national standards to protect consumers and the standard marks of the S.A.B.S. serve as the only assurance to the South African buying public that a specific product complies with the national standards and that the manufacturing process and the quality control system are continuously monitored by the S.A.B.S.

Up until the present, each individual local authority such as a municipality, has the right to compile its own building by-laws. These by-laws complement the Standard Building Regulations promulgated by the S.A.B.S. However, in order to eliminate the present situation where individual local authorities have the right to compile their own building by-laws with the resulting "anomalies and confusion"(40), the S.A.B.S. has undergone six years of work to arrive at a completely new set of uniform regulations "expected to save millions of Rands and which will come as a particular relief to contractors, engineers and architects"(40). This new set of regulations is at present in draft form and has been sent to the building professions and authorities for comment.

The new regulations, in draft form, have generated much criticism, such as "highly objectionable" to quote Cape Town City Engineer - Jan Brand who added that in their present form they "could have very grave consequences"(40). Amongst these consequences are higher building costs and greater delays in the approval of plans. One may draw the inference that this response is a result of SABS setting unreachable, unrealistic and therefore undesirable standards. By way of an analogy, this is the same as setting "Rolls-Royce" standards for "Volkswagen" levels of requirement. This explains the predicted consequence of an increase in building costs if building regulations are set higher than "realistic" standards. It must be borne in mind that such regulations as these, if they are to be applied to the "masses" on a national basis, should set quality standards meeting the minimum requirement of the nations "masses". Should any individual or minority group desire higher levels of quality and more stringent standards, they may simply be added as requirements over and above the nationally accepted quality levels, in such cases.

Building regulations are able to be revised and modified to incorporate new requirements necessitated by progress which arises out of technical innovations, new products, new building methods and the changing needs of society. It is often the case that the amount of effort required to 'move mountains' is expended to effect such changes, which necessitates the arduous task of passing legislation, however, the facility for change does exist. The S.A.B.S. reviews its codes of practice and its standards when necessary in order to keep abreast of progress. It invites comment and considers such comment as it may receive, for incorporation into the standards and codes when revisions are made. The S.A.B.S. recognises the need for positive feedback as seen in this process.

Clients have a set of requirements, which are dictated to them by the type of building they need and the levels of usage to which they intend to subject the building. They, together with the design consultants, will select the standards which are not required by statute (National Building Regulations or Municipal Building Regulations). The specification drawn up by the design consultants for use on individual projects will include, in accordance with the client's brief and as the design consultant's see fit, additional levels of quality to ensure that the end product - the

building - will be fit for the use to which it is going to be put. These additional or higher quality levels will naturally incur an extra cost if the levels are much in excess or set much higher than the levels contained in generally accepted standards, or the norm for the Building Industry (Standard Building Regulations and Municipal Building Regulations).

Products and components that are incorporated into the building will normally have widely accepted levels of quality, either specified in S.A.B.S. Standards or by a manufacturer's specification. It is common practice for the design consultant to specify readily available products, the specifications of which are known to him. Such product specifications will meet the building's requirements in the way the design consultant intends to employ such products in the building. In many instances, the design consultant will have a range of products to choose from. In this manner, the design consultants, collectively, create a demand for a particular building product. Should the manufacturer find that the demand for his product is falling off, he would be hard pressed in the absence of positive and constructive feedback from the design consultants to know why his product is not meeting their requirements.
The design **consultants** consequently bear a responsibility of monitoring the products and components which they specify for incorporation into a building, in order to determine whether their specified products are meeting the requirements, (ie. whether their quality in design has been adequate or whether the quality of reliability of conformance in the product has been adequate). Where quality of reliability conformance has been acceptable and there has been a product failure, a failure of the system in which the product has been used could be a result of inferior quality of design, **or** inferior quality of conformance in workmanship. Whatever happens, whether defects are manifest or whether the product performs as specified, the design consultant should be obliged to confirm the soundness of his choice of specification.

The most important aspect of this process is the aspect of feeding back information to the producer or manufacturer of the product concerning the performance data. The manufacturer is then able to produce his product so that it meets the product specification, or, alter the product specifica-

tion so that it matches the performance of the product that he is producing. This will ultimately ensure that accurate quality levels are established. (Refer also para. 1.2.1.2 Characteristics of Quality. ibid.).

5.4 ATTAINING QUALITY LEVELS

Once having established the quality levels at the design stage, it is necessary for the design consultants to impart to the prospective tenderers in a clear way, the exact nature of these levels. This is normally done in the Bills of Quantities, a contractual document, where in the first bill, a Preliminary & General Bill, there is an item stating that materials and workmanship are to conform to the description. This item involves both the quality and the quantity of materials and implicates such quantity and quality of materials in subsequent Bills, each of which covers the individual building trades. The levels of quality are clearly defined in these 'trade' bills, in their preambles and quantities divisions. Examples of these are found in Appendix 4.

It can be seen from the appendix, that in the specification of these quality levels, much reference is made of S.A.B.S. and British standards as guides for generally accepted levels of quality. Further quality levels are specified there, as seen in the strength of concrete and mortar mixes. Certain trade products such as "Synthaprufe" and "Secomastic" are specified where the design consultant has established the quality level in accordance with the trade product manufacturers' product specifications.

It now remains for the builder/contractor to see to it that these quality levels are reached and maintained throughout his responsibility during the construction phase. It is all very well to specify a concrete of a desired quality level by carefully detailing the materials and proportions in which they are to be combined, but to arrive at a concrete that is of the required strength (strength being only one of the many quality characteristics of concrete, and perhaps the most important) it is necessary for the contractor/builder to ensure that he reaches this level

of quality with adequate confidence in doing so and with the least waste of resources (materials, money, labour and time).

To discuss the manner in which quality in concrete can be achieved, reference is made to a lecture delivered to the South African Society of Quality Control in mid 1981, by Mr. J.W. Lane, Deputy Director of the Portland Cement Institue, Johannesburg [36]. Mr. Lane makes mention of the fact that concrete is a material that varies in quality. The S.A.B.S. has a code of practice for the design and construction of reinforced, prestressed and pre-cast concrete - S.A.B.S. 0100, 1980. However, Mr. Lane says "The publication of S.A.B.S. Code of Practice for Quality Management Systems, S.A.B.S. 0157, 1979, suggests that it is necessary to consider the application of the system to the quality control of concrete".

Concrete has three main physical states:
Firstly, the state of concrete in its un-mixed ingredients stage; cement, fine aggregates (sand), coarse aggregates (stone) and water, sometimes admixture and/or pozzola;
Secondly, the fresh or plastic mixed state;
Thirdly, the hardened state [36].

The desirable properties of each of these states are listed in Appendix 5.
It can be seen from appendix 5 that the S.A.B.S. has established a Code of Practice - S.A.B.S. 0100, to assist in the achievement of quality of conformance in the manufacture of concrete. It also sets standards for quality of design in that it establishes certain acceptance criteria for concrete strength. S.A.B.S. Standard Methods provide a uniform and accurate set of measures for determining whether acceptance criteria have been met. Mr. Lane's paper comments on the various clauses of S.A.B.S. 0157 and how they provide an integrated and definitive set of requirements for a practical series of quality management systems - in the specific areas of the design, manufacture and installation of concrete.

Now it is not only quality in concrete that can be achieved through the application of S.A.B.S. 0157 during the design, manufacture and installation process, but also other products, components and materials used in the construction of buildings. Neither is S.A.B.S. 0157 restricted to such tangible items, but encompasses the all-important aspect of services as well.

It is important to realise that all activities affecting quality should be accomplished under suitably controlled conditions such as: - the use of appropriate equipment, suitable environmental conditions for accomplishing the activity, adequate cleanliness; against the use of prohibited materials; and assurance that all pre-requisites for the given activity have been satisfied. Furthermore, there should be adequate assurance that any **special** controls, processes, test equipment, tools and skills as may be necessary to attain the required quality, are available and properly used and that quality is verified by inspection and test. A special process will also include a new process that has not been tried and tested and is not general practice. The personnel performing such activities affecting quality should be indoctrinated and trained as necessary to assure that suitable proficiency is achieved and maintained. It should consequently be the responsibility of management to ensure that the adequacy of measures taken to ensure quality in activities affecting quality are acceptable and of the desired level. This should be effected periodically through a review of the system or programme set up to manage for quality. Once having met all these requirements, a contractor should be able to demonstrate his ability to achieve the quality level requirements specified in a contract.

The system of activities established to provide a quality product or service that meets the needs of users is generally termed a quality programme. A typical quality programme has requirements as set out in a management consultant - Dr. C. L. Carter's "Q.A. Programme Standard"(41) which is a guide to drawing up a Q. A. Programme. Refer to appendix 6 for a summarised list of these requirements.
S.A.B.S. 0157 has further, more developed requirements than are outlined in Carter's Q.A. Programme Standard. Aspects concerning the administration of the quality programme are outlined in greater detail in S.A.B.S.

0157, making a distinction between personnel performing quality functions, the management representatives and the purchaser's or evaluator's representative (see para. 2.2 Organisation S.A.B.S. 0157 Parts I, II & III). The S.A.B.S. avoids American terminology, for example in Carter's standard, in section 4, "Quality Programme Audits" are mentioned, but S.A.B.S. 0157 simply talks of a "review of the quality system". (See para. 2.3). Both describe the same process. Carter makes brief mention of planning in clause 3.11 of his standard, while S.A.B.S. 0157, in para. 2.4 lists seven criteria related to quality planning. S.A.B.S. refers to the documented directives that prescribe the communication of contract requirements and the performance of work in design, development, manufacture and installation, which will affect quality - as being "work instructions". Carter, and the accepted American terminology, refer to these simply as 'procedures'.

Both Carter and the S.A.B.S. address the documentation of factual data that records results of tests and other conditions reflecting the achievement or non-achievement of quality and the effectiveness of operation of the quality system. This is a very important aspect of any quality management system as it will provide management with an accurate and true account of how well the 'quality mission' is faring.

Quality Assurance and Quality Management are often condemned because they generate unexpected volumes of paper. This concern gives rise to a whole new area of expertise where specialists in the field of paperwork design may help a great extent to reduce this 'unnecessary evil' to levels acceptable to the layman. It is the documentation of factual data that will help management pick up areas of poor quality performance before such areas become too costly to tolerate. It will help identify trends in quality performance that are developing and if used correctly by quality management, can be used to effect great reduction in unnecessary costs.

Corrective Action is another important area, which both S.A.B.S. 0157 and Carter acknowledge, requires adequate feedback data to determine causes of failure and institution of adequate prevention measures.

Carter's design information section, para. 3.2 does not make specific mention of the 'control of physical and functional tolerances to avoid the use of irrational limits', as does S.A.B.S. 0157. It is most desirable to pay attention to the setting of realistic quality levels. In this area, great cost savings may be made in the proper establishment of quality levels - not too high and not too low - which will provide assurance that the end product will be fit for use. (Refer to Chapter One para. 1.2.2.1 The Economics of Quality. Ibid). Again, S.A.B.S. addresses Design Control more fully than does Carter in his Q.A. Programme Standard. S.A.B.S. 0157 continues, addressing the area of documentation and change control more fully than does Carter. Carter refers to the purchasing of material and services and 'procurement' - another American term and again, S.A.B.S. 0157 deals with this more explicitly. (See S.A.B.S. 0157 para. 2.11).

Carter and the S.A.B.S. address inspection, measuring and testing equipment equally well. In their manufacturing control sections, they also provide the same guidelines. S.A.B.S. 0157 para. 2.14 - completed inspection and testing is parallelled by Carter's para. 3.6 'acceptance', and where his subsection 3.6.2 is also parallelled by S.A.B.S. 0157's para. 2.15 on Sampling Procedures. S.A.B.S. 0157 para. 2.17 addresses inspection status but Carter's standard does not. Carter mentions handling and shipping briefly in para. 3.6.1 while S.A.B.S. 0157 deals more fully with these aspects in para. 2.18, as well as the aspect of storage.

Carter omits to address the very important aspect of training with respect to operatives concerned with activities affecting quality. S.A.B.S. 0157 deals with these admirably in para. 2.19. Generally in today's highly specialised and technical fields of industry, training is an essential part of any production programme. Refer to Dr. T. Hodgson's paper on "Education and Training in Quality Assurance"(34).

While the S.A.B.S. has separated Organisation; Planning; Work Instructions; Records; Corrective Action; Design Control; Documentation and Change Control; Control of Inspection, Measuring and Testing Equipment; Control of Purchased Material and Services; Manufacturing Control; Samp-

ling Procedures; Indication of Inspection Status; Production and Preservation of Product Quality, and Training; - Carter has separated Quality Management (with sub-sections on Organisation and Procedures); Design Information (with sub-section on Change Control); Procurement (with sub-sections on Source Inspection, Fabricated Material and Raw Materials); Material Control; Manufacture (with sub-sections on Process control and Special Processes); Acceptance (with sub-sections on Sampling Inspections and Non-conforming materials); Measuring Instruments; Quality Information (with sub-sections on Quality control Records and Corrective Action); and Quality Programme Audits. As headings to each one's respective standards, both are seen to have incorporated most of the salient elements of a quality management system or quality assurance programme. It is felt that the S.A.B.S., has provided a better, more thorough and well presented standard or code of practice in their S.A.B.S. 0157.

S.A.B.S. 0157 was compiled incorporating input from all fields of industry in South Africa as well as consumer representing bodies. Considering this and the need in South Africa that this code of practice has been designed to satisfy, it is concluded that by carefully following this Code of Practice in any South African industry today, the resultant achievement of quality would as a minimum be acceptable to users. The assurance of this acceptability shown by all clients or consumers on the receiving end of the products, materials and components is what this code helps to generate. All in all, S.A.B.S. 0157 is a comprehensive well presented and easily understood code of practice that addresses quality management thoroughly and explicitly. It now remains to see how it may be applied to the Building Industry in South Africa.

5.5 S.A.B.S. 0157 AND THE BUILDING INDUSTRY IN SOUTH AFRICA

S.A.B.S. 0157, as previously mentioned, was designed to meet the needs of modern industry, where the party responsible for the supply of goods and services may apply the set of definitive procedures laid down on the code of practice to assure the desired levels of quality in such goods and services. The Building Industry in South Africa, however, does differ from most other industries, in the following respects:

A building contractor is not a manufacturer in the common meaning of the word. The product the builder is concerned with is 'the building', which is commonly a 'one-off' item. Where a builder is concerned with a large scale housing scheme, many of the units he has to build may be identical, but he will invariably have only one contract for part or all of the scheme, the nature and requirements of which are unlikely to be repeated in another contract.

A manufacturer, on the other hand, deals with one or many products, most of which are being produced 'en-masse'. The broad distinction being made here is one of homogeneity in the manufacturing industry and one of dissimilar or 'one-off' products in the building industry. The place of work activity is also a major difference. The manufacturer's product is generally produced under a factory roof, but the building contractor is required to produce or build his product - a building or structure, at various different sites within the geographical area in which he is prepared to operate. The manufacturer generally conceives of a product and sets about producing it at his factory. He might require materials and even components for his product to come from other factories, but due to the repetitious nature of the units he is manufacturing, he is able to manufacture and assemble under one roof, from where the product is delivered to the customer.

The building contractor does not conceive of the product or building that he builds - that is the responsibility of the client and his design consultants. The location of the building is determined by the client and consequently, the builder finds himself with certain parameters and constraints dictated to him by others - unlike the manufacturer.

At this juncture, it ought to be realised that the nature of product has little bearing on the quality management principles that ought to be followed in order to assure quality in the product or service. A building is a 'one-off' project, where shape, size and function may differ from project to project. There are nevertheless enough attributes that are the same from one project to the next, upon which statistical sampling procedures could be employed in the control of quality. Such statistical applications could be used to control the quality of building products and components such as bricks, ingredients of concrete and mortar, plumb-

ing fittings, reinforcing steel, tiles, windows and a host of others too numerous to mention.

What is important to consider is that in the building industry today, there is very little of the entire scope of the building project that is physically constructed by the general building contractor. The general building contractor normally erects the reinforced concrete or other type framed structure. He may do the brickwork or he may sub-contract that portion of the works to a sub-contractor who specialises in brickwork. Most of the items in many of the trades contained in the bill of quantities find themselves on modern building projects, being carried out by sub-contractors. As far as the client and architect are concerned, it is the builder that is performing the work, and it is he who has ultimate responsibility for all the work so performed. The builder may sub-let or assign protions of the work out to lower-tier contractors providing that the architect has given his approval to sub-let a specific portion of the works to a specific sub- contractor. (Refer also to clause 14 of the Agreement and Schedule of conditions of building Contract - 'White Form').

Twenty to thirty years ago, when the requirements of clients and buildings were far less sophisticated than they are today, the builder had in his organisation's scope of supply, all the building trades necessary. Consequently, he did not find it necessary to sub-let his work. He also had full control over all trades in his organisation and was able to keep standards, skills and workmanship up to a high level. From about the 1960's onwards with the development of more sophisticated and complex buildings, improved technology and the advent of new products and systems such as air-conditioning plants and others, a complete new set of skills was required. It became impossible for one general builder to supply all these skills, and so specialist organisations were developed, each supplying an individual or small set of specialist skills for each of the trades that had become more sophisticated or were simply new to the industry. With this greater degree of specialisation in the trades came sub-contracting.

What may be concluded from the above, is that the building contractor is now not only providing a product, but also a management and coordination (of sub-contractors) service, in order to achieve the end product. Consequently, it can be argued, that as far as quality is concerned, Part II of S.A.B.S. 0157 (which deals with a system for manufacture and installation) is applicable and can be used by a contractor on his contracts to assist him in quality assurance.

Part II fo S.A.B.S. 0157 lists the requirements that need to be followed by the general contractor. (Refer to Appendix 7).

While it is not intended to cover the vast area of the implementation of quality management systems, a brief example or description of where a building contractor will find each clause of S.A.B.S. 0157 applicable to him, follows:

Sect. 2.1 This section requires no further elaboration.

2.2.1 This individual could be a contracts manager, site agent, assistant contracts manager, or a person whose sole responsibility will be the field of quality. It should not be the general foreman whose task is to coordinate the works and who would find himself hard pressed to provide an objective and independent evaluation of the quality of the work for which he is responsible. The contractor would call the individual fulfilling the requirement of this section, a Quality (Assurance) Manager or Engineer.

2.2.2 This portion and function would best be carried out by the client's representative. This would mean that the architect would be a prime candidate for this position, however, he may be assisted by the Clerk of Works who is a resident individual.

It would, of course, not be the contractor's responsibility to ensure that this position was filled by a representative of the client. (See chapter 2 paras. 2.2.2.1 sub.4 and 2.2.3.2.1 sub.7 Ibid). The contractor himself, bearing a responsibility for his subcontract-

ors' and certain suppliers' quality, would find it in his own interests to have a similar individual appointed to protect such interests. This would be looked after by the QA Manager or Engineer.

Sect. 2.3 It would be the responsibility of the QA Manager/Engineer to perform this function and to the extent that it covers sub-contractors and sub-tier suppliers.

Sect. 2.4 Items 2.4 a) to g) will fall under the contractor's scope of management and would require an input from the QA Manager/Engineer. (Refer to chapter 2, paras. 2.2.3.1 and 2.2.3.2 Ibid).

Sect. 2.5 Work Instructions would be compiled by the QA Manager/Engineer, drawing such necessary information as this clause requires, from the specifications, drawings and Bills of Quantities (Contract Documents) and other in-house building procedures that the contracting organisation has adopted.

Sect. 2.6 This section requires no further elaboration, excepting that the QA Manager/Engineer should earmark the relevant documentation that is generated so that it may become a quality record.

Sect. 2.7 This section requires that measures should be established to assure that the causes of significant conditions adverse to quality are determined and that corrective action is taken to preclude repetition. It is necessary for the contractor to determine the nature of defect identified, but all defects should be brought to the attention of the technical representative of the client - preferably a member of the design team. It would then be incumbent upon this individual to direct that proper corrective action be implemented and measures be taken to ensure that recurrence is prevented. The disposition of corrective action desired would take the form of an instruction from the architect (See paras 2.2.1.1 sub. 4 and 2.2.3.1 sub. 1 Ibid). While this would be similar to an instruction, it should nevertheless be identified as a corrective action request by both the contractor and architect and should be a comprehensive document listing all information pertaining to the defect and would ultimately become a quality record. It

is also necessary that both the architect and the contractor take cognizance of the cause of the defect, whether it be due to poor workmanship or supply of materials on the part of the contractor, or specification of inferior quality levels by the designer.

Sect. 2.8 This section requires little further elaboration since most building contracts employing a reputable team (contractor and design consultants) generally do observe document control, especially on drawings. The document control system should not be restricted to drawings only. It should cover instructions, corrective action requests, quality system reviews, receipt and other inspections, clerk of works reports, specifications and any other documentation affecting quality, and their changes. It is normally good practice to keep a log of all such changes with their dates and associated revision numbers.

Sect. 2.9 Control in this area could be as widely spread as including the checking of the accuracy of artisans' tape measures and rules, however, the important items of plant used such as concrete weigh-batching mixers, should receive this control on a fairly regular and strict basis. Other equipment falling under this category would be concrete test-specimen crushing machines (normally performed off-site at approved testing houses), dumpy-levels and theodolites and the like. The extent of this section would not be limited to the contractor's equipment only, but also extend to that of his sub-contractors and as far as his suppliers also.

Sect. 2.10 This section and its sub-sections are self-explanatory. Sub-section 2.10.2, as far as specified materials and products are concerned, would include a transcription from the specification and bill of quantities preambles and drawings to the purchase order. Where not specifically mentioned, it would be incumbent upon the contractor to specify certain standards, whether they be recognised S.A.B.S. standards or his own, in order to assure that the requirements of his quality programme will be met and in achieving this, he will be protecting his image in terms of his quality policy.

Sub-section 2.10.3 is also self-explanatory, but information pertaining to the level of quality of the goods being received should be made known to the architect, in the event that the material he has specified does not meet his acceptance criteria.

Sect. 2.11 This section includes one of the most important areas of control that the contractor would find necessary to consider in order to provide assurance that the quality of the end product is of the desirable level and attained without wasting resources. The contractor's planning should consider activities during work phases, between which inspections may be made. These inspections should be made by the contractor's quality control inspector, not the foreman or other works personnel. Manufacturing or construction sequences should be adhered to and strictly controlled and the work of one activity should be completed, checked and inspected and accepted before proceeding to the next activity in the sequence. The architect should be notified, in advance, of this construction or manufacturing programme so that he may be present if he so desires, at the inspection stages.

Sect. 2.12 This section necessarily implicates nominated sub-contractors, (See Chapter 2, para. 2.2.3.1 sub.10 ibid), but further, requires no elaboration.

Sect. 2.13 This section simply requires that at the finished product stage, whether it be a room, a roof, foundations or any element of a building, an inspection upon that entire element be made and full compliance to the requirements for that element be assessed. Such inspections at various stages should generate documentary evidence so that inspections at a later stage, of larger sections of the works incorporating many elements, may be made with adequate assurance that prior work (which may by that stage have been covered up) is of an acceptable status.

Sect. 2.14 This section is self-explanatory but refer also to Chapter 2 para. 2.2.3.2.1 sub.4 ibid. (Note: The purchaser's representative is deemed to be the architect, in this instance).

Sect. 2.15 This section requires no further elaboration, but would need to be considered by both the architect and the contractor and indication should be made whether rejection, repair or rework will be required.

Sect. 2.16 This section is self-explanatory. One could conclude that a colour-coding system would be a practical system to follow in this instance.

Sect. 2.17 The 'general' paragraph of this section sums up the intent of the section admirably. The care exercised in the handling, packing, stacking, storing, shipping and delivery of goods and materials ultimately affects the overall quality of the products or materials, and very often their usable quantity. Consideration should be given to the environmental conditions, modes of transport, types and degrees of traffic in storage areas and a host of other items. Both of these phases (handling/delivery and storage) should be physically checked at source and destination, for conformance to applicable requirements.

Sect. 2.18 This section is perhaps the most important section as regards the building industry in general today. There is a widespread opinion that the training of all personnel, from general foreman down to artisans and labourers, in all trades, is inadequate for the work which they have to perform. This is one of the main causes for the popular belief that quality in the Building Industry will never be achieved without an improvement in the training in general and in particular, an upgrading of the general foreman. Training for special processes in particular, should be mandatory. Certification, providing recognition of level of skill and competence should be made to provide objective evidence of an individual's capabilities. Training should also not be a 'one-off' event, but re-evaluation and re-certification should be performed at reasonable intervals, to assure the maintenance of the desired level of skills.

From the above, it can be concluded that Part II of S.A.B.S. 0157 could be adapted with a fair amount of ease, for use in building contracting

organisations. It would then seem logical that the client's design consultants could also observe the requirements laid down in Part I of S.A.B.S. 0157. Both the design consultants and the contractor would be able to observe the requirements of Part III of S.A.B.S. 0157 inasmuch as it affects the suppliers of building products and components.

All that now remains to be done, is the adaptation of the Agreement and Schedule of Conditions of Building Contract (The White Form) to incorporate contractual requirements pertaining to the implementation of S.A.B.S. 0157 Parts I, II & III on such building projects where clients deem it necessary to have quality assurance prescribed. This, then, could be a logical step for the Joint Study Committee of the Building Industries Federation of South Africa (Refer to para. 2.1.2.1 Chapter 2 ibid) to follow, once the concept of quality assurance becomes accepted by all in the Building Industry in South Africa.

CONCLUSION

This chapter has shown how levels of quality are set in the South African Building Industry. It shows how a distinction between these levels and the management of attaining these levels exists. It discusses guides which have been developed to assist management in attaining these levels in general industry and how SABS 0157 is one such guide which has recently been developed for Industry in South Africa. It continues, in demonstrating the applicability of SABS 0157 to the South African Building Industry.

This chapter has reconciled Chapter One with Chapter Two demonstrating that the two: Quality Assurance and the Building Industry, are compatible. Chapter Three identifies the current position in the growing national awareness of Quality Assurance and demonstrates that industry has its feet on the path to successful implementation of quality management in many of its divisions. Chapter Four identifies the need for quality management and the attitudes to quality prevailing in the industry today. It also demonstrates the ease with which Q.A. may be adopted in the Building Industry.

The reader is now left with the question: "Where to now?" The answer is really to amend the current attitudes towards quality, introduce to the right organisations in the right manner the true principles of quality management. That on its own, is an area so vast that it warrants a separate study altogether. Nevertheless, Chapter Six provides conclusions and recommendations which will lead the reader through the gate in what ought to be the right direction for successful implementation of quality assurance in the Building Industry.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

Chapter One introduced the philosophy of Quality Assurance. QA was defined as being a management system, but one that had been developed to meet the requirements of ever-changing production needs. The meaning of the word quality was defined as being "fitness for use", or, in the context of quality of conformance, "conformance to the requirements". The concepts of quality of design and quality of conformance were discussed, emphasising the importance of the distinction between the two for quality management. The author then discussed the economics of quality, quality costs and the philosophies of Company-wide Quality Control and Quality Control Circles. The conclusion drawn from chapter one is that the system of quality assurance was the result of a logical progression in the development process for production management systems. It is seen to be a management system that has met the need to fulfill a new set of requirements with particular respect to the management of quality and reduction of costs.

Chapter Two introduced the Building Industry in South Africa, providing a brief history and showing its complex structure and nature of contracting. It describes the functions of the Building Industries Federation (South Africa) and the economic problems with which this industry is beset. The divisions within the building industry, the building team and their roles, as well as the types of contract in the industry were discussed. Project Management was also discussed, showing how well suited to quality management this system of operating proves to be. The building industry is shown, in this chapter to be a complex industry frought with problems. While many of its problems are seen to result from outside economic pressures, the management problems of meeting market needs and the needs internal to building contracting organisations, are themselves complex. The building industry is consequently seen to be a complex but relatively unsophisticated industry which requires certain refinement and is in dire

need of an improved image - professionally in its management attitudes and especially within its overall cost structure.

Chapter Three addresses the problem of quality awareness in South Africa. It makes comparisons to the successes quality has proffered the Japanese. While Japan's circumstances are vastly different from South Africa's, their manufacturing philosophy is tightly bound to productivity. This is seen to have given rise to a very strong group-thinking philosophy, which is now an integral part of Japanese culture, as are their quality control concepts. South Africa is seen to be lagging behind in the struggle for a share in the World Market Pie. The greatest efforts in the promotion of QA in South Africa, is seen to have been undertaken by two individuals; Dr. T. Hodgson of the C.S.I.R. and Deneys Zeederberg, former director of quality at ARMSCOR. It is argued that this task should be undertaken by official bodies, not individuals. The important relationship between quality and productivity, and the development of a Code of Practice for Quality Management Systems by the South African Bureau of Standards, was discussed in this chapter. The author then argued the need for a national strategy, the focal point of the strategy being the promotion of quality awareness. The greatest responsibility in implementing a nation-wide quality strategy is seen to rest with central government, but more realistically speaking, could result in being steered by the S.A.B.S. or its National Advisory Council for Quality Management.

Chapter Four moves from a discussion of national quality awareness (in chapter three) into a discussion of the need for a quality awareness in the Building Industry. The conclusion that there is a need for quality assurance in the building industry was reached through the evaluation of a series of questionnaires and interviews held in Cape Town's local building industry. Despite the small sample of respondents, it is argued that the overall result from a combined evaluation of both the questionnaire results and the interviews, do illustrate current attitudes towards quality. It is shown that there is a significant lack of understanding of the meaning of the word quality, quality concepts, quality costing and in general, quality management, amongst all members and types in the building industry. It is also shown that there is a great degree of interface inefficiency between the client, building professions and contractors.

Chapter Five deals with setting and attaining quality levels in the building industry. The responsibilities of setting these levels is followed by a discussion on achieving these levels. The broad distinction being made in this chapter, is that between quality of design and quality of conformance, as applied to the building industry. S.A.B.S. 0157, Code of Practice for Quality Management Systems, is investigated with a comparison being made between it and an American guide to quality management. S.A.B.S. 0157 is then discussed with particular reference to its application in the building industry, showing that the two <u>are</u> compatible.

The thesis of this study is seen to be the following:

1) The Building Industry in South Africa has a need for a management system that deals with quality in the true sense of the word "fitness-for-use".

2) The lack of quality awareness in the building industry is a barrier to the quality problem-solving ability of the industry.

This study has argued that:

1) The system now generally known as Quality Assurance, fits the need that the building industry has for dealing with quality and that S.A.B.S. 0157, Code of Practice for Quality Management Systems can be applied with relative ease to address the quality problems of the building industry.

2) There is a significant ignorance of the principles of quality management and the concepts of quality of design and conformance in this industry. While there does exist a growing awareness of QA in South African manufacturing industry, it is significantly absent in the building industry.

3) There is a need to reduce the costs of scrap and reject work, and that a properly applied QA programme will achieve this, and in so doing increase productivity and profitability.

4) There is no national QA strategy endorsed by central government for the building industry in South Africa. This study recognises the need for quality strategies to be formulated by individual industries who would seek co-operation and equal interest from central government above them, and from industries with related interfaces, alongside them. Acknowledgement and support from central government will add impetus to the national strategy.

From these arguments it is concluded that the building industry does need quality assurance. Consequently, an investigation into the implementation of qualtiy management systems in individual organisations and on projects, as well as an investigation into the strategy for the building industry, are recommended areas for further study. There would, however, be serious questions to consider in this further study. The questions address the major aspects that will have to be considered before effective implementation of QA could take place:

* Who should be responsible for steering the implementation of quality management systems within the industry and the promotion of quality awareness?

* How would the traditional contractual relationships of the members of the building team be reconciled with quality assurance requirements, without a project management system resulting?

* How can members of the building industry reconcile the principles of qualtiy assurance (especially in the area of

the audit) with professionalism and the statutes governing professionals?

* How can QA requirements be incorporated into the industry's standard conditions of building contract?

* Who should be responsible for setting standards pertaining to training in QA in the industry?

* Who should be responsible for setting standards for quality and for establishing guides for quality management with particular reference to the building industry; also for quality assessment of supplier and service organisations?

The answers to these questions will have an influence on the degree of success that the implementation of QA will have in the building industry. The manner in which the aspects contained in these questions are addressed by the members of the building industry will necessarily influence the future and progress of the building industry in South Africa. The author feels that some aspects of the above questions may constitute barriers to the future successful implementation of QA in the building industry. What is therefore required, is a mature attitude and positive approach towards QA by the professions, contractors, suppliers and clients alike. A negative or disinterested approach from just one group in the building industry, could retard progress considerably.

In dealing with the formulation of a national strategy for QA in the building industry, of paramount importance will be the selection of a team that represents all involved in the building industry. This team will need to be dedicated to solving the present quality problems; to promoting QA and to provide a framework through which the present ways of operating in the industry may be streamlined to improve quality.

The first body that springs to mind for this purpose, is the Joint Study Committee. This committee first came into being in

1960, "with a view to assisting the building industry with the interpretation of new concepts and provisions and also to rectify, if and when necessary, anomalies which might arise in practice out of the amended provisions (of the then recently revised form of conditions of building contract)"[13]. This committee is still in existence and was active in revising the standard form of conditions of building contract in 1977. Thus, the Joint Study Committee would seem admirably suited to undertake this work of guiding the implementation of QA in the building industry. Liaison with the National Advisory Committee for Quality Management (S.A.B.S.) is essential, as this committee was responsible for initiating quality training programmes in general industry and S.A.B.S. 0157. However, the next alternative is an ad hoc committee which should, as a minimum requirement, comprise a delegate from each of the professional institutes, trade associations and advisory bodies involved in the building industry. Whatever committee is formed its primary duties would be to focus attention on two broad fronts:

1) A macro approach, concerning QA for the building industry as a whole;
2) A micro approach, concerning QA for the individual organisation.

The first deals with the implementation of a national strategy and ironing out problems related to conditions of contract and quality assessment. The second deals with the implementation of quality management systems and programmes in individual organisations.

In conclusion, apart from the need for quality assurance that has been identified for the building industry, there is a need for further study in the area of national quality strategy for the building industry, focussing attention on the problems of quality awareness and the aspect of implementing quality management in organisations in the building industry. Considering the economic factors of an increasing shortage of all necessary production resources with which the building industry is presently faced, there should be no delay in the industries pursuit of the recommendations contained in this chapter.

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APPENDIX 1

(Refer Chapter 2)

Summary of Relevant Conditions of Contract

1. Scope of the Contract. The contractor undertakes to carry out and complete the works in accordance with the directions of the architect. He undertakes to build in accordance with the plans, specifications and directions which will be provided by the employer through the architect. This does not mean that the contractor need not employ his own expert knowledge of building construction and the use of materials. It is interesting to note that where an employer does not employ an architect or other specialist adviser, so that he, the employer, is relying on the skill and judgement of the contractor to provide for design and specification, there is an implied term that the work will be fit for the purpose. Here, the contractor's obligations are that the workmanship will be of a proper standard and quality; that the materials will be fit for the purpose for which they were intended; that the materials will be of a proper standard and quality and that the completed work will be fit for its purpose.

Where an employer does employ an architect, however, the contractor is relieved of many of these obligations and undertakes to build according to drawings and a specification supplied to him by the architect. The end result in either case, is that the workmanship must be of proper standard and quality.

The contract document does not make the contractor responsible for the design of any part of the works. The architect has the authority to require the works to be carried out to his reasonable satisfaction, in accordance with the drawings and specification which form part of the agreement. Should the contractor believe that the architect is behaving unreasonably, he is entitled to invoke the arbitration provisions of the agreement.

The architect is empowered to give instructions and issue further drawings which he deems necessary to have the work satisfactorily performed and he is also authorised to make variations in the design

and quality of the work. The contractor is required to comply with these instructions, of course, only to the extent where such variations do not change the essential nature of the work to be done as described in the contract documents. The contractor will, however, be remunerated for such variations.

2. Drawings and Bill of Quantities. The contractor is required to keep a copy of all drawings and the specificaiton on the works. With the falling into disuse of the specification and the incorporation of much of the specification into the bill of quantities, it has become common practice to keep one unpriced copy of the bill of quantities on the site and refer to this document for information regarding required finishes. The bill is, however, purely a pricing document and is not intended to be used as a specification. The lengthy preambles which describe the materials to be used and methods of procedure, do however, conform somewhat to a specification. After the final payment has been made to the contractor he is required to return to the architect, all drawings and specifications bearing the architect's name.

3. The Contractor to Provide Everything Necessary . The contractor is obliged to provide everything necessary for the works, whether particularly described in the contract documents or not. He is also required to bring to the architect's notice any discrepancy he finds in the contract documents. Likewise, the architect is required to order, that is, issue instructions or direct, everything necessary for the proper execution of the works. The contractor is required to comply with statutes in the execution of the works and by specific provision , will be reimbursed for the cost of such work.
Besides being bound to do everything necessary for the proper execution of the works, the contractor is responsible for the cost of any work not particularly shown or described on the reasonable assumption that the same can be reasonably implied from the drawings and specification.

4. Materials and Workmanship to Conform to Description. The materials and workmanship shall, so far as is procurable be of the kinds

required by the contract and the onus of proof that this is so, rests with the contractor. Should any tests be required to be carried out in this action of proof, the contractor is entitled to receive payment for them, only if the materials are shown to conform with the contract requirements.

The contractor should pass on to his suppliers, where warranties are applicable, the warranty of suitability of purpose and freedom from patent and latent defects in any named goods, or if these suppliers will not accept these warranties, the contractor should limit his own liability to the employer. He does, however, remain responsible for patent defects, that is those defects obvious on a reasonable examination by any normal builder. (A patent defect is defined as being an obvious unconcealed defect).

5. Foreman. The contractor is required to keep on the works for all of the time that the works are being carried out, a competent representative to whom the architect can give any instructions in the pursuance of the scope of the contract. When the architects instructions are given to that person, they are deemed to have been given to the contractor. A foreman is generally the principal workman superintending others, even if there is just one workman, as long as that one workman fulfilled the requirement of competence. On a job of any magnitude, it is customary for each trade to have its own individual foreman under the overall control of someone usually called the general foreman or a works foreman, but may be a contracts manager or site agent. It is necessary for the contractor to inform the architect which particular person has been appointed to fulfill this requirement.

6. Access for Architect to Works. The contractor is required to afford the architect and his representative access to the works and to the workshops or other places where the work is being prepared for the contract at all reasonable times. Since the architect's consent for the assignment by the contractor for any portion of the works to be performed by a third person or sub-contractor must be obtained by the main contractor, the architect may readily secure access to the premises of such sub-contractors by making his consent to such

subletting conditional upon the sub-contractor accepting this access.

7. Clerk of Works. The contractor is required to afford every facility for the performance of his duties to a person known as the Clerk of Works. The Clerk of Works usually acts solely as an inspector on behalf of the employer, under the directions of the architect.

8. Defects after Completion. The contractor is required to remedy any defective work and replace defective materials under the terms of the contract, so that a complete building without any defect can be handed over on a due date. The architet is empowered to instruct the contractor to make good defective work, even after the works have been handed over and the contract is believed to be complete. At practical or substantial completion of the job, there is an additional three month period, known as the 'maintenance period', during which the contractor is liable for the making good of defects which arise out of a breach of contract. When the works have been completed, the contractor then receives half of the amount of the retention monies. A retention fund is provided for, to safeguard the employer against over payment and to make good defects the contractor has failed to do himself and paying damages to which the employer has become entitled as a result of failure by the contractor to complete the works within the stipulated period. The architect normally makes an inspection at the time of practical completion, to mark the beginning of the defects liability period. At the end of the defects liability period, three months after the works have been accepted as complete, a further inspection will be made by the architect. He prepares a list of all defects, considered architects instructions, with which the contractor is required to comply, within a reasonable time before the contract is considered complete. In the case of roofs and items that might leak, the length of the defects liability period is six months after the completion of the works, extended as necessary to permit a test of the roof by sufficiently heavy rain if no rain falls within this six month period.

After the expiration of the defects liability period, the right of the employer to order making good of the defects will become

extinct. Defects which appear outside the defects liability period has expired, fall outside of the scope of the contract. These generally are considered as being latent defects, which are defects that are not apparent to the ordinary man even if apparent to the expert, or defects which a reasonable examination would not have disclosed. The employer is not precluded from claiming the cost of remedying such defects. The provisions of the Prescription Act binds the contractor to make good defects that take place up to three years after the end of the defects liability period.

9. Prices for Variations. The measurement and valuation of variations is normally performed by the quantity surveyor, in consultation with the architect. Where in the opinion of the architect, extra work cannot be properly measured and valued, day work will be ordered. The term 'day work' has a specific meaning in relation to building contracts. It refers to a method of pricing work by recording the hours spent on it by the various tradesmen and their hourly wages, and recording also the quantities of any materials and the hours of any plant used. The contractor is required to deliver to the architect or his representative the supporting vouchers showing the time spent and the materials used each week. This is done not later than twenty one days after the end of the week concerned. Failure by the contractor to do so disqualifies him from recovering the expenses on the basis of day work and it is then left to the architect to decide a fair price for the work. The contractor is required to provide proof if he claims more than the statutory minimum rate of pay for his workmen.

10. Nominated Sub-Contractors. A third party chosen by the employer or the architect on his behalf, is referred to in the contract document as a nominated sub-contractor. The contractor's obligations in respect of his work are the same as in respect of the work of those sub-contractors which he chose himself, with the sole exception of delay, default or insolvency of the nominated sub-contractor. This means that once the nominated sub-contractor has been accepted, the contractor's responsibility for his performance becomes the same as

it is for his own subcontractors with the exceptions mentioned above.

Nominated sub-contractors are those whom, because of their specialist knowledge and skill or for any other reason, the employer or architect on his behalf, has chosen to perform specialist work. They commonly fall within a group of approximately twenty specialist types such as electrical contractors, lift engineers, fire protection services or specialists, shopfitting contractors, insulation, heating, ventilation and air-conditioning contractors and so on..

The contractor does have the right to refuse to employ any contractor selected by the architect, against whom he has reasonable objection. This applies also to terms of payment to the sub-contractor.

APPENDIX 2

(Refer Chapter 4)

Questionnaire to the Architects

Res 698215 Work (02224)2110

(QUESTIONNAIRE REF. No. AQ)

INSTRUCTIONS FOR THE COMPLETION OF THIS QUESTIONNAIRE:

Where space is provided for comments, please complete as concisely as possible in block capitals.

Where "yes" or "no" circles and numbered multiple answer zones are provided, please make a cross, in the applicable zone, eg:  .

Where the multiple answer zone is followed by the word 'other', please specify as concisely as possible.

Please complete all questions contained in this questionnaire to the best of your ability, reflecting as accurately as possible your current practice, aims or views.

GENERAL

NAME OF PARTICIPATING INDIVIDUAL .....

NAME OF ORGANISATION BY WHICH INDIVIDUAL (above) IS EMPLOYED: .....

.....

POSITION WITHIN THE ORGANISATION HELD BY THE PARTICIPATING INDIVIDUAL: .....

.....

BUSINESS ADDRESS OF THE ORGANISATION: .....

..... Code ..... Telephone No.: .....

1. For how many years have you been practising as an Architect? .....

2. Do you practise as; An individual Architect? .....

   A member of an Architectural Partnership? .....

   .....

   Other? (please specify) .....

   .....

3. If you are a member of a partnership, how many partners do you have? ..

   .....

4. Do you have other non-partner members in your employ who perform the functions of an architect? .....

   If yes, specify how many you have ....., and briefly what type of functions they perform: .....

   .....

   .....

5. List the projects in the Building Industry on which you/your organisation are currently working? .....

   .....

   .....

   .....

   .....

   .....

6. List the projects in the Building Industry in which you/your organisation have been involved over the past decade (1970 - 1980):

   Please complete the following matrix, using where applicable, the following code;

Type of Involvement □	Type of Building ⬡	Type of Contract ○	Type of Client △
A Design only	I Office Block	A Conventional	I Insurance Co.
B Design and contract administration	II Shopping Complex	B Turnkey	II Pension Fund
C Contract Administration only	III Apartment Blocks	C Cost-Plus	III Prov. Admin.
D Design, Contract Admin. Final Account	IV Hospital	D Negotiated	IV P.W.D.
E Final Account only	V School	E Other	V Government
F Other	VI University		VI Other
	VII Other		

Code: eg. □ D ⬡ V Ⓐ A △ III

MATRIX

YEAR	NAME/TITLE OF CONTRACT/PROJECT	Type of Involvement	Type of Building	Type of Contract	Type of Client
1970	EXAMPLE: BAMBOERSVLEI HIGH SCHOOL	D	V	A	III
1970					
1971					

YEAR	NAME/TITLE OF CONTRACT/PROJECT	□ Type of Involvement	⬡ Type of Building	○ Type of Contract	△ Type of Client
1972					
1973					
1974					
1975					

YEAR	NAME/TITLE OF CONTRACT/PROJECT	□ Type of Involvement	⬡ Type of Building	○ Type of Contract	△ Type of Client
1976					
1977					
1978					
1979					

YEAR	NAME/TITLE OF CONTRACT/PROJECT	Type of Involvement	Type of Building	Type of Contract	Type of Client
1980					

7. Has/have you/your organisation made any notable achievements in the architectural field, such as receiving design awards, special mentions, etc.,; (please specify, and when) .....

.....

.....

.....

8. Does your organisation specialise in any particular type of architecture i.e. design of schools, hospitals, churches etc., (please specify) ....

.....

.....

.....

.....

A. ORGANISATION:

1. DOES YOUR FIRM HAVE AN INDEPENDENT INTRASTRUCTURE (department, section or group), TO DEAL WITH QUALITY PROBLEMS? YES [1] NO [2]

IF YES; What is this department, section or group called?

(3) Quality Assurance; (4) Quality Control; (5) Inspection; (6) Other (please specify) .....

.....

++++++++++

B. PROGRAMME:

1. DOES YOUR FIRM HAVE A WRITTEN QUALITY POLICY ENDORSED BY TOP MANAGEMENT? [1] [2]

2. DOES YOUR FIRM HAVE A WRITTEN QUALITY ASSURANCE, QUALITY CONTROL OR INSPECTION MANUAL? [1] [2]

IF YES; What is it called?

(3) Quality Assurance Manual
(4) Quality Control Manual
(5) Inspection Manual
(6) Other (please specify) .....

.....

.....

3. DOES YOUR FIRM HAVE DETAILED WRITTEN INSTRUCTIONS PROCEDURES FOR IMPLEMENTING QUALITY ACTIVITIES? [1] [2]

IF YES; What are they called? YES NO

(3) Quality Assurance Procedures

(4) Quality Control Procedures

(5) Inspection Procedures

(6) Other, (please specify) .....

.....

.....

4. ARE ANY OF THE ABOVE (in B.1,2&3) REVIEWED AND UPDATED ON A REGULARLY SCHEDULED BASIS? [1] [2]

IF YES; Which ones?

(3) Policy

(4) Manual

(5) Procedures

(6) Other, (please specify) .....

.....

.....

++++++++++

C. CONTROL OF THE DESIGNS:

1. DOES YOUR FIRM REQUIRE THE DESIGNER TO STATE THE ASSUMPTIONS AND REFERENCES USED AS THE BASIS FOR HIS DESIGN? [1] [2]

IF YES; Is the requirement

(3) A written requirement

(4) Not a written requirement, but "we've done it this way for years"

(5) Depends on the individual

(6) Other, ...

.....

.....

IF YES; How are assumptions or references stated? YES NO

(7) On a standardised form or format

(8) Depends on the individual

(9) Other, ...

.....

2. DOES YOUR FIRM REQUIRE CALCULATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? [1] [2]

IF YES; Is the review comment or modification .

(7) Documented on some standard format?

(8) Not documented, but transmitted verbally or telephonically?

(9) Other, ...

.....

IF YES; How does your firm ensure that modifications to design calculations are incorporated into the design?

(7) Using a design review comment register or control log,

(8) Depends on the individual,

(9) Other, ...

.....

3. DOES YOUR FIRM REQUIRE SPECIFICATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? [1] [2]

IF YES; Is this second or independent review ..

(7) Formally documented

(8) Discussed informally at a meeting,

(9) Other, ...

.....

IF YES; How does your firm ensure that specification changes or modifications are included in the original 'master spec.'?

YES NO

(7) Using an itemised specification log or register,

(8) Depends on the individual,

(9) Other, ...

.....

4. DOES YOUR FIRM REQUIRE DRAWINGS TO BE SUBJECTED TO AN INDEPENDENT OR SECOND REVIEW? [1] [2]

IF YES; Are the results of the second or independent review ...

(7) Documented using some standard format and procedure,

(8) Not documented, but done informally, verbally or telephonically,

(9) Other, ...

.....

IF YES; How does your firm ensure that the results of the second or independent drawing review are incorporated into the 'master drawing file' (working drawings) ...

(7) Through the use of a drawing control procedure and log or register,

(8) Informal alterations of drawings and their copies,

(9) Other, ...

.....

5. DOES YOUR FIRM REQUIRE THE CONTROL OF DESIGN CHANGES INITIATED AT OR THROUGH THE DESIGN OFFICE? [1] [2]

IF YES; Are these design changes ...

(7) Formally documented and effected using a standard format,

(8) Effected informally via telephone or other consultation,

(9) Other, ...

.....

IF YES; How does your organisation ensure that the design changes are implemented? YES NO

(7) A formal design change and inspection procedure,

(8) Some other informal in-house procedure, being standard practice,

(9) Other, ...

.....

6. DOES YOUR FIRM REQUIRE THE CONTROL OF DESIGN CHANGES MADE IN THE FIELD? [1] [2]

IF YES; Are these design changes ...

(7) Formally documented and effectively implemented using a standard format and procedure,

(8) Effected informally and in some other in-house standardised manner,

(9) Other, ...

.....

IF YES; How does your firm ensure that the design changes made in the field are implemented properly?

(7) A formal design change and inspection procedure,

(8) An informal procedure depending upon the individual,

(9) Other, ...

.....

++++++++++

D. DOCUMENT CONTROL:

1. DOES YOUR FIRM REQUIRE THE IDENTIFICATION OF THOSE TO WHOM SPECIFICATIONS ARE ISSUED? [1] [2]

IF YES; Does this system of identification control comprise ... YES NO

(7) Formally documented control log containing spec. details, dates and personnel to whom issued?

(8) An informal circulation?

(9) Other, ...

.....

2. DOES YOUR FIRM ENSURE THAT DETAILS OF CHANGES MADE TO THE SPECIFICATIONS ARE CONVEYED TO THE INDIVIDUALS WHO HAVE BEEN ISSUED WITH THE INITIAL OR SUPERSEDED SPECIFICATION? [1] [2]

IF YES; To effect this control, does your organisation use ...

(7) A formal control log containing dates, individuals names and spec. changes?

(8) Controlled, informally and depending upon the individual?

(9) Other, ...

.....

3. DOES YOUR FIRM REQUIRE THE IDENTIFICATION OF THOSE TO WHOM DRAWINGS ARE ISSUED? [1] [2]

IF YES; Does this system of identification control require ...

(7) A formally documented control log or index containing drawing numbers, dates and individuals names,

(8) An informal circulation,

(9) Other, ...

.....

4. DOES YOUR FIRM ENSURE THAT CHANGES TO DRAWINGS ISSUED ARE CONVEYED TO THOSE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED DRAWING IS ISSUED? YES [1] NO [2]

IF YES; Does this system of control comprise ...

(7) A formally documented control log containing dates, revision numbers and individual names,

(8) An informal method, either telephonically, verbally or depending on the individual,

(9) Other, ...

.....

5. DOES YOUR FIRM REQUIRE THE IDENTIFICATION OF THOSE TO WHOM PURCHASE ORDERS ARE ISSUED? [1] [2]

IF YES; Does this identification control system comprise ...

(7) A formally documented control log or register,

(8) Depends on the individual,

(9) Other, ...

.....

6. DOES YOUR FIRM ENSURE THAT DETAILS OF REVISIONS TO PURCHASE ORDERS ARE CONVEYED TO THE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED PURCHASE ORDERS WERE ISSUED? [1] [2]

++++++++++

E. PROCUREMENT CONTROL:

1. DOES YOUR FIRM REQUIRE THAT RECORDS OF THE HISTORY OF THE TENDERERS CAPABILITY OR PERFORMANCE ARE KEPT? [1] [2]

2. DOES YOUR FIRM REQUIRE THE USE OF A "QUALIFIED TENDERERS" LIST FOR EACH PROJECT? [1] [2]

IF YES; Is this list based on ... YES NO

(10) Membership to a quality institution, association or society (i.e. a quality consideration)

(11) Contractors reputations - Financially

(12) Contractors reputations - Performance,

(13) A combination of above, (specify which ones, e.g. 11 & 12) .....

(14) Other, ...

.....

IF YES; The evaluation for their quality considerations is based on ...

(7) A formal consideration every time,

(8) An informal consideration, depending on control,

(9) Other, ...

.....

IF YES; Which one of the following quality aspects would fit your definition of a "Qualified Tenderer" best?

(3) A contractor who has an acceptable Quality Assurance Programme,

(4) A contractor who has an acceptable Quality Control Manual,

(5) A contractor who performs acceptable inspections on his work,

3. DOES YOUR FIRM REQUIRE THAT A VISIT TO AND EVALUATION OF TENDERERS FOR EACH PROJECT, BEFORE THE AWARD OF THE CONTRACT, BE MADE? [1] ▽2

IF YES; Are the results of the visit, and evaluation ...

(7) Formally documented in a report,

(8) Informally noted,

(9) Other, ...

4. DOES YOUR FIRM REQUIRE AN INSPECTION AND EXAMINATION OF CONTRACTORS ORGANISATION AND BEHAVIOUR DURING PERFORMANCE OF WORK? YES [1] NO [2]

IF YES; The results of this examination are ...

(7) Formally documented in a report,

(8) Noted informally,

(9) Other, ...

.....

IF YES; Does your firm include these results ...

(7) In the document containing the initial report on the contracting organisation,

(8) Contract general correspondence file,

(9) Other, ...

.....

++++++++++

F. INSPECTION:

1. DOES YOUR FIRM PERFORM INSPECTIONS DURING THE CONSTRUCTION PHASE? [1] [2]

IF YES; Are the results of these inspections ...

(7) Formally documented,

(8) Informally noted,

(9) Other, ...

.....

IF NO; Who if anyone, performs inspections?
Please specify, ...

.....

IF YES; Does your firm maintain a qualification level for those people performing inspections? [1] [2]

IF YES; What forms the basis of your firm's levels of qualification? YES NO

(3) Requirements laid down in the firm's quality policy?

(4) Requirements laid down in codes of practice or standards, etc.,

(5) Informal requirements based on inspection performance, other experience and proven track record of the inspector,

(6) Other, ...

.....

++++++++++

G. TESTING:

1. DOES YOUR FIRM REQUIRE TESTS TO BE PERFORMED ON MATERIALS, PARTS, COMPONENTS, SYSTEMS? [1] [2]

IF YES; Are these tests performed in accordance with ...

(7) Written test procedures incorporating requirements and acceptance limits,

(8) The individual's requirements as he may see fit,

(9) Other, ...

.....

IF YES; ... and the results of the tests are not satisfactory or acceptable, how does your firm ensure acceptability of materials, parts, components and systems?

(3) A formal document instructing corrective action to be taken by the contractor,

(4) Simply by marking the unacceptable items and rejecting them from being used further,

(5) A verbal or telephonic instruction,

(6) Other, ...

.....

2. DOES YOUR FIRM REQUIRE THAT TESTING EQUIPMENT BE EXAMINED FOR ACCURACY, MAINTENANCE AND CALIBRATION, AND VALID RELATIONSHIP TO A NATIONALLY RECOGNISED STANDARD? YES NO [1] [2]

IF YES; Are the results of these inspections of test equipment ...

(7) Documented formally,

(8) Informally noted,

(9) Other, ...

.....

IF YES; The frequency of examination for each type of equipment is ...

(7) Listed in a schedule,

(8) Up to the individual,

(9) Other, ...

.....

++++++++++

H. HANDLING:

1. DOES YOUR FIRM DIRECT THAT THE REQUIREMENTS OF LIFTING, MOVING, CLEANING, COATING, ENVIRONMENTAL CONDITIONS AND OTHER APPLICABLE CODES, STANDARDS, REGULATIONS, SPECIFICATIONS AND DESIGN DOCUMENTS PERTAINING TO MATERIAL AND EQUIPMENT, BE OBSERVED BY THE CONTRACTORS? [1] [2]

IF YES; Are these requirements ...

(7) Documented in contractual documents, such as specifications, drawings, procedures, etc.,

(8) Left up to the individual,

(9) Other, ...

.....

IF YES; How does your firm ensure that these requirements are being carried out? YES NO

(3) Check to see that the contractor's/ Supplier's quality policy, which has been accepted and includes handling precautions, is being followed satisfactorily,

(4) Confirm that the contractor's/supplier's quality manual, which contains measures pertaining to handling, is being followed,

(5) On-site / off-site / supplier inspection,

(6) Other, ...

.....

++++++++++

I. DEVIATIONS FROM REQUIREMENTS:

1. DOES YOUR FIRM REQUIRE THAT MATERIALS, PARTS OR COMPONENTS WHICH DO NOT CONFORM TO REQUIREMENTS, ARE TO BE CONTROLLED IN ORDER TO PREVENT THEIR INADVERTENT USE? [1] [2]

IF YES; Are these non-conformances ...

(7) Documented formally, showing the item identification, description or non-conformance, proposed rectification, further inspection requirements and approval signature of authority,

(8) Not documented, but handled by some other 'in-house' method, or left up to the individual to sort out,

(9) Other, ...

.....

2. DOES YOUR FIRM REQUIRE THAT NON-CONFORMING ITEMS BE CLEARLY MARKED TO IDENTIFY THEM AS NON-CONFORMANT AND PHYSICALLY SEPARATED FROM OTHER ACCEPTABLE ITEMS? [1] [2]

IF YES; Your firm does this ... YES NO

(7) Through the implementation of a control procedure for non-conforming items,

(8) Left up to the individual to control,

(9) Other, ...

.....

++++++++++

3. DOES YOUR FIRM REQUIRE THAT THE CAUSE OF ALL CONDITIONS ADVERSE TO QUALITY SUCH AS FAILURES, MALFUNCTIONS, DEFICIENCIES, DEVIATIONS, DEFECTIVE MATERIAL AND EQUIPMENT AND NON-CONFORMANCES ARE PROPERLY IDENTIFIED AND CORRECTED, WITH THE CAUSE OF SUCH CONDITIONS BEING DETERMINED AS WELL AS THE CORRECTIVE ACTION TO BE TAKEN TO PREVENT REPETITIONS? [1] [2]

IF YES; Your firm does this by ...

(7) A special document listing all those requirements,

(8) Left up to the individual,

(9) Other, ...

.....

++++++++++

J. RECORDS:

1. DOES YOUR FIRM REQUIRE THAT DOCUMENTS RELATING TO INSPECTIONS, TESTS, MONITORING OF WORK PERFORMANCE, MATERIALS ANALYSES, QUALIFICATIONS OF PERSONNEL AND PROCEDURES AND EQUIPMENT AND ALL OTHER DOCUMENTS AFFECTING QUALITY, BE PREPARED AND MAINTAINED IN ACCORDANCE WITH SPECIFIC REQUIREMENTS? [1] [2]

IF YES; These requirements are ...	YES	NO
(7) Laid down in a procedure and used on all contracts,		
(8) Informally observed,		
(9) Other, ...		

.....

++++++++++

END

THANK YOU

APPENDIX 3

(Refer Chapter 4)

Questionnaire to Building Contractors

04.

Res 698215 Work (02224)2110

(QUESTIONNAIRE REF. No. BQ)

INSTRUCTIONS FOR THE COMPLETION OF THIS QUESTIONNAIRE:

Where space is provided for comments, please complete as concisely as possible in block capitals.

Where "yes" or "no" circles and numbered multiple answer zones are provided, please make a cross, in the applicable zone, eg: ⊗

Where the multiple answer zone is followed by the word 'other', please specify as concisely as possible.

Please complete all questions contained in this questionnaire to the best of your ability, reflecting as accurately as possible your current practice, aims or views.

GENERAL

NAME OF PARTICIPATING INDIVIDUAL .....

NAME OF ORGANISATION BY WHICH INDIVIDUAL (above) IS EMPLOYED: .....

.....

POSITION WITHIN THE ORGANISATION HELD BY THE PARTICIPATING INDIVIDUAL: .....

.....

BUSINESS ADDRESS OF THE ORGANISATION: .....

..... Code ..... Telephone No.: .....

1. For how many years has your company been a Building Contracting organisation? .....

2. If you are a director of your company, how many other directors besides yourself, are there in your company? .....

3. Do you have other non-directing members in your employ who perform the management functions of a building contractor? .....

4. If yes, specify how many you have; ..... and briefly, what type of function they perform: .....

.....

.....

5. List the contracts in the Building Industry that your organisation currently have: .....

.....

.....

.....

6. List the projects in the Building Industry on which your organisation has been involved over the past decade (1970 - 1980):
Please complete the following matrix, using where applicable, the following code;

Type of Involvement ⬡	Type of Building △	Type of Contract ○	Type of Client □
A Complete Contract, from turning the first sod to final account	I Office Block	A Conventional	I Insurance Co.
B Part of Contract ie; Superstructure only or foundations only, etc.	II Shopping Complex	B Turnkey	II Pension Fund
C Part of Consortium of Contractors	III Apartment Blocks	C Cost-Plus	III Prov. Admin.
D Specialist works only, ie; requiring a unique construction technique	IV Hospital	D Negotiated	IV P.W.D.
E Other	V School	E Other	V Government
			VI Other

M A T R I X

YEAR	NAME/TITLE OF CONTRACT/PROJECT	NAME OF CLIENT	Type of Involvement	Type of Building	Type of Contract	Type of Client
1970	EXAMPLE: BAMBOESVLEI HIGH SCHOOL	CAPE PROV.ADMIN.	A	V	A	III
1970						
1971						
1972						
1973						

M A T R I X

YEAR	NAME/TITLE OF CONYRACT/PROJECT	NAME OF CLIENT	⬡ Type of In-volvement	△ Type of Building	○ Type of Contract	□ Type of Client
1974						
1975						
1976						
1977						

M A T R I X

YEAR	NAME/TITLE OF CONTRACT/PROJECT	NAME OF CLIENT	Type of In-volvement	Type of Building	Type of Contract	Type of Client
1978						
1979						
1980						

7. Has your company made any notable achievements in the building field, such as receiving any awards, special mentions etc.? (Please specify and when) .....

.....

.....

.....

8. Does your organisation specialise in any particular type of building?

i.e. schools, hospitals, churches etc., (please specify) .....

.....

.....

.....

9. Does your organisation specialise in any particular type of building technique? eg: highly industrialised building methods, pre-casting, pre-fabricated units etc. (please specify) .....

.....

.....

.....

++++++++++

A. ORGANISATION:

1. DOES YOUR COMPANY HAVE AN INDEPENDENT INTRASTRUCTURE (department, section or group), TO DEAL WITH QUALITY PROBLEMS?

YES (1) NO (2)

IF YES; What is this department, section or group called?

(3) Quality Assurance

(4) Quality Control

(5) Inspection

(6) Other (please specify) .....

.....

++++++++++

B. PROGRAMME

	YES	NO
1. DOES YOUR COMPANY HAVE A WRITTEN QUALITY POLICY ENDORSED BY TOP MANAGEMENT?	(1)	(2)
2. DOES YOUR COMPANY HAVE A WRITTEN QUALITY ASSURANCE, QUALITY CONTROL OR INSPECTION MANUAL?	(1)	(2)

IF YES; What is it called?

(3) Quality Assurance Manual

(4) Quality Control Manual

(5) Inspection Manual

(6) Other (please specify) .....

.....

.....

	YES	NO
3. DOES YOUR COMPANY HAVE DETAILED WRITTEN INSTRUCTION PROCEDURES FOR IMPLEMENTING QUALITY ACTIVITIES?	(1)	(2)

IF YES; What are they called?

(3) Quality Assurance Procedures

(4) Quality Control Procedures

(5) Inspection Procedures

(6) Other, (please specify) .....

.....

.....

	YES	NO
4. ARE ANY OF THE ABOVE (in B.1,2&3) REVIEWED AND UPDATED ON A REGULARLY SCHEDULED BASIS?	(1)	(2)

IF YES; Which ones?

(3) Policy

(4) Manual

(5) Procedures

(6) Other, (please specify) .....

.....

++++++++++

C. CONTROL OF THE DESIGNS

YES NO

1. DOES YOUR COMPANY DO DESIGN WORK? (1) (2)

IF NO, Please go to question No. 4.

IF YES; Please continue with question No. 2

2. DOES YOUR COMPANY REQUIRE THE DESIGNER TO STATE THE ASSUMPTIONS AND REFERENCES USED AS THE BASIS FOR HIS DESIGN? (1) (2)

IF YES; Is the requirement ...

(3) A written requirement

(4) Not a written requirement, but "we've done it this way for years"

(5) Depends on the individual

(6) Other, ...

.....

IF YES; How are assumptions or references stated?

(7) On a standardised form or format

(8) Depends on the individual

(9) Other, ...

.....

3. DOES YOUR COMPANY REQUIRE CALCULATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? (1) (2)

IF YES; Is the review comment or modification .

(7) Documented on some standard format

(8) No documented, but transmitted verbally or telephonically

(9) Other, ...

.....

IF YES; How does your company ensure that modifications to design calculations are incorporated into the design? YES NO

(7) Using a design review comment register or control log

(8) Depends on the individual

(9) Other, ...

.....

4. DOES YOUR COMPANY DRAW UP SPECIFICATIONS OF ANY SORT? (1) (2)

IF NO, Please go to question No. 6.

IF YES, Please continue with question No. 5.

5. DOES YOUR COMPANY REQUIRE SPECIFICATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? (1) (2)

IF YES; Is this second or independent review ...

(7) Formally documented

(8) Discussed informally at a meeting

(9) Other, ...

.....

6. DOES YOUR COMPANY REQUIRE THAT CHANGES OR MODIFICATIONS TO SPECIFICATIONS ARE COMMUNICATED TO THE JOB-SITE? (1) (2)

IF YES; Your company does this by ...

(7) Using a formally documented and controlled information transmittal system

(8) Depends on the individual

(9) Other, ...

.....

7. DOES YOUR COMPANY INITIATE OR ORIGINATE WORKING DRAWINGS?

YES (1) NO (2)

IF NO; Go to question No. 9.

IF YES; Continue with question No. 8.

8. DOES YOUR COMPANY REQUIRE DRAWINGS TO BE SUBJECTED TO AN INDEPENDENT OR SECOND REVIEW?

(1) (2)

IF YES; Are the results of the second or independent review ...

(7) Documented using some standard format and procedure

(8) Not documented, but done informally, verbally or telephonically

(9) Other, ...

.....

IF YES; How does your company ensure that the results of the second or independent drawing review are incorporated into the "master drawing file" (working drawings) ...?

(7) Through the use of a drawing control procedure and log or register

(8) Informal alterations of drawings and their copies

(9) Other, ...

.....

9. DOES YOUR COMPANY REQUIRE THE CONTROL OF DESIGN CHANGES INITIATED AT OR THROUGH THE DESIGN OFFICE?

(1) (2)

IF YES; Are these design changes ...

(7) Formally documented and effected using a standard format and information transmittal system

(8) Effected informally via telephone or other consultation

(9) Other, ...

.....

IF YES; How does your organisation ensure that the design changes are implemented properly? YES NO

(7) A formal design change and inspection procedure

(8) Some other informal in-house procedure, being standard practice

(9) Other, ...

.....

10. DOES YOUR COMPANY REQUIRE THE CONTROL OF DESIGN CHANGES MADE IN THE FIELD? (1) (2)

IF YES; Are these design changes ...

(7) Formally documented and effectively implemented using a standard format and procedure

(8) Effected informally and in some other in-house standardised manner

(9) Other, ...

.....

IF YES; How does your company ensure that the design changes made in the field are implemented properly?

(7) By using a formal design change and inspection procedure

(8) An informal procedure depending upon the individual

(9) Other, ...

.....

++++++++++

D. DOCUMENT CONTROL

1. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM SPECIFICATIONS ARE ISSUED? (1) (2)

IF YES; Does this system of identification control comprise ... YES NO

(7) A formally documented control log containing spec. details, dates and personnel to whom issued?

(8) An informal circulation?

(9) Other, ...

.....

2. DOES YOUR COMPANY ENSURE THAT DETAILS OF CHANGES MADE TO THE SPECIFICATIONS ARE CONVEYED TO THE INDIVIDUALS WHO HAVE BEEN ISSUED WITH THE INITIAL OR SUPERSEDED SPECIFICATION? (1) (2)

IF YES; To effect this control, does your organisation use ...

(7) A formal control log containing dates, individuals names and spec. changes?

(8) Controlled, informally and depending upon the individual?

(9) Other, ...

.....

3. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM DRAWINGS ARE ISSUED? (1) (2)

IF YES; Does this system of identification control require ...

(7) A formally documented control log or index containing drawing numbers, dates and individuals names,

(8) An informal circulation,

(9) Other, ...

.....

4. DOES YOUR COMPANY ENSURE THAT CHANGES TO DRAWINGS ISSUED ARE CONVEYED TO THOSE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED DRAWING IS ISSUED? YES (1) NO (2)

IF YES; Does this system of control comprise ...

(7) A formally documented control log containing dates, revision numbers and individual names,

(8) An informal method, either telephonically, verbally or depending on the individual,

(9) Other, ...

.....

5. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM PURCHASE ORDERS ARE ISSUED? (1) (2)

IF YES; Does this identification control system comprise ...

(7) A formally documented control log or register,

(8) Depends on the individual,

(9) Other, ...

.....

6. DOES YOUR COMPANY ENSURE THAT DETAILS OF REVISIONS TO PURCHASE ORDERS ARE CONVEYED TO THE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED PURCHASE ORDERS WERE ISSUED? (1) (2)

++++++++++

E. PROCUREMENT CONTROL:

1. DOES YOUR COMPANY REQUIRE THAT RECORDS OF THE HISTORY OF THE SUB-CONTRACTOR'S AND SUBTIER SUPPLIER'S (VENDOR'S) CAPABILITY OR PERFORMANCE BE KEPT? (1) (2)

2. DOES YOUR COMPANY REQUIRE THE USE OF A "QUALIFIED SUB-CONTRACTORS" LIST FOR EACH CONTRACT? YES (1) NO (2)

IF YES; Is this list based on ...

(10) Membership to a quality institution, association or society (i.e. a quality consideration)

(11) Sub-Contractors reputations - Financially

(12) Sub-Contractors reputations - Performance,

(13) A combination of above, (specify which ones, e.g. 11 & 12) .....

(14) Other, ...

.....

IF YES; The evaluation for their quality considerations is based on ...

(7) A formal consideration every time,

(8) An informal consideration, depending on control,

(9) Other, ...

.....

IF YES; Which one of the following quality aspects would fit your definition of a "Qualified Sub-Contractor" best?

(3) A Sub-Contractor who has an acceptable Quality Assurance Programme,

(4) A Sub-contractor who has an acceptable Quality Control Manual,

(5) A Sub-contractor who performs acceptable inspections on his work,

3. DOES YOUR COMPANY REQUIRE THAT A VISIT TO AND EVALUATION OF SUB-CONTRACTORS FOR EACH CONTRACT, BEFORE THE AWARD OF THE CONTRACT, BE MADE? (1) (2)

IF YES; Are the results of the visit, and evaluation ...

(7) Formally documented in a report, YES NO

(8) Informally noted,

(9) Other, ...

.....

4. DOES YOUR COMPANY REQUIRE AN INSPECTION AND EXAMINATION OF SUB-CONTRACTOR'S ORGANISATION AND BEHAVIOUR DURING PERFORMANCE OF WORK? (1) (2)

IF YES; The results of this examination are ...

(7) Formally documented in a report,

(8) Noted informally,

(9) Other, ...

.....

IF YES; Does your company include these results ...

(7) In the document containing the initial report on the contracting organisation,

(8) Sub-Contract general correspondence file,

(9) Other, ...

.....

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F. INSPECTION:

1. DOES YOUR COMPANY PERFORM INSPECTIONS DURING THE CONSTRUCTION PHASE? (1) (2)

IF YES; Are the results of these inspections ...

(7) Formally documented,

(8) Informally noted,

(9) Other, ...

.....

IF NO; Who if anyone, performs inspections? YES NO
Please specify, ...

.....

IF YES; Does your company maintain a qualification level for those people performing inspections? (1) (2)

IF YES; What forms the basis of your company's levels of qualification?

(3) Requirements laid down in the company's quality policy?

(4) Requirements laid down in codes of practice or standards, etc.,

(5) Informal requirements based on inspection performance, other experience and proven track record of the inspector,

(6) Other, ...

.....

++++++++++

G. TESTING:

1. DOES YOUR COMPANY REQUIRE TESTS TO BE PERFORMED ON

MATERIALS, PARTS, COMPONENTS, SYSTEMS WITHIN THE

SCOPE OF THE CONTRACT? (1) (2)

IF YES; Do these tests cover materials, parts, components and systems being provided both by your organisation and sub-contracting organisations? (1) (2)

IF NO; Are these tests limited to your organisation's work only? (1) (2)

OR

Are these tests limited to sub-contractor's work only? (1) (2)

2. IF YOUR COMPANY DOES REQUIRE TESTS TO BE PERFORMED,

Are these tests performed in accordance with ....

(7) Written test procedures incorporating requirements and acceptance limits

(8) The individual's requirements as he may see fit

(9) Other, ... YES NO

.....

3. IF YOUR COMPANY DOES REQUIRE TESTS TO BE PERFORMED,

... and the test results are not satisfactory or acceptable, how does your company ensure acceptability of materials, parts, components and systems?

(3) A formal document instructing corrective action to be taken by your company's works department or the sub-contracting organisation, whichever is applicable

(4) Simply by marking the unacceptable items and rejecting them from being used further

(5) A verbal or telephonic instruction

(6) Other, ...

.....

4. DOES YOUR COMPANY REQUIRE THAT TESTING EQUIPMENT BE EXAMINED FOR ACCURACY, MAINTENANCE AND CALIBRATION, AND VALID RELATIONSHIP TO A NATIONALLY RECOGNISED STANDARD? (1) (2)

IF YES; Are the results of these inspections of test equipment ...

(7) Documented formally

(8) Informally noted

(9) Other, ...

.....

IF YES; The frequency of examination for each type of equipment is ...

(7) Listed in a schedule

(8) Up to the individual

(9) Other, ...

.....

++++++++++

i

H. HANDLING

YES NO

1. DOES YOUR COMPANY DIRECT THAT THE REQUIREMENTS OF LIFTING, MOVING, CLEANING, COATING, ENVIRONMENTAL CONDITIONS AND OTHER APPLICABLE CODES, STANDARDS, REGULATIONS, SPECIFICATIONS AND DESIGN DOCUMENTS PERTAINING TO MATERIAL AND EQUIPMENT, BE OBSERVED BY YOUR COMPANY'S WORKS DEPT. AND THE SUB-CONTRACTING ORGANISATIONS? (1) (2)

IF YES; Are these requirements ...

(7) Documented in contractual documents, such as specifications, drawings, procedures, etc.,

(8) Left up to the individual,

(9) Other, ...

.....

IF YES; How does your company ensure that these requirements are being carried out?

(3) Check to see that the Works Dept. or sub-contracting organisation or supplier's quality policy, which has been accepted and which includes handling precautions, is being satisfactorily followed.

(4) Confirm that the Works Dept. or sub-contractor's / supplier's quality manual which contains measures pertaining to handling, is being followed

(5) On-site / off-site works dept., sub-contractor or supplier inspection

(6) Other, ...

.....

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I. DEVIATIONS FROM REQUIREMENTS:

1. DOES YOUR COMPANY REQUIRE THAT MATERIALS, PARTS OR COMPONENTS WHICH DO NOT CONFORM TO REQUIREMENTS, BE CONTROLLED IN ORDER TO PREVENT THEIR INADVERTENT USE? (1) (2)

IF YES; Are these non-conformances ... YES NO

(7) Documented formally, showing the item identification, description or non-conformance, proposed rectification, further inspection requirements and approval signature of authority,

(8) Not documented, but handled by some other 'in-house' method, or left up to the individual to sort out,

(9) Other, ...

.....

2. DOES YOUR COMPANY REQUIRE THAT NON-CONFORMING ITEMS BE CLEARLY MARKED TO IDENTIFY THEM AS NON-CONFORMANT AND PHYSICALLY SEPARATED FROM OTHER ACCEPTABLE ITEMS? (1) (2)

IF YES; Your company does this ...

(7) Through the implementation of a control procedure for non-conforming items,

(8) Left up to the individual to control,

(9) Other, ...

.....

3. DOES YOUR COMPANY REQUIRE THAT THE CAUSE OF ALL CONDITIONS ADVERSE TO QUALITY SUCH AS FAILURES, MALFUNCTIONS, DEFICIENCIES, DEVIATIONS, DEFECTIVE MATERIAL AND EQUIPMENT AND NON-CONFORMANCES BE PROPERLY IDENTIFIED AND CORRECTED, WITH THE CAUSE OF SUCH CONDITIONS BEING DETERMINED AS WELL AS THE CORRECTIVE ACTION TO BE TAKEN TO PREVENT THEIR REPETITION? (1) (2)

IF YES; Your company does this by ...

(7) A special document listing all those requirements,

(8) Left up to the individual,

(9) Other, ...

.....

J. RECORDS

	YES	NO
1. DOES YOUR COMPANY REQUIRE THAT DOCUMENTS RELATING TO INSPECTIONS, TESTS, MONITORING OF WORK PERFORMANCE, MATERIALS ANALYSES, QUALIFICATIONS OF PERSONNEL AND PROCEDURES AND EQUIPMENT AND ALL OTHER DOCUMENTS AFFECTING QUALITY, BE PREPARED AND MAINTAINED IN ACCORDANCE WITH SPECIFIC REQUIREMENTS?	(1)	(2)
IF YES; Does this requirement extend to subcontractors and subtier suppliers too?	(1)	(2)

++++++++++

END

THANK YOU

APPENDIX 4

(Refer Chapter 5)

Selected Typical Trade Preambles to Bills of Quantities

Ex: Trade Preambles to the EXCAVATOR

Filling.

"The filling is to be of approved hard, dry materials, arising from the excavations or carted onto site as prescribed and is to be deposited in layers not exceeding 300mm thick, each layer well watered, consolidated by means of earth rammers, and levelled".

Ex: Trade Preambles to the CONCRETOR.

Cement.

"The cement is to be the best Portland cement from an approved manufacturer and is to comply with the requirements of the current S.A.B.S. Specification No.:471 for Portland Cement".

Rapid Hardening Cement.

"The rapid-hardening cement is to be the best rapid-hardening Portland Cement from an approved manufacturer and is to comply with the requirements of the current S.A.B.S. specificaiton No:471 for rapid-hardening Portland cement".

Sand.

"The sand shall not contain organic impurities in excess of the quality which will give a No:3 Standard depth of colour as specified in B.S.S. 882".

Stone.

"The increase in mass of a representative dry sample of stone shall not exceed 8% after immersion in water when tested as laid down in B.S.S. 882".

Reinforced Concrete.

"The following are the minimum crushing strengths required in megapascals: Concrete mix A; B; C: Crushing strength after 28 days X M.Pa; Y M.Pa; X M.Pa".

"Concrete 1:3:6 of 40mm stone shall be held to mean 'concrete comprised 1 part cement, three parts sand and 6 parts stone by volume, broken to pass a 40mm ring all ways".

"Vibrated concrete 1:3:6 of 40mm stone using Portland Cement in surface beds and steps".

"Vibrated concrete 1:2:4 of 40mm stone, using Portland Cement in footings and column bases".

Steel Rod Reinforcement.

"The mild steel rod reinforcement for the concrete is to comply with the requirements of the current British Standard Specification No:785 for mild steel".

"The high tensile steel rod reinforcement for concrete is to comply with the requirements of the current British Standard Specification No:1144 for high tensile steel".

Ex: Trade Preambles for the BRICKLAYER.

Bricks.

"The bricks are to be stock bricks from an approved brickworks and are to comply with the requirements of the current S.A.B.S. specification No:227 for 'general purpose' burnt clay building bricks".

Lime.

"The lime is to be dry hydrated lime from an approved manufacturer and is to comply with the requirements of the current S.A.B.S. Specification No:523 for building lime".

Brickwork in Superstructure.

"Breeze brickwork in 5 to 1 Portland Cement mortar with 10% lime added to bulk immediately before use in 75mm brick-on-edge walls and 110mm 'brick walls'".

"Burnt clay brickwork in 5 to 1 Portland Cement mortar with 10% lime added to bulk immediately before use in 110mm walls and 220mm walls and cavity walls formed of two 110mm thicknesses with a 50mm clear cavity between".

Reinforcement to Brickwork - Steel wire reinforcement.

"The wire for brickwork reinforcement is to be hard drawn steel wire with a yield point of 5 000 Bars and is to comply with the requirements of the current British Standard Specification No:785".

Waterproofing Compounds.

"Two coats of 'Synthaprufe' or other equal and approved waterproofing compound applied to surfaces of concrete behind brick lining walls".

"'Secomastic' or other equal and approved mastic pointing to joints between flanges of metal windows and brick reveals".

Sheet Asphalt Waterproofing Membranes.

"The waterproofing membranes for damp proof courses are to comply with the requirements of the current S.A.B.S. Specification No:248 for damp-proof courses".

"The waterproofing membranes for roof coverings are to comply with the requirements of the current S.A.B.S. Specification No:92 for asphaltic roofing".

APPENDIX 5

(Refer Chapter 5)

Desirable Properties of Concrete Ingredients

1) The ingredients are to be of adequate and proved and consistent quality, i.e. material properties of aggregates such as:

Grading and Dust Content (829)
Fineness Modulus (829)
Chloride Content (831)
Organic Impurities (832)
Presence of Sugar (833)
Soluble Deleterious Impurities (834)
10% FACT values (842)
Aggregate Crushing Values (841)
Water Demands (835)
Drying Shrinkage and Wetting Expansion (836)
Content of Material of Low Density (837)
Sand Equivalent (838)
Clay and Silt Content (BS 812)
Soundness (839)
Shell Content (840)
Durability (842)
Shape (845)
Abrasion Resistance (846)
Aggregate from Natural Resources (1083)

NOTE: The figure in brackets refer to the S.A.B.S. identification number of S.A.B.S. Standard Methods.

Water to be of suitable quality and as per Part II of S.A.B.S. 0100 clause 3.2.b.

Admixtures - depending on the type and properties required, different admixtures might be supplied, however, the following material properties should be considered:

Effects of over and under dosage; effects of compounds within the admixture on other ingredients or materials of concrete with respect to corrosion of reinforcement, and chloride contents and degree of air entrainment. (Reference should be made to Part II of S.A.B.S. 0100 clause 3.2.b.).

Cement - is to be normal Portland Cement complying with the requirements of S.A.B.S. Standard 471-1971 (or rapid hardening Portland Cement), or sulphate resisting Portland Cement, or Portland blastfurnace cement complying with the requirements of S.A.B.S. Standard 626, 1971 - whichever one provides the desired qualities.

Certain of the properties of cement may be tested to verify conformance to the specification, such as:

Aluminium Oxide Content (738)
Calcium Oxide Content (739)
Cement Mortar: Air content (755)
Coarse Particle Content (746)
Consistency of cement Paste (Standard) (751)
Density (747)
Ferric Oxide Content (738)
Insoluble Residue Content (744)
Lime Saturation Factor (745)
Magnesium Oxide Content (740)
Setting Time (752)
Silicone Dioxide Content (735 & 736)
Soundness (753)
Specific Surface (748)
Sulphode Sulphur Content (742)
Sulphur Trioxide Content (741)
Sodium and Potassium Content (551)

2. Adequate workability and consistency, refer to S.A.B.S. 0100 Part II - Materials and Excecution of Work.

3. Strength and Durability.

APPENDIX 6

(Refer Chapter 5)

Summarised List of Carter's QA Programme Standard

Sect. 1 Definition of Terms:

There should be an opening section providing definitions of all terms used in the programme.

Sect. 2 Scope:

2.1 Applicability

When this standard is prescribed or specified by contract or agreement, it provides a specification of the general requirements to be met by the quality programme of a contractor or other organisation. All the requirements apply to a given contract except to the extent that they are specifically deleted, supplemented or amended in the contract.

2.2 General Purpose

This standard requires the establishment and maintenance of a quality programme by the contractor and his subcontractors to assure compliance with the requirements of the contract. The quality programme including its procedures and operations, shall be documented by the contractor and shall be subject to review by the buyer's representative.

The programme shall apply to the control of quality throughout all areas of contract performance including, as appropriate, the procurement, identification, stocking and issue of material; the entire process of manufacture; and the packaging, storing and shipping of material.

The programme shall provide that as early as possible, discrepancies (defects and programme deficiencies) shall be discovered and corrective action taken.

Sect. 3 Requirements

3.1 Quality Management

3.1.1 General. There shall be adequate planning, forceful direction and control in the sense of measurement and evaluation of the effectiveness of the quality programme.

3.1.2 Organisation. Administration of the quality programme shall be vested in a responsible, authoritative element of the organisation, with a clear access to management. The organisation shall be staffed by technically competent personnel with freedom to make decisions without hint of pressure of bias. It shall also have sufficient authority to ensure that quality requirements are consistently maintained.

3.1.3 Procedures. Written quality control, test and inspection procedures shall be used for pertinent operations. These procedures shall be kept current and shall be available at all locations where they will be used.

3.2 Design Information

3.2.1 General. Design information for a product (such as drawings, specifications and standards) shall be maintained to ensure that items are fabricated, inspected and tested to the latest applicable requirements. In like manner, task definitions for a service shall be maintained to ensure that the servies are performed and inspected to the latest applicable requirements.

3.2.2 Change Control. All changes to design information or task definition shall be processed in a manner that will ensure accomplishment as specified, and a record of actual incorporation points (by date, batch, lot, unit or other specific identification) shall be maintained.

3.3 Procurement

3.3.1 General. Adequate control over procurement sources shall be maintained to ensure that services and supplies conform to specified requirements, including this specification. Purchase orders (or contracts)

shall be controlled to ensure incorporation of pertinent technical and quality requirements, including authorised changes. Adequate records of inspections and tests performed on purchased material shall be maintained.

3.3.2 Source Inspection. The buyer and his authorised representatives reserve the right to inspect, at the source, any supplies furnished or services rendered under this contract. Inspection at the source shall not necessarily constitute acceptance, nor shall it relieve the seller of his responsibility to furnish acceptable products. When it is not practical or feasible to determine quality conformance of purchased items, inspection at the source is authorised.

3.3.3 Fabricated Material. All purchased material shall be evaluated to ensure conformance with the requirements of applicable standards and specifications. When required, shipment of materials shall be accompanied by certified test reports that demonstrate the conformance of raw materials, plating etc., to the requirements stated in the purchase order or product specification. When submission of certified test reports is not specifically required, every shipment shall be accompanied by a certificate stating the conformance to all requirements has been ascertained, that quantitative data reports are on file and that copies of test results will be furnished on request. The validity of certifications shall be verified periodically. Provisions will be made for withholding from use all incoming supplies pending completion of each required inspection and test or receipt of necessary test reports. The seller shall be notified whenever nonconforming materials are received, and corrective action shall be initiated when warranted.

3.3.4 Raw Materials. Raw materials shall normally be tested to determine conformance to applicable specifications. Unless otherwise required by the purchase order or the

product specification, certified test reports identifiable with the material may be accepted in lieu of such tests. When certifications are used as a basis for acceptance, the test results shall be compared with specification requirements. Furthermore, the validity of certifications shall be periodically verified by independent testing.

3.4 Material Control

Adequate methods and facilities shall be established for controlling the identification, handling and storage of raw and fabricated materials. The identification shall include indications of the inspection status of the material. These controls shall be maintained from the time of receipt of the material until delivery to the customer. In order to protect the material from damage, deterioration, loss or substitution.

3.5 Manufacture

3.5.1 General. Sufficient control shall be maintained over manufacturing processes to prevent excessive product defectiveness and variability, and to assure conformance of the characteristics of product, which can be verified only at the time and point of manufacture.

3.5.2 Process Control. Evaluations and controls shall be established and maintained at appropriately located points in the manufacturing process to assure continuous control of quality parts, components and assemblies.

3.5.3 Special Processes. Adequate methods and facilities shall be provided to assure conformance with requirements for special process specifications, such as welding, plating, anodising, non-destructive testing, heat treating, soldering and testing of materials. Certifications, such as those for personnel, procedures, and equipment, shall be maintained as required.

3.6 Acceptance

3.6.1 General. Inspection and testing of completed material shall be performed as necessary to assure that contract requirements have been met. Sufficient surveillance shall be maintained over preservation, marking, packing and shipping operations to assure compliance with requirements and to prevent damage, deterioration, loss or substitutions.

3.6.2 Sampling Inspection. Any acceptance sampling procedures that differ from those that are required by the contract, shall afford adequate assurance that the quality meets acceptable levels, and shall be approved by the buyer.

3.6.3 Non-conforming Material. Procedures and facilities for the handling of non-conforming material shall require prominent identification of the material and prompt removal from the work area. Unless otherwise provided in the product specification, the seller may, at his option, scrap the material or request disposition instructions from the buyer.

3.7 Measuring Instruments.

Validity of measurements and tests shall be assured through the use of suitable inspection measuring and test equipment of the range, validity, and type necessary to determine conformance of articles to contract requirements. At intervals established to ensure continued validity, measuring devices shall be verified or calibrated against certified standards that have a known valid relationship to national standards. Tooling used as a media of inspection shall be included in this programme. Furthermore, every device so verified shall bear an indication attesting to the current status and showing the date (or other basis) on which inspection or recalibration is next required.

3.8 Quality Information

3.8.1 General. Information from control areas described in paragraphs 3.1 through 3.7 of this specification shall be systematically utilised for the prevention, detection, and correction of deficiencies in the programme that affect quality.

3.8.2 Quality Control Records. For all inspections and tests, records that include data on both conforming and non-conforming products shall be maintained. A continuous review of these records shall be made, and summary information shall be reported periodically to responsible management.

3.8.3 Corrective Action. Prompt action shall be taken to correct conditions that cause defective materials. Use shall be made of feedback data generated by the customer as well as data generated internally.

Sect. 4 Quality Programme Audits.

Quality programmes will be audited by the buyer for conformance to the intent of this specification. Disapproval of the programme or major portions thereof may be cause for withholding acceptance of products.

PART II: QUALITY SYSTEM FOR MANUFACTURE AND INSTALLATION

1. SCOPE

1.1 This part of the code establishes quality management system requirements for manufacture and installation for application, as appropriate, to products or services to ensure compliance with specified technical requirements.

2. REQUIREMENTS

2.1 QUALITY SYSTEM. The supplier should provide a co-ordinated and formally documented statement of his quality system, including quality management objectives, policies, organization, and procedures, for the implementation of all activities carried out in compliance with the terms of this code. This system should demonstrate his ability to achieve the specified requirements.

2.2 ORGANIZATION

2.2.1 Personnel Performing Quality Functions. The supplier should appoint a management representative who, notwithstanding any other responsibilities he may carry, should have the necessary authority and the responsibility for ensuring that the requirements of this code are implemented and maintained.

2.2.2 Purchaser's or Evaluator's Representative. Dependent upon the application of the code, the purchaser or evaluating organization may appoint a representative, hereinafter referred to as the purchaser's representative, to ensure on his behalf that the system established in compliance with this code is satisfactory. The supplier should provide reasonable access for this purpose.

2.3 REVIEW OF THE QUALITY SYSTEM. The quality system established in accordance with the requirements of this code should be periodically and systematically reviewed by the supplier to ensure its continued effectiveness. Records of the review should be maintained and be available to the purchaser's representative.

2.4 PLANNING. The supplier should establish a procedure for conducting a sufficiently extensive and timely review of purchaser requirements to ensure

a) the adequate and documented control of manufacturing and installation activities;

b) the timely identification and acquisition of any control, processes, inspection equipment, fixtures, tooling, manpower resources and skills that may be needed to achieve the required quality;

c) the updating of quality control, inspection and testing techniques including the development of new instrumentation;

d) the identification of any measurement involving measurement capability that exceeds the known state of the art, or any new measurement capability needed to inspect the product, in adequate time for such capability to be developed;

e) the clarification of standards of acceptability for all features and requirements, including those which contain a subjective element;

f) the compatability of the design, the manufacturing process, installation, inspection procedures, and the applicable documentation before production begins;

g) the preparation of documented quality plans when required by a contract.

2.5 WORK INSTRUCTIONS. The supplier should develop and maintain clear and complete documented instructions that prescribe the communication of contract requirements and the performance of work in manufacture and installation that would be adversely affected by lack of such instructions.

2.6 RECORDS. The supplier should develop and maintain records that demonstrate achievement of the required quality and the effective operation of the quality system. These records should be safely retained and made available for evaluation by the purchaser's representative, for an agreed period. Pertinent subcontractor records are an element of these data. Records should include, as appropriate, explicit identification of the material, part, subassembly, assembly, equipment, subsystem or sytem, the nature and number of observations made, number and type of deficiencies found, the quantities approved or rejected, and the nature of rectification and corrective action taken.

2.7 CORRECTIVE ACTION. The supplier should establish and maintain documented procedures to provide for

a) a continuing analysis of concessions granted and materiel scrapped, reworked, modified, or otherwise repaired, to determine the cause and corrective action needed;

b) a continuing monitoring of processes and work operations, and analysis of records to detect and eliminate potential causes of non-conforming materiel;

c) an assurance that corrective actions are effective.

With regard to defects and failures detected by the end user, the supplier should establish and maintain documented procedures for analysing such defects and failures in order to determine the cause and institute corrective action.

2.8 DOCUMENTATION AND CHANGE CONTROL. The supplier should establish and maintain a system to control all documentation that relates to the requirements of this code. To this end the system should ensure that

a) the pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed;

b) all changes to documentation are in writing and processed in a manner which will ensure prompt action at the specified and effective point;

c) records are maintained of changes as they are made;

d) documents are re-issued after a practicable number of changes have been issued;

e) provision is made for the prompt removal of obsolete documents from all points of issue or use.

2.9 CONTROL OF INSPECTION, MEASURING, AND TESTING EQUIPMENT. The supplier should be responsible for providing, controlling, calibrating, and maintaining inspection, measuring, and testing equipment suitable to demonstrate compliance of supplies with specified requirements. Equipment should be used in a manner which ensures that measurement uncertainty is consistent with the required measurement capability.

Calibration accuracy of this equipment should be commensurate with the required accuracy of measurement and should be traceable to national standards.

Where jigs, fixtures, templates, patterns, or other such devices are used as inspection media, they should be proven capable of verifying the acceptability of materiel prior to release for use during manufacture, and should be reproven at established periods. The supplier should establish the extent and frequency of such proving and maintain records as evidence of control. Design data pertaining to tools and gauges should be made available, when required by the purchaser's representative, for verification that the devices are functionally adequate.

2.10 CONTROL OF PURCHASED MATERIEL AND SERVICES

2.10.1 Purchasing. The supplier should be responsible for ensuring that all purchased materiel and services comply with specified requirements. The selection of sources and the type and extent of control exercised by the supplier should be dependent upon the type of materiel and his supplier's demonstrated capability.

The supplier should ensure that controls are effective by including, if need be, monitoring at his supplier's plant.

2.10.2 Purchasing Data. Each purchasing document should contain a clear description of materiel and services ordered including, as applicable,

a) the type, class, style, grade, or other precise identification;

b) the title, or other positive identification and applicable issue, of specifications, drawings, process requirements, inspection instructions, and other relevant technical data.

2.10.3 Receiving Inspection. The supplier should ensure that no incoming materiel is used or processed unless and until inspected or otherwise verified as complying with specified requirements. Materiel may be released for urgent production purposes, providing it is identified in a positive manner that will permit immediate recall and replacement in the event of non-conformance prior to despatch.

In determining the amount and nature of receiving inspection, consideration should be given to the control exercised at source, and documented evidence of quality compliance provided. Corrective action should be initiated in co-operation with suppliers upon receipt of non-conforming supplies.

Any verification of purchased materiel by the purchaser's representative should not form part of the supplier's quality system unless otherwise specifically agreed.

2.11 MANUFACTURING CONTROL

2.11.1 General. The supplier should ensure that manufacturing operations are carried out under controlled conditions. Controlled conditions should include documented work instructions defining the manner of manufacturing or processing, suitable manufacturing equipment, and any special working environment.

Criteria for workmanship should be prescribed to the greatest practical extent by written standards, photographs, or representative samples.

The supplier should provide for testing and inspection, as required, after each work operation that affects quality. Alternatively, control by monitoring process methods, equipment, and personnel may be provided. When essential, both inspection and monitoring should be provided. Inspection methods or controls should be corrected whenever their unsuitability is demonstrated.

2.11.2 Control of Special Processes. The supplier should establish and maintain control of all special processes which form part of production, inspection, or required safety precautions. Equipment, essential processing environment, and any necessary personnel qualifications should be prescribed.

2.12 PURCHASER-SUPPLIED MATERIEL. The supplier should establish and maintain procedures for the inspection, storage, and maintenance of purchaser-supplied materiel provided for incorporation into the supplies. Any such materiel lost, damaged, or otherwise unsuitable for use should be recorded and reported to the purchaser.

2.13 COMPLETED ITEM INSPECTION AND TESTING. The supplier should perform all inspection and testing on the finished product or service necessary to complete the evidence of full compliance with specified requirements. Procedures for final inspection and testing should ensure that inspections and tests that should have been conducted at earlier stages have, in fact, been performed and that the data are acceptable.

2.14 SAMPLING PROCEDURES. Sampling procedures used by the supplier should be as stated in the contract or should be subject to approval by the purchaser's representative.

2.15 CONTROL OF NON-CONFORMING MATERIEL. The supplier should establish and maintain procedures for controlling materiel which does not comply with specified technical requirements. These procedures should include provision for identification, segregation, and disposition, as appropriate. All non-conforming materiel should be clearly identified to prevent unauthorized use, shipment, or mixing with conforming materiel. Holding areas should be provided and procedures mutually agreed between the supplier and the purchaser's representative. Repair, rework, or concessions on non-conforming materiel and re-inspection should be in accordance with documented procedures and, when applicable, acceptable to the purchaser's representative. Adequate records, clearly identifying the materiel, the nature and extent of non-conformance, and the disposition, should be maintained.

2.16 INDICATION OF INSPECTION STATUS. The supplier should establish and maintain a system for identifying the inspection status of materiel during all stages of manufacture. The supplier should ensure the ability to distinguish between inspected and uninspected materiel by using some suitable form of identification.

2.17 PROTECTION AND PRESERVATION OF PRODUCT QUALITY

2.17.1 General. The supplier should establish and maintain a system of controlling his packing, preservation, and marking processes (including materials used) to the extent necessary to ensure compliance with specified requirements and to identify, preserve, and segregate all materiel from the time of receipt until the supplier's responsibility ceases.

2.17.2 Materiel Handling. The system should include methods of handling that prevent abuse, misuse, damage, or deterioration.

2.17.3 Storage. The supplier should provide secure storage areas or stock rooms for the isolation and protection of materiel, pending use or shipment. Appropriate systems for authorizing receipt and despatch to and from such areas should be prescribed. To detect deterioration, the condition of the stock should be periodically assessed.

2.17.4 Delivery. The supplier should arrange for the protection of the quality of his product after final inspection including, where appropriate, specified packing and preservation during transit. The supplier should ensure, to the extent practicable, the safe arrival and ready identification of the product at its destination.

2.18 TRAINING. The supplier should ensure that all personnel performing inspections and tests have appropriate experience or training.

APPENDIX 8

(Refer Chapter 4)

REVISED QUESTIONNAIRE TO BUILDING CONTRACTING ORGANISATIONS

SECTION I

A. ORGANISATION: YES NO

1. DOES YOUR COMPANY HAVE AN INDEPENDENT INTRASTRUCTURE (department, section or group), TO DEAL WITH QUALITY PROBLEMS? 1 2

IF YES; What is this department, section or group called?

3 Quality Assurance
4 Quality Control
5 Inspection
6 Other (please specify) .....
.....

B. PROGRAMME:

1. DOES YOUR COMPANY HAVE A WRITTEN QUALITY POLICY ENDORSED BY TOP MANAGEMENT? 1 2

2. DOES YOUR COMPANY HAVE A WRITTEN QUALITY ASSURANCE, QUALITY CONTROL OR INSPECTION MANUAL? 1 2

IF YES; What is it called?

3 Quality Assurance Manual
4 Quality Control Manual
5 Inspection Manual
6 Other (please specify) .....
.....

3. DOES YOUR COMPANY HAVE DETAILED WRITTEN INSTRUCTION PROCEDURES FOR IMPLEMENTING QUALITY ACTIVITIES? 1 2

IF YES; What are they called?

3 Quality Assurance Procedures
4 Quality Control Procedures
5 Inspection Procedures
6 Other (specify) .....
.....

4. ARE ANY OF THE ABOVE (in B.1, 2 & 3) REVIEWED AND UPDATED ON A REGULARLY SCHEDULED BASIS? 1 2

IF YES; Which ones?

3 Policy
4 Manual
5 Procedures
6 Other (specify) .....
.....

C. CONTROL OF THE DESIGNS:

1. DOES YOUR COMPANY DO DESIGN WORK? 1 2

IF NO, Please go to question No. 5

IF YES, Please continue with question No. 2.

2. Please specify type of design work'

10 Structural
11 Architectural
12 Mechanical
13 Electrical
14 Heating, Ventilating or Air Conditioning

15 Plumbing

16 Landscaping

17 Finishes or Interior / Exterior Decor

Note: In question 2 above, the questionee may make a cross over more than one zone, if more than one are applicable.

3. DOES YOUR COMPANY REQUIRE THE DESIGNER TO STATE THE ASSUMPTIONS AND REFERENCES USED AS THE BASIS FOR HIS DESIGN? 1 2

IF YES; Is the requirement ...

3 A written requirement

4 Not a written requirement, but "we've done it this way for years"

5 Depends on the individual

6 Other .....
.....

IF YES; How are the assumptions or references stated?

7 On a standardised form or format

8 Depends on the individual

9 Other .....
.....

4. DOES YOUR COMPANY REQUIRE CALCULATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? 1 2

IF YES; Is the review comment or modification ...

7 Documented on some standard format

8 Not documented, but transmitted verbally or telephonically

9 Other .....
.....

IF YES; How does your company ensure that modifications to design calculations are incorporated into the design?

7 Using a design review comment register or control log
8 Depend on the individual
9 Other .....
.....

5. DOES YOUR COMPANY DRAW UP SPECIFICATIONS OF ANY SORT? 1 2

IF NO, Please go to question No. 8.

IF YES, Please continue with question No. 6.

6. DOES YOUR COMPANY REQUIRE SPECIFICATIONS TO BE SUBJECTED TO A SECOND OR INDEPENDENT REVIEW? 1 2

IF YES, Is this second or independent review ..

7 Formally documented
8 Discussed informally at a meeting
9 Other .....
.....

7. DOES YOUR COMPANY REQUIRE THAT CHANGES OR MODIFICATIONS TO SPECIFICATIONS ARE COMMUNICATED TO THE JOB-SITE? 1 2

IF YES; Your company does this by ...

7 Using a formally documented and controlled information transmittal system
8 Depends on the individual
9 Other .....
.....

8 DOES YOUR COMPANY INITIATE OR ORIGINATE WORKING DRAWINGS? 1 2

IF NO, Please go to question No. 10.

IF YES, Please continue with question No. 9.

9 DOES YOUR COMPANY REQUIRE DRAWINGS TO BE SUBJECTED TO AN INDEPENDENT OR SECOND REVIEW? 1 2

IF YES; Are the results of the second or independent review ...

7 Documented using some standard format or procedure
8 Not documented, but done informally, verbally or telephonically
9 Other .....
.....

IF YES; How does your company ensure that the results of the second or independent drawing review are incorporated into the 'master drawing file' (working drawings) ...?

7 Through the use of a drawing control procedure and log or register
8 Informal alterations of drawings and their copies
9 Other .....
.....

10. DOES YOUR COMPANY REQUIRE THE CONTROL OF DESIGN CHANGES INITIATED AT OR THROUGH THE DESIGN OFFICE? 1 2

IF YES; Are these design changes ...

7 Formally documented and effected using a standard format and infomation transmittal system
8 Effected informally via telephone or other consultation
9 Other .....
.....

IF YES; How does your organisation ensure that the design changes are implemented properly?

7 A formal design change and inspection procedure?
8 Some other informal in-house procedure, being standard practice
9 Other .....
.....

11 DOES YOUR COMPANY REQUIRE THE CONTROL OF DESIGN CHANGES MADE IN THE FIELD? 1 2

IF YES; Are these design changes ...

7 Formally documented and effectively implemented using a standard format and procedure
8 Effected informally and in an in-house standardised manner
9 Other .....
.....

IF YES; How does your company ensure that the Design changes made in the field are implemented properly?

7 By Using a formal design change and inspection procedure
8 An informal procedure depending upon the individual
9 Other .....
.....

D. DOCUMENT CONTROL: YES NO

1. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM SPECIFICATIONS ARE ISSUED? 1 2

IF YES; Does this system of identification control comprise ...

7 A formally documented control log containing specification details, dates and personnel to who issued?

8 An informal circulation

9 Other .....
.....

2. DOES YOUR COMPANY ENSURE THAT DETAILS OF CHANGES MADE TO SPECIFICATIONS ARE CONVEYED TO THE INDIVIDUALS WHO HAVE BEEN ISSUED WITH THE INITIAL OR SUPERSEDED SPECIFICATION? 1 2

IF YES; To effect this control, does your organisation use ...

7 A formal control log contained dates, individuals name and specification change?

8 Controlled informally and depending upon the individual?

9 Other .....
.....

3. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM DRAWINGS ARE ISSUED? 1 2

IF YES; Does this system of identification control require ...

7 A formally documented control log or index containing drawing numbers, dates and individuals' names

8 An informal circulation

9 Other .....
.....

4. DOES YOUR COMPANY ENSURE THAT CHANGES TO DRAWINGS ISSUED ARE CONVEYED TO THOSE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED DRAWING IS ISSUED? 1 2

IF YES; Does this system of control comprise ...

7 Formally documented control log contained dates, revision numbers, and individuals' names
8 An informal method, either telephonically, verbally, or depending on the individual
9 Other .....
.....

5. DOES YOUR COMPANY REQUIRE THE IDENTIFICATION OF THOSE TO WHOM PURCHASE ORDERS ARE ISSUED? 1 2

IF YES; Does this identification control system comprise ...

7 A formally documented control log or register
8 Depends on the individual
9 Other .....
.....

6. DOES YOUR COMPANY ENSURE THAT DETAILS OF REVISIONS TO PURCHASE ORDERS AR CONVEYED TO THE INDIVIDUALS TO WHOM THE INITIAL OR SUPERSEDED PURCHASE ORDERS WERE ISSUED? 1 2

E. PROCUREMENT CONTROL:

1. DOES YOUR COMPANY REQUIRE THAT RECORDS OF THE HISTORY OF THE SUB-CONTRACTORS AND SUB-TIER SUPPLIERS (VENDORS) CAPABILITY OR PERFORMANCE BE KEPT? 1 2

2. DOES YOUR COMPANY REQUIRE THE USE OF A "QUALIFIED SUB-CONTRACTOS" LIST FOR EACH CONTRACT? 1 2

IF YES; Is this list based on ...

10 Membership to a quality institution, association or society (i.e. a quality consideration)

11 Membership to an institute, association or society recognised in the Building Industry

12 Sub-Contractors reputations - financially

13 Sub-Contractors reputation - performance-wise

14 A combination of above (specify which ones, i.e. 11 & 12) .....
.....

15 Other .....
.....

IF YES; The evaluation for their quality considerations is based on ...

7 A formal consideration every time

8 An informal consideration, depending on control

9 Other .....
.....

IF YES; Which one of the following quality aspects would fit your definition of a qualified sub-contractor best?

3 A sub-contractor who has an acceptable Quality Assurance Programme

4 A sub-contractor who has an acceptable Quality Control Manual

5 A sub-contractor who performs acceptable inspections on his work?

3. DOES YOUR COMPANY REQUIRE THAT A VISIT TO AND EVALUATION OF SUB-CONTRACTORS FOR EACH CONTRACT BEFORE THE AWARD OF THE CONTRACT, BE MADE? 1 2

IF YES; Are the results of the visit and evalation ...

7 Formally documented in a report

8 Informally noted

9 Other .....

.....

4. DOES YOUR COMPANY REQUIRE AN INSPECTION AND EXAMINATION OF SUB-CONTRACTORS ORGANISATION AND BEHAVIOUR DURING PERFORMANCE OF WORK? 1 2

IF YES; The results of this examination are ...

7 Formally documented in a report

8 Informally noted

9 Other .....

.....

IF YES; Does your company include these results ...

7 In the document containing the initial report on the contracting organisation

8 Sub-contract general correspondense file

9 Other .....

.....

F. INSPECTION: YES NO

1. DOES YOUR COMPANY PERFORM INSPECTIONS DURING THE CONSTRUCTION PHASE? 1 2

IF YES; Are the results of these inspections ...

7 Formally documented

8 Informally noted

9 Other .....

.....

IF NO; Who, if anyone, performs inspections during

the construction phase? Please specify:

.....

IF YES; Does your company maintain a qualification level for those people performing inspections? 1 2

IF YES; What forms the basis of your company's levels of qualification?

3 Requirements laid down in the company's quality policy

4 Requirements laid down in codes of practice or standards etc.

5 Informal requirements based on inspection performance, other experience and proven track record of the inspector

6 Other .....
.....

G. TESTING:

1. DOES YOUR COMPANY REQUIRE TESTS TO BE PERFORMED ON MATERIALS, PARTS, COMPONENTS, SYSTEMS WITHIN THE SCOPE OF THE CONTRACT? 1 2

IF YES; Do these tests cover materials, parts, components and systems being provided by both your organisation and sub-contracting organisations? 1 2

IF NO; Are these tests limited to your organisations work only? 1 2

OR

Are these tests limited to sub-contractors work only? 1 2

2. IF YOUR COMPANY DOES REQUIRE TESTS TO BE PERFORMED,

Are these tests performed in accordance with ...

7 Written test procedures incorporating requirements and acceptance limits
8 The individual's requirement as he may see fit
9 Other .....
.....

3. IF YOUR COMPANY DOES REQUIRE TESTS TO BE PERFORMED, ...and the test results are not satisfactory or acceptble, how does your company ensure acceptability of materials, parts, components and systems?

3 A formal document instructing corrective action to be taken by your company's works department or the sub-contracting organisation, whichever is applicable
4 Simply by marking the unacceptable items and rejecting them from further use
5 A verbal or telephonic instruction
6 Other .....
.....

4. DOES YOUR COMPANY REQUIRE THAT TESTING EQUIPMENT BE EXAMINED FOR ACCURACY, MAINTENANCE AND CALIBRATION AND VALID RELATIONSHIP TO A NATIONALLY RECOGNISED STANDARD? 1 2

IF YES; Are the results of these inspections of test equipment ...

7 Documented formally
8 Informally noted
9 Other .....
.....

IF YES; The frequency of examination for each type of

equipment is ...

7 Listed in a schedule
8 Up to the individual
9 Other .....
.....

H. HANDLING:

1. DOES YOUR COMPANY DIRECT THAT THE REQUIREMENTS OF LIFTING, MOVING, CLEANING, COATING, ENVIRONMENTAL CONDITIONS, REGULATIONS, SPECIFICATIONS AND DESIGN DOCUMENTS PERTAINIG TO MATERIAL AND EQUIPMENT, BE OBSERVED BY YOUR COMPANY'S WORKS DEPARTMENT AND THE SUB-CONTRACTING ORGANISATIONS? 1 2

IF YES; Are these requirements ...

7 Documented in contractural documents such as specifications, drawigns, procedures etc.
8 Left up to the individual
9 Other .....
.....

IF YES; How does your company ensure that these requirements are being carried out?

3 Check to see that the works department or sub-contractign organisation or suppliers quality policy, which has been accepted and which includes handling precautions, is being satisfactorily followed?
4 Confirm that the works department or sub-contracting organisation or supplirs quality manual, which contains measures pertaining to handling, is being followed
5 On-site / off site works department, sub-contractor or supplier inspection

6 Other .....
.....

I DEVIATION FROM REQUIREMENTS:

1. DOES YOUR COMPANY REQUIRE THAT MATERIALS, PARTS OR COMPONENTS THAT DO NOT CONFORM TO REQUIREMENTS BE CONTROLLED IN ORDER TO PREVENT THEIR INADVERTENT USE? 1 2

IF YES; Are these non-conformances ...

7 Documented formally, showing the item identification, description of non-conformance, proposed rectification, further inspection requirements and approval signature of authority
8 Not documented, but handled by some other 'in-house' method
9 Other .....
.....

2. DOES YOUR COMPANY REQURIE THAT NON-CONFORMING ITEMS BE CLEARLY MARKED TO IDENTIFY THEM AS NON-CONFORMANT AND PHYSICALLY SEPARATED FROM OTHER ACCEPTABLE ITEMS? 1 2

IF YES; Your company does this by

7 The implementation of a control procedure for non-conforming items
8 Left up to the individual to control
9 Other .....
.....

3. DOES YOUR COMPANY REQUIRE THAT THE CAUSE OF ALL CONDITIONS ADVERSE TO QUALITY SUCH AS FAILURES, MALFUNCTIONS, DEFICIENCIES, DEVIATIONS, DEFECTIVE MATERIAL AND EQUIPMENT AND NON-CONFORMANCES BE PROPERLY IDENTIFIED AND CORRECTED, WITH THE CAUSE OF SUCH CONDITIONS BEING

DETERMINED AS WELL AS THE CORRECTIVE ACTION TO BE TAKEN TO PREVENT THEIR REPETITION? 1 2

IF YES; Your company does this by ...

7 A special document listing all those requirements
8 Left up to the individual
9 Other .....
.....

J. RECORDS:

1. DOES YOUR COMPANY REQUIRE THAT DOCUMENTS RELATING TO INSPECTIONS, TESTS, MONITORING OF WORK PERFORMANCE, MATERIALS ANALYSES, QUALIFICATIONS OF PERSONNEL AND PROCEDURES AND EQUIPMENT AND ALL OTHER DOCUMENTS AFFECTING QUALITY, BE PREPARED AND MAINTAINED IN ACCORDANCE WITH SPECIFIC REQUIREMENTS? 1 2

IF YES; These requirements are ...

7 Laid down in a procedure and used in all contracts
8 Informally observed
9 Other .....
.....

IF YES; Does this requirement extend to sub-contractors and sub-tier suppleirs too? 1 2

SECTION II

NOTE: The questionee is advised that the completion of this section is optional. You are nevertheles urged to complete this section to provide a more meaningful contribution with section I.

GENERAL

1. List the position within the organisation held by the participatig individual .....

2. For how many years has your company been a building contracting organisation? .....

3. If you are a director of your company, how many other directors besides yourself, are there in your company? .....

4. Do you have other non-directig members in your employ who perform the management functions of a building contractor? .....

5. If yes, specify how many you have:.....and briefly what type of functions they perform? .....

6. List the contracts in the building industry that your organisation currently have: .....

7. List the projects in th building industry on which your organisation has been involved over the past five years 1977 to 1981. Please complt the following matrix, using where applicable, the following code:

Type of involvement	Type of building	Type of Contract	Type of Client
A. Complete contract from turning of the first sod to final account	I Office Block	A. Bill of Quantities or Measured	I Insurance Co
	II Shopping complex		II Pension Fund
B. Part of contract ie, superstructure only or foundations only etc.	III Apartment Block	B. Negotiated Cost-plus or Package Deal	III Prov.Admin
	IV Hospital	C. Turnkey	IV P.W.D.
			V Quasi-Govt.

C. Part of consortium of contractors

D. Specialist work

E. Other

V Factory or Warehouse

VI School

VII Hotel

VIII Other

D. Sub-contractor to Project Management

E. Other

VI Local Authority

VII Property Development Company

VIII Dept. Store or supermkt chain

IX Other

MATRIX

YEAR	NAME/TITLE OF CONTRACT/PROJECT				
1977	Example' Tamboersvlei High School	D	V	A	III
1977					
1978					
1979					
1980					
1981					

8. Has your company made any notable achievements in the building field, such as receiving any awards, special mentions etc.? Please specify, and when:

9. Does your organisation specialize in any particular type of building? e.g. schools, hospitals, churches etc. Please specify:

10. Does your organisation specialize in any particular type of building technique? e.gh. highly industrialised building methods, pre-casting, pre-fabricated untis etc. Please specify:

11. Please insert any additional comments concerning this questionnaire that you might have to volunteer, below'

APPENDIX 9
(TABLES)

TABLE ONE
Model of interplay among quality cost categories

Steps in quality cost reduction

Quality cost category	A. Minimal appraisal and prevention costs	B. Increase in appraisal cost (product sorting)	C. Increase in appraisal cost (process controls)	D. Increase in prevention costs
Ext failures	20	3	2	1
Int failures	1	12	8	4
Sorting	1	3	2	1
Process cntls	1	1	4	2
Prevention	1	1	1	2
TOTAL	24	20	17	10

TABLE TWO
Company wide quality control in Japan

Six features of Japanese quality systems
1) Company-wide QC (CWQC)
2) QC Audit
3) Industrial Education and Training
4) QC Circle Activities
5) Application of Statistical Methods
6) Nation-wide QC promotion activities

Company Wide Quality Control (CWQC)
1) All departments must participate in and execute QC
2) Every employee (chairman, president, director, middle manager, engineer, clerk, foreman, worker, etc.) must participate in and execute QC
3) Integrated Control: Quality Control: Cost Control (profit control): Quantity Control (delivery control)

CWQC is a revolution in management philosophy
1) Quality first, results in large profits in long term.
   Profit first, is only a short term policy.
2) Market in is consumer orientated.
   Product out is producer orientated.
3) The next process is the consumer (user).
4) Fact Control
   *Fact-Data-Analysis Action.
   *True data- False data.
   *Statistical analysis-7 tools.
5) Industrial democracy
   *Top-down management and
    Bottom up management
   *All workers are human beings.
   *Respect human dignity.
6) Functional activities
   *Quality Assurance
   *Cost Control
   *Quality Control
   *New Product Development
   *Sub-Contractors

TABLE THREE

Investment in Building

Annual Growth Rates

YEAR	1974	1975	1976	1977	1978	1979	1980	Ave. P.a.	1981	1982
GDP	7,6	1,6	1,4	0,0	2,3	3,8	7,9	3,5	4,5	2,5
GDE	15,6	0,2	-3,2	-6,0	1,1	3,0	11,9	-3,2	5,0	3,5
Total Buildings	5,2	-5,2	-4,2	-3,2	-13,4	3,5	4,4	-1,8	7,5	2,5
1)Residntl Bldgs	4,2	-3,3	-5,4	-18,4	-6,9	9,3	11,9	1,2	4,0	4,0
1.1 Priv.Sect.	5,5	-14,1	-7,3	-17,7	-11,9	1,9	19,6	-3,3	4,0	4,0
1.2 Publ.Auth.	6,3	32,4	-1,3	-23,9	11,2	17,6	-4,0	5,5	5,0	6,0
1.3 Publ.Corps	-25,0	69,4	1,6	6,4	-20,7	52,2	11,4	11,8	3,0	4,0
2)Non-Res.Bldgs.	6,1	6,7	-3,1	9,7	17,5	-0,6	-1,5	4,9	10,0	2,0
2.1 Priv.Sect.	7,0	-13,4	1,2	23,5	-23,8	-2,2	-4,4	-1,7	10,0	5,0
2.2 Publ.Auth.	9,9	6,6	2,9	-5,0	-7,7	-1,6	1,9	0,4	4,0	0,0
2.3 Publ.Corps	13,5	-15,0	17,1	-3,7	-17,7	-9,5	-10,2	-3,6	10,0	0,6

TABLE 4(A)

TABLE OF RESULTS FROM QUESTIONNAIRES COMPLETED BY ARCHITECTS

A:ORGANISATION	Resp.A.	Resp.B.
1 No	*	*
1 Yes		
3		
4		
5		
6		
B:PROGRAMME		
1 No		
1 Yes	*	*
2 No	*	
2 Yes		*
3		
4		
5		
6		
3 No	*	
3 Yes		*
3		
4		
5		
6		*
4 No		
4 Yes	*	*
3		
4		
5		
6		
C:CONTROL OF DESIGNS		
1 No	*	
1 Yes		*
3		*
4		
5		
6		
7		*
8		
9		

C:CONTROL OF DESIGNS Cntd	Resp.A.	Resp.B.
2 No	*	
2 Yes		*
7		*
8		
9		
7		*
8		
9		
3 No	*	
3 Yes		*
7		
8		
9		*
7		*
8		
9		
4 No	*	
4 Yes		*
7		*
8		
9		
7		*
8		
9		
5 No	*	
5 Yes		*
7		*
8		
9		
7		*
8		
9		
6 No	*	
6 Yes		*
7		*
8		
9		
7		*
8		
9		

D:DOCUMENT CONTROL	Resp.A.	Resp.B.
1 No		
1 Yes	*	*
7	*	*
8		
9		
2 No		
2 Yes	*	*
7		*
8	*	
9		
3 No		
3 Yes	*	*
7	*	*
8		
9		
4 No	*	*
4 Yes		
7	*	*
8		
9		
5 No		*
5 Yes	*	
7		
8	*	
9		
6 No	*	*
6 Yes		
E:PROCUREMENT CONTROL		
1 No	*	
1 Yes		*
2 No	*	*
2 Yes		
10		
11		
12		
13		
14		

E 2 Continued.	Resp.A.	Resp.B.
7		
8		
9		
3		
4		
5		
3 No	*	*
3 Yes		
7		
8		
9		
4 No		
4 Yes	*	*
7	*	*
8		
9		
7	*	
8		*
9		
F:INSPECTION		
1 No		
1 Yes	*	*
7	*	*
8		
9		
YES/NO		
YES/YES	*	*
3		*
4		
5	*	
6		
G:TESTING		
1 No		
1 Yes	*	*
7		*
8	*	
9		
3	*	*
4		
5		
6		

G:TESTING Cntd	Resp.A.	Resp.B.
3	*	*
4		
5		
6		
2 No	*	
2 Yes		*
7		*
8		
9		
7		*
8		
9		
H:HANDLING		
1 No		
1 Yes	*	*
7	*	*
8		
9		
3		*
4		
5	*	
6		
I:DEVIATIONS		
1 No	*	
1 Yes		*
7		*
8		
9		
2 No		*
2 Yes	*	
7		
8	*	
9		
3 No		
3 Yes	*	*
7	*	*
8		
9		
J:RECORDS		
1 No		
1 Yes	*	*
7		*
8	*	
9		

TABLE 4(B)

TABLE OF QUESTIONNAIRE RESULTS FROM BUILDING CONTRACTORS

A:ORGANISATION:	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
1 No	*	*	*		*	*	5
1 Yes				*			1
3							
4							
5							
6				*			1
B:PROGRAMME:							
1 No			*		*	*	3
1 Yes	*	*		*			3
2 No		*	*	*	*	*	5
2 Yes	*						1
3							
4							
5							
6	*						1
3 No		*	*	*	*	*	5
3 Yes	*						1
3							
4	*						1
5							
6							
4 No		*	*	*	*	*	5
4 Yes	*						1
3							
4							
5	*						1
6							
C:CONTROL OF THE DESIGNS							
1 No		*	*			*	3
1 Yes	*			*	*		3
2 No		*	*	*	*	*	5
2 Yes	*						1
3	*						1
4							
5							
6							
7							
8	*						1
9							
3 No	*	*	*			*	4
3 Yes				*	*		2

C:CONTROL OF THE DESIGNS:	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
1 No		*	*			*	3
1 Yes	*			*	*		3
2 No		*	*	*	*	*	5
2 Yes	*						1
3	*						1
4							
5							
6							
7							
8	*						1
9							
3 No	*	*	*			*	4
3 Yes				*	*		2
7							
8							
9					*		1
7							
8							
9				*	-		1
4 No		*	*			*	3
4 Yes	*			*	*		3
5 No		*	*		*	*	4
5 Yes							
7							
8							
9							

C:CONTROL OF THE DESIGNS Cnt	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
7							
8							
9					*		1
7							
8							
9				*	-		1
4 No		*	*			*	3
4 Yes	*			*	*		3
5 No		*	*		*	*	4
5 Yes	*			*			2
7	*						1
8				*			1
9							
6 No							
6 Yes	*	*	*	*	*	*	6
7	*	*	*	*	*	*	6
8							
9							
7 No			*			*	2
7 Yes	*	*		*	*		4
8 No	*		*			*	3
8 Yes		*		*	*		
7							
8				*			1
9		*					1
7		*		-	-		1
8							
9							
9 No			*				1
9 Yes	*	*		*	*	*	5
7		*			*	*	3
8	*			*			2
9							
7							
8	*	*			*	*	4
9				*			1
10 No							
10 Yes	*	*	*	*	*	*	6
7			*	*	*	*	4
8	*	*					2
9							

D.DOCUMENT CONTROL	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
1 No			*	*			2
1 Yes	*	*			*	*	4
7	*	*			*	*	4
8							
9							
2 No							
2 Yes	*	*	*	*	*	*	6
7		*		*	*	*	4
8	*		*				2
9							
3 No							
3 Yes	*	*	*	*	*	*	6
7		*	*	*	*	*	5
8	*						1
9							
4 No							
4 Yes	*	*	*	*	*	*	6
7	*	*	*	*	*	*	6
8							
9							
5 No			*				1
5 Yes	*	*		*	*	*	5
7	*			*		*	3
8		*					1
9							
6 No							
6 Yes	*	*	*	*	*	*	6
E. PROCUREMENT CONTROL							
1 No	*		*				2
1 Yes		*		*	-	*	3
2 No			*				1
2 Yes	*	*		*	*	*	5
10							
11							
12				*			1
13	*	*			*	*	4
14							
7	*						1
8		*		*	*	*	4
9							

E.PROCUREMENT CONTROL Cntd.	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
3							
4	*						1
5		*		*	*		3
3 No	*	*	*	*	*	*	6
3 Yes							
7							
8							
9							
4 No							
4 Yes	*	*	*	*	*	*	6
7			*				1
8	*	*		*		*	4
9							
7							
8	*	*		*			3
9							
F. INSPECTION							
1 No							
1 Yes	*	*	*	*	*	*	6
7	*			*		*	3
8		*				*	2
9			*				1
IF YES/NO			*		*	*	3
IF YES/YES	*	*		*			3
3	*						1
4							
5		*					1
6				*			1
G. TESTING							
1 No			*	*		*	3
1 Yes	*	*			*		3
IF YES/NO							
IF YES/YES	*	*			*		3
IF NO/NO							
IF NO/YES							
2 7		*			*		2
8	*						1 *
9							
3 3		*			*		2
4	*						
5							
6							

G.TESTING	Resp.A.	Resp.B.	Resp.C.	Resp.D.	Resp.E.	Resp.F.	TOTAL
4 No			*				1
4 Yes		*		*	*		3
7					*		1
8				*			
9		*					1
7					*		1
8				*			1
9		*					1
H. HANDLING							
1 No			*		*		2
1 Yes	-	*		*		*	3
7		*					1
8				*			1
9							
3							
4							
5		*		*			2
6							
I. DEVIATIONS							
1 No			*		*		2
1 Yes		*		*		*	3
7		*		*			2
8							
9							
2 No			*		*		2
2 Yes		*		*			2
7							
8				*			1
9		*					1
3 No						*	1
3 Yes		*	*	*	*		4
7				*			1
8		*	*		*		3
9							
J. RECORDS							
1 No			*		*		2
1 Yes	*	*		*		*	4
IF YES/NO							
IF YES/YES		*		*			2

APPENDIX 10
(FIGURES)

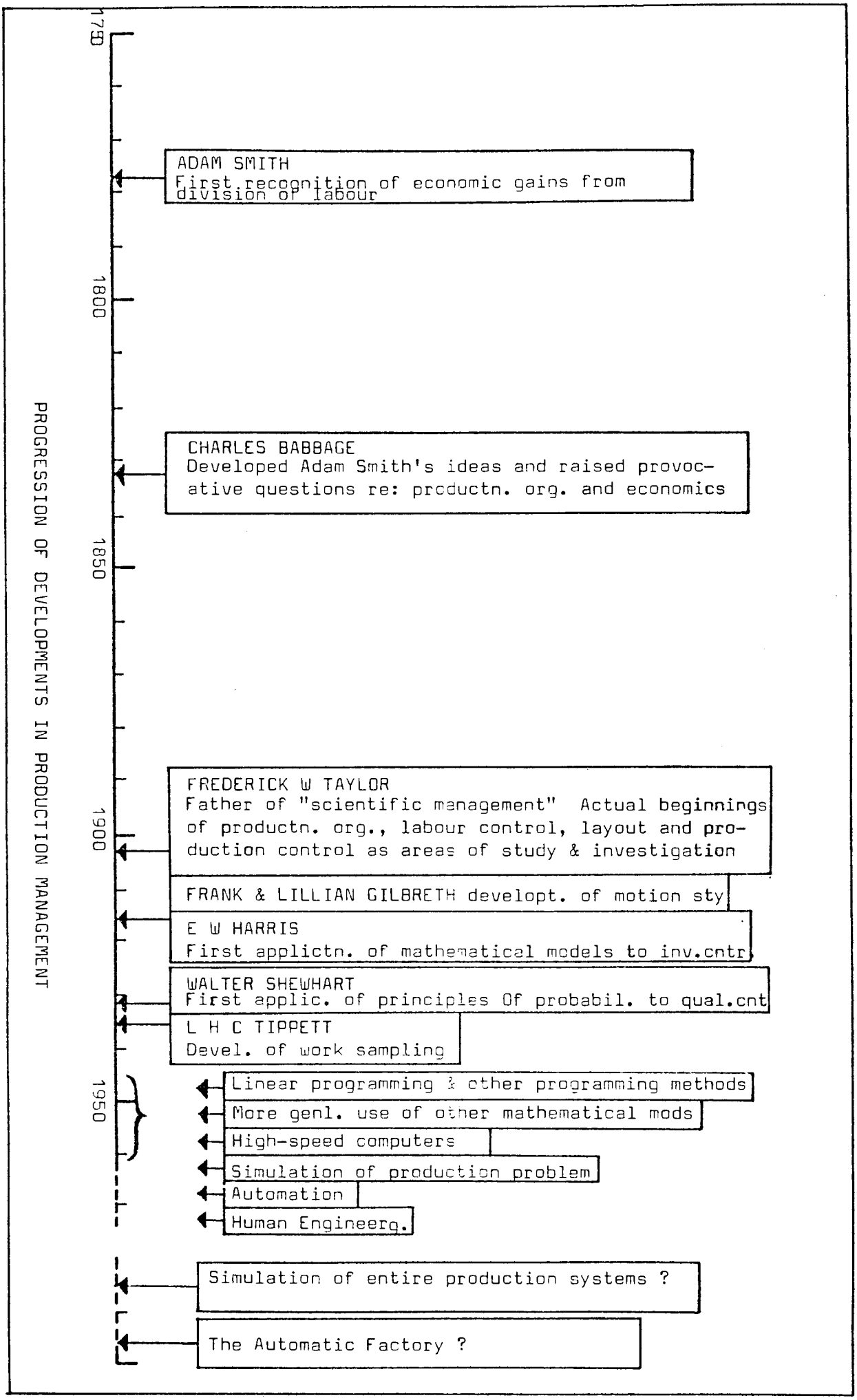
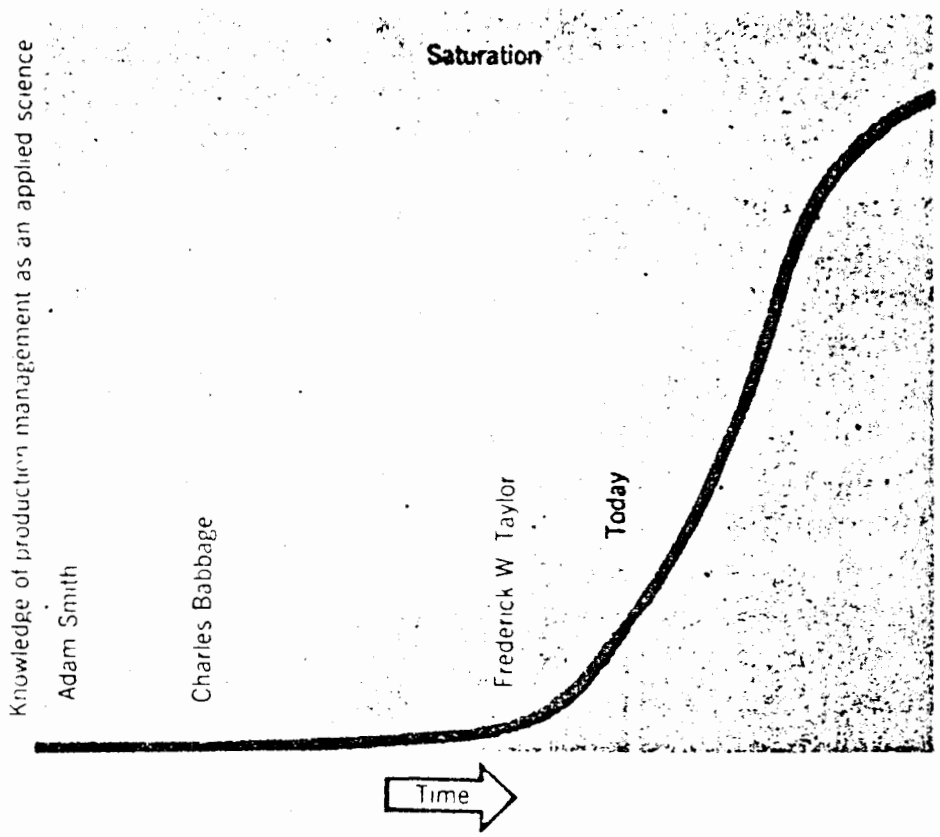
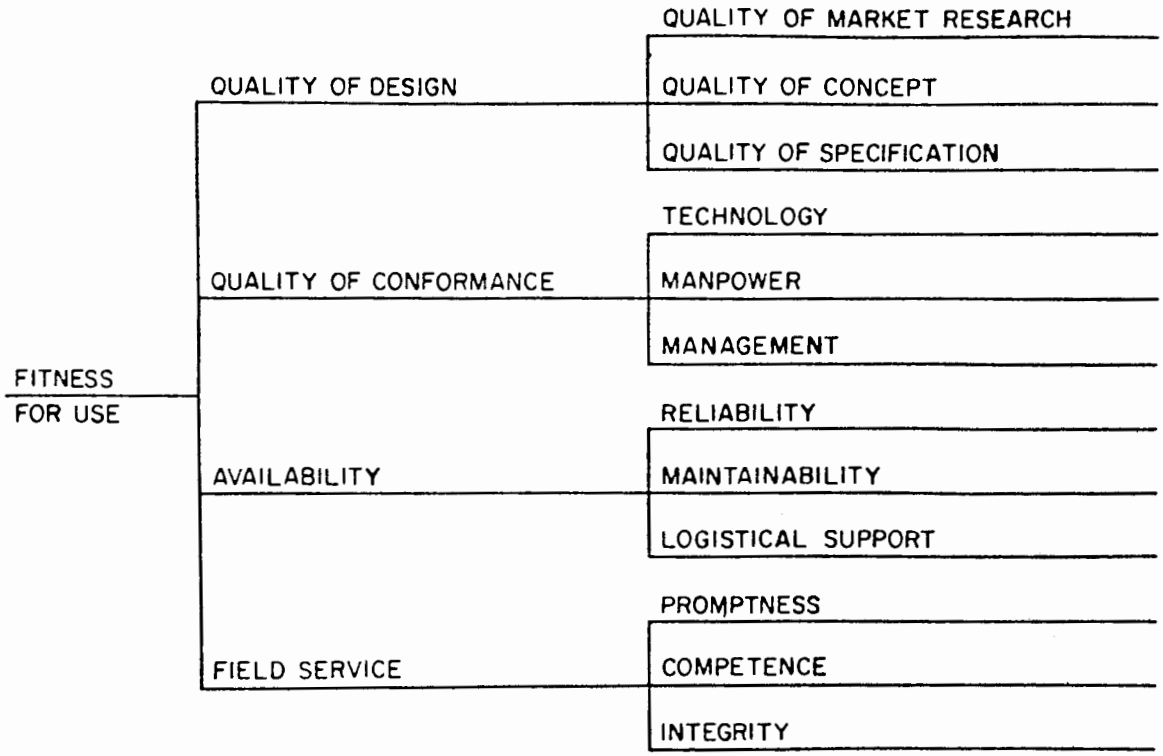

PROGRESSION OF DEVELOPMENTS IN PRODUCTION MANAGEMENT
1750
1800
1850
1900
1950
ADAM SMITH
First recognition of economic gains from division of labour
CHARLES BABBAGE
Developed Adam Smith's ideas and raised provocative questions re: productn. org. and economics
FREDERICK W TAYLOR
Father of "scientific management" Actual beginnings of productn. org., labour control, layout and production control as areas of study & investigation
FRANK & LILLIAN GILBRETH developt. of motion sty
E W HARRIS
First applictn. of mathematical models to inv.cntr
WALTER SHEWHART
First applic. of principles Of probabil. to qual.cnt
L H C TIPPETT
Devel. of work sampling
Linear programming & other programming methods
More genl. use of other mathematical mods
High-speed computers
Simulation of production problem
Automation
Human Engineerg.
Simulation of entire production systems ?
The Automatic Factory ?

FIG.1



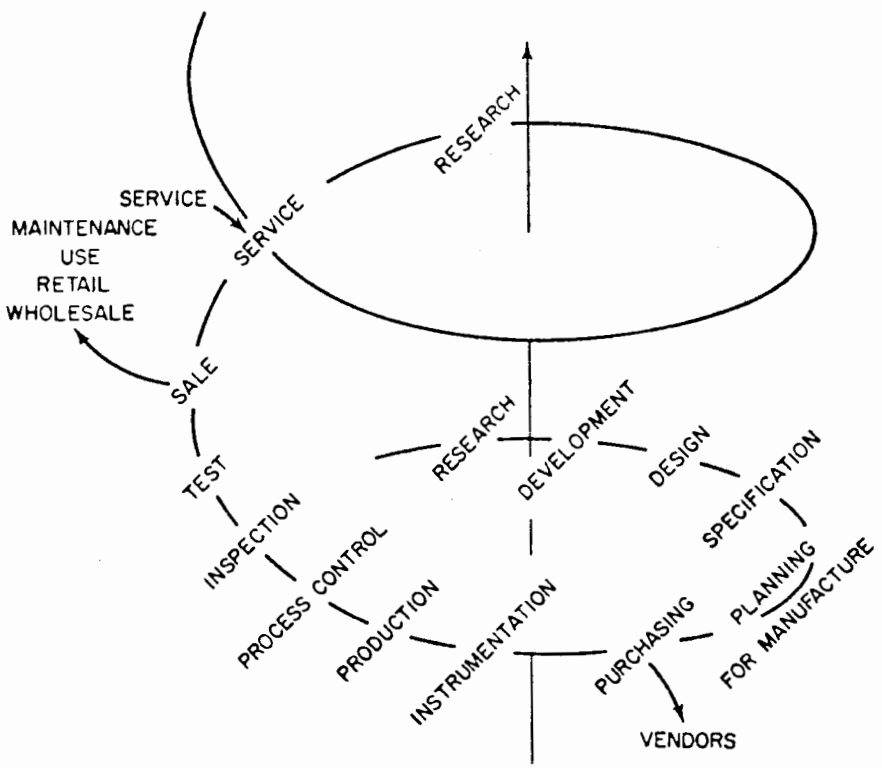
Growth curve of knowledge of production management as an applied science.

FIG. 2



Interrelation among parameters.

FIG. 3



The spiral of progress in quality.

FIG. 4

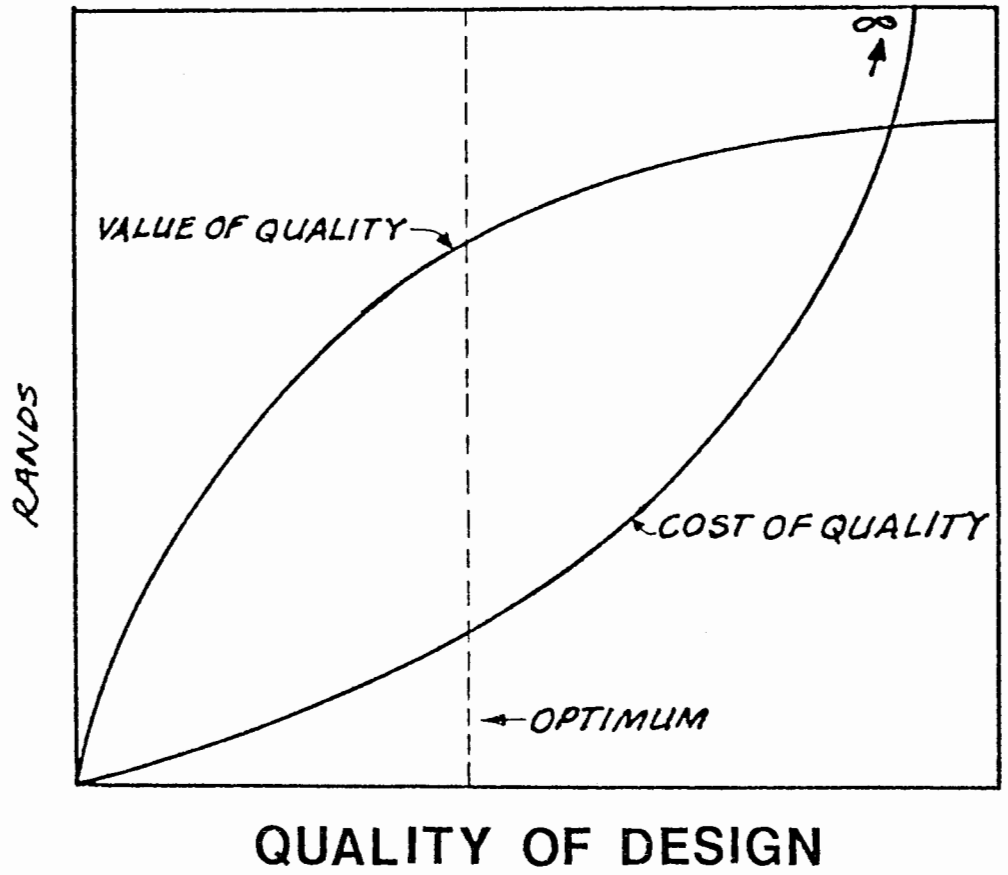

∞
VALUE OF QUALITY
RANDS
COST OF QUALITY
OPTIMUM
QUALITY OF DESIGN

FIG. 5

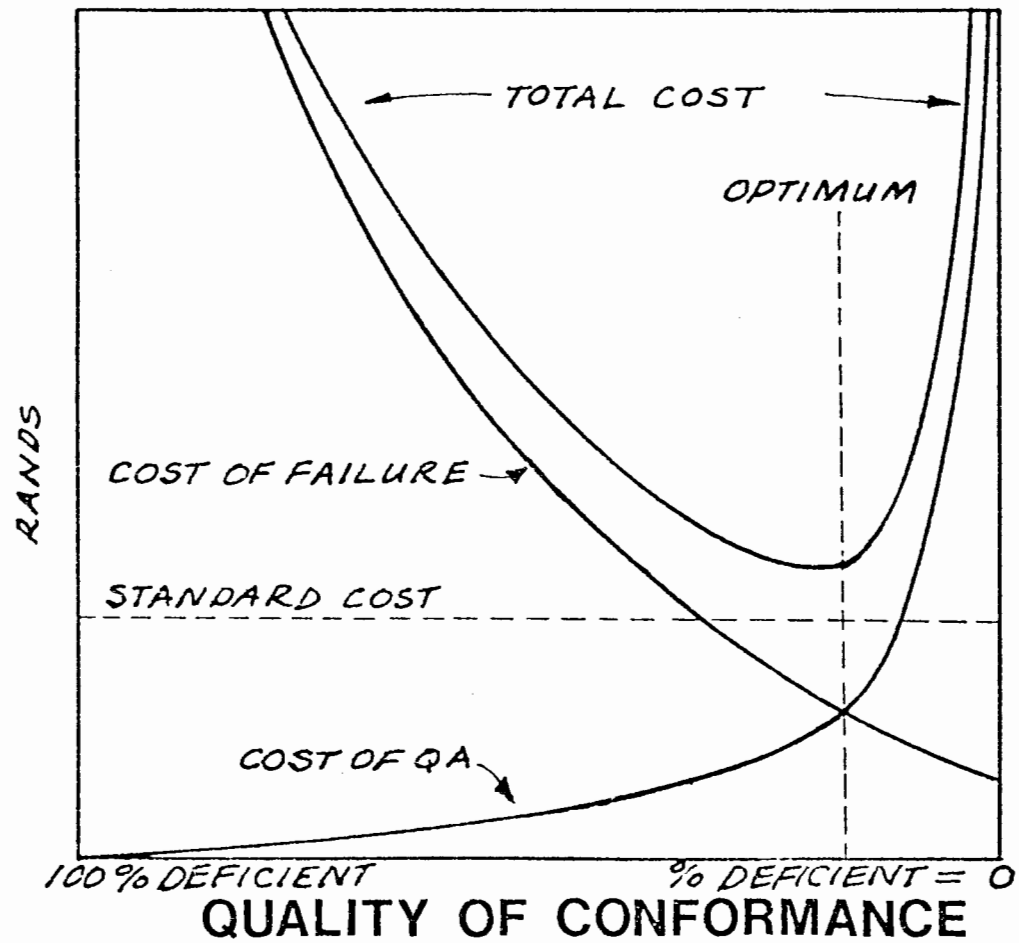

TOTAL COST
OPTIMUM
RANDS
COST OF FAILURE
STANDARD COST
COST OF QA
100 % DEFICIENT
% DEFICIENT = 0
QUALITY OF CONFORMANCE

FIG. 6

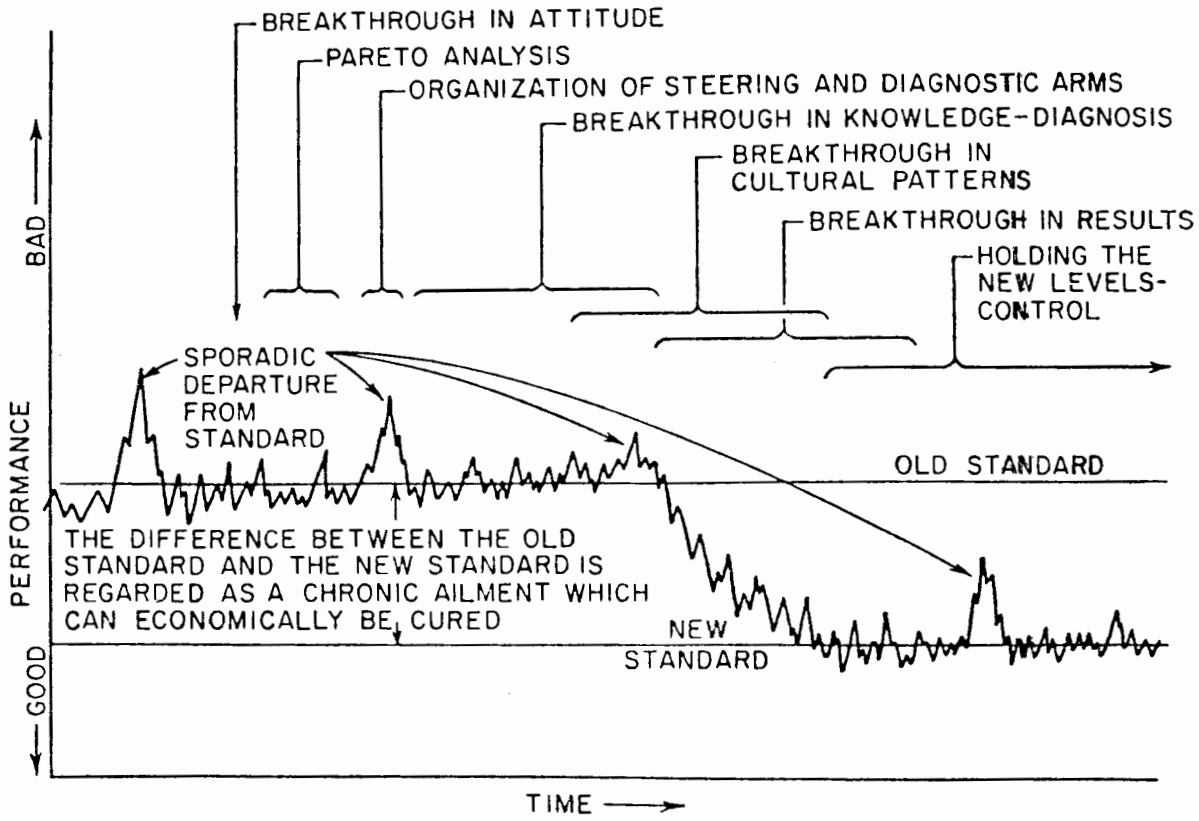
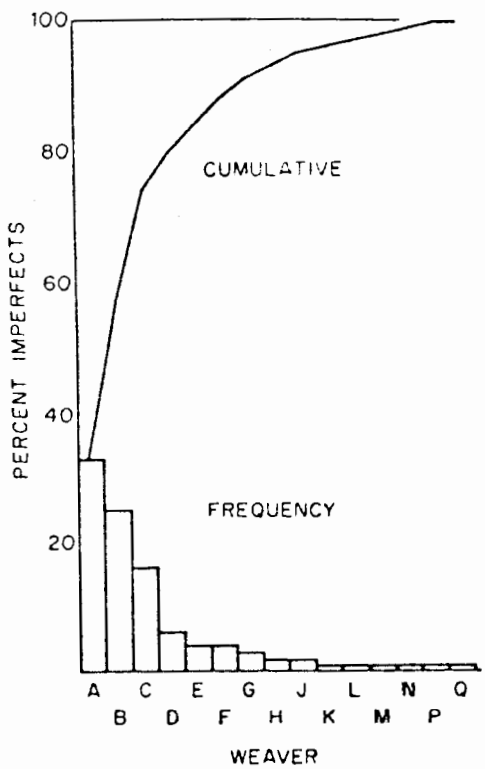
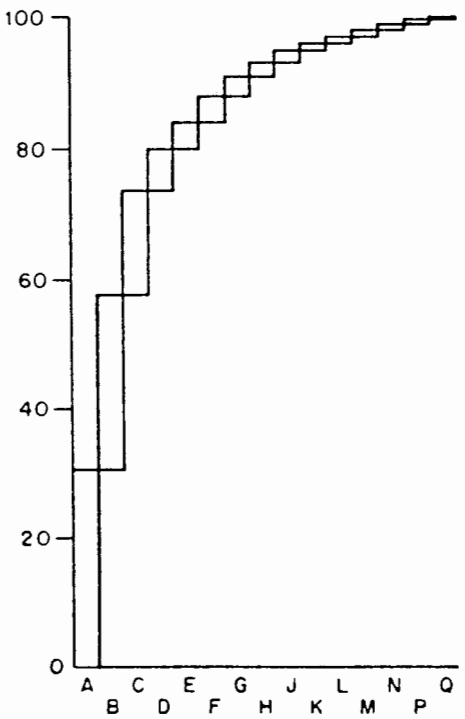


FIG. 7



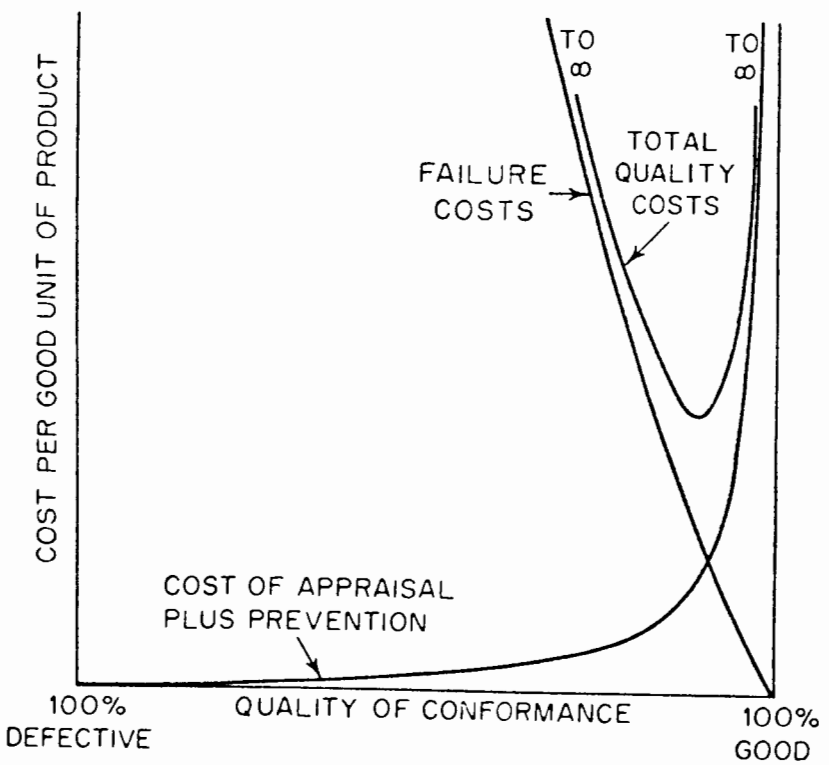
Pareto analysis of weaving imperfects.

FIG. 8



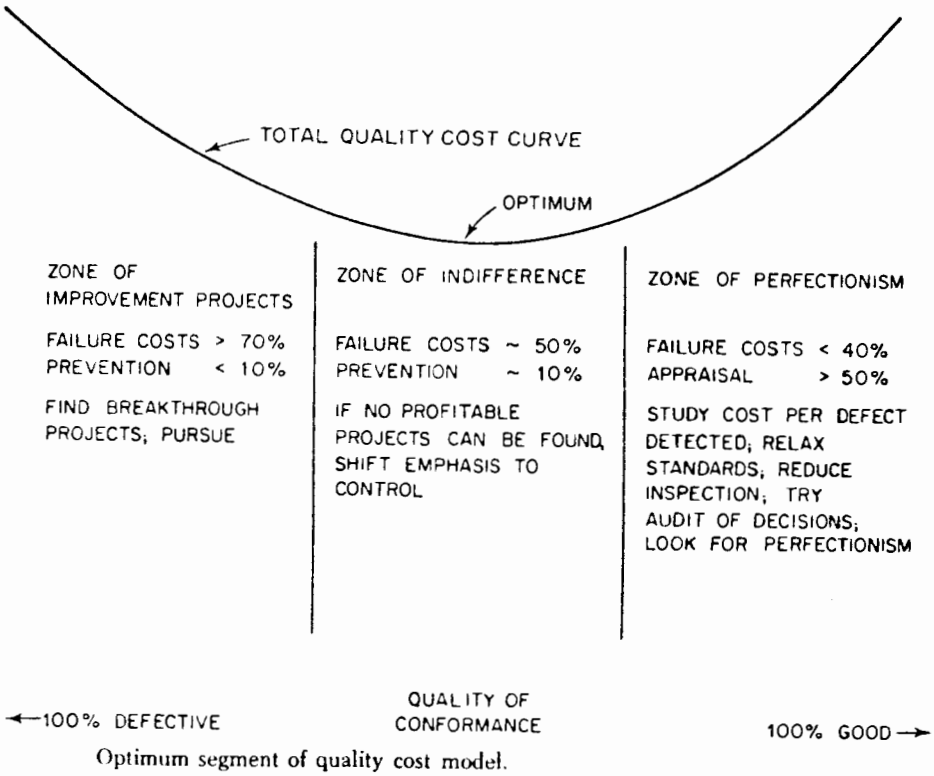
Alternative Pareto diagram.

FIG. 9



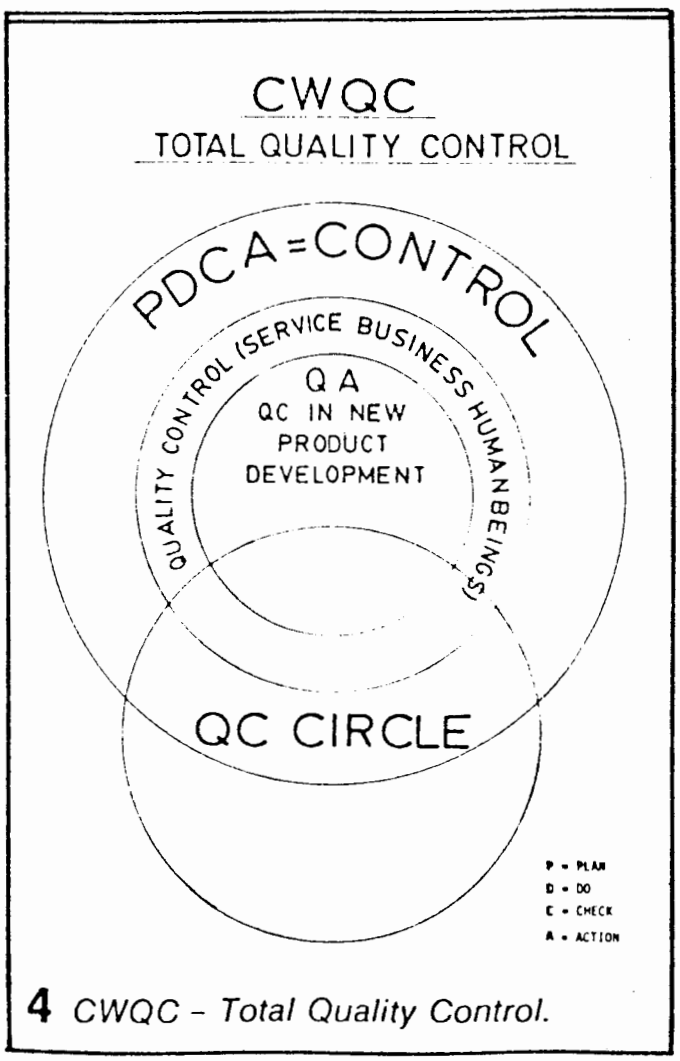
Model for optimum quality costs.

FIG. 10



Optimum segment of quality cost model.

FIG. 11



4 *CWQC – Total Quality Control.*

FIG. 12

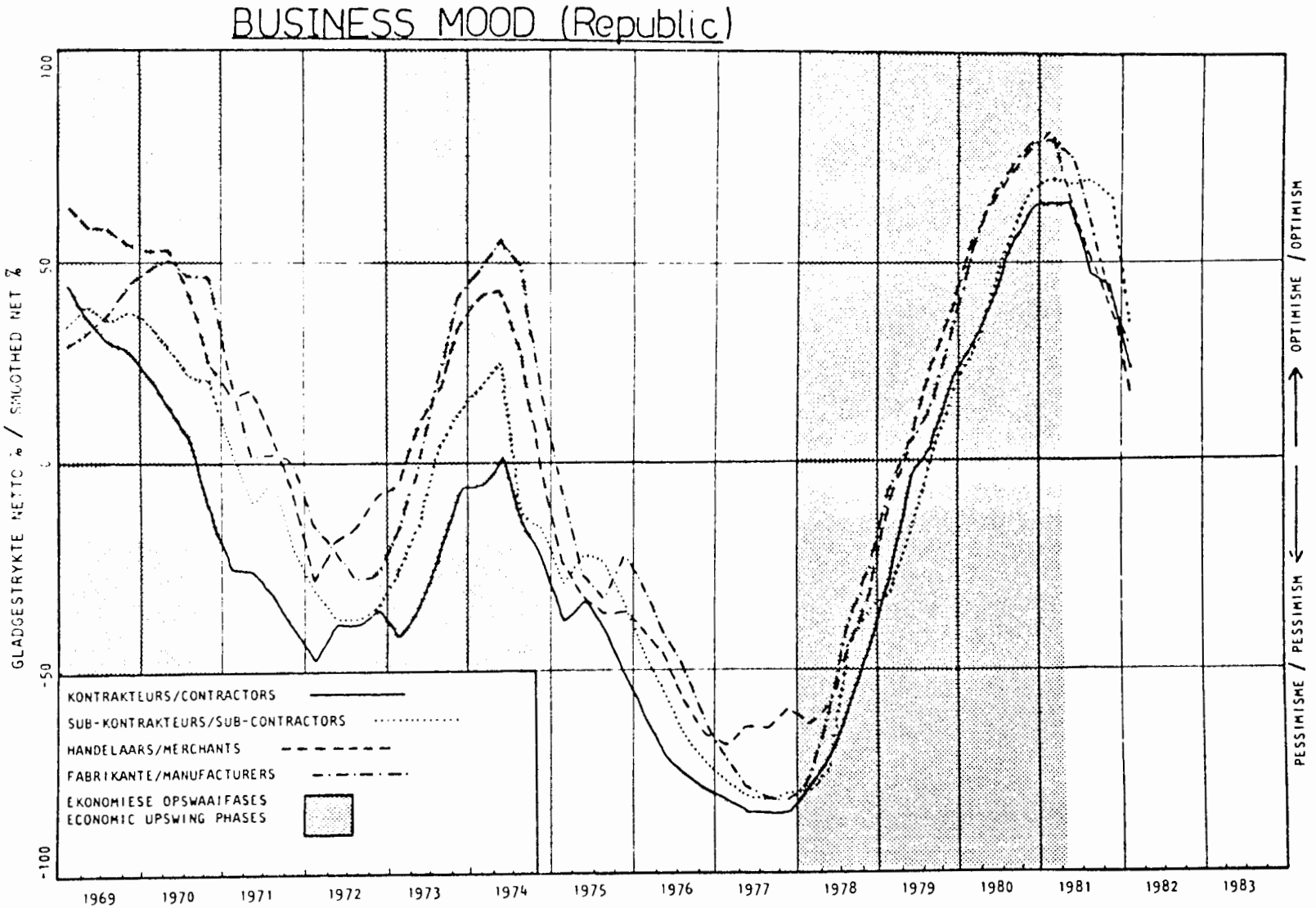

BUSINESS MOOD (Republic)
GLADGESTRYKTE NETTO % / SMOOTHED NET %
100
50
0
-50
-100
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
KONTRAKTEURS/CONTRACTORS
SUB-KONTRAKTEURS/SUB-CONTRACTORS
HANDELAARS/MERCHANTS
FABRIKANTE/MANUFACTURERS
EKONOMIESE OPSWAAIFASES
ECONOMIC UPSWING PHASES
PESSIMISME / PESSIMISM
OPTIMISME / OPTIMISM

FIG. 13

INFLASIE / INFLATION

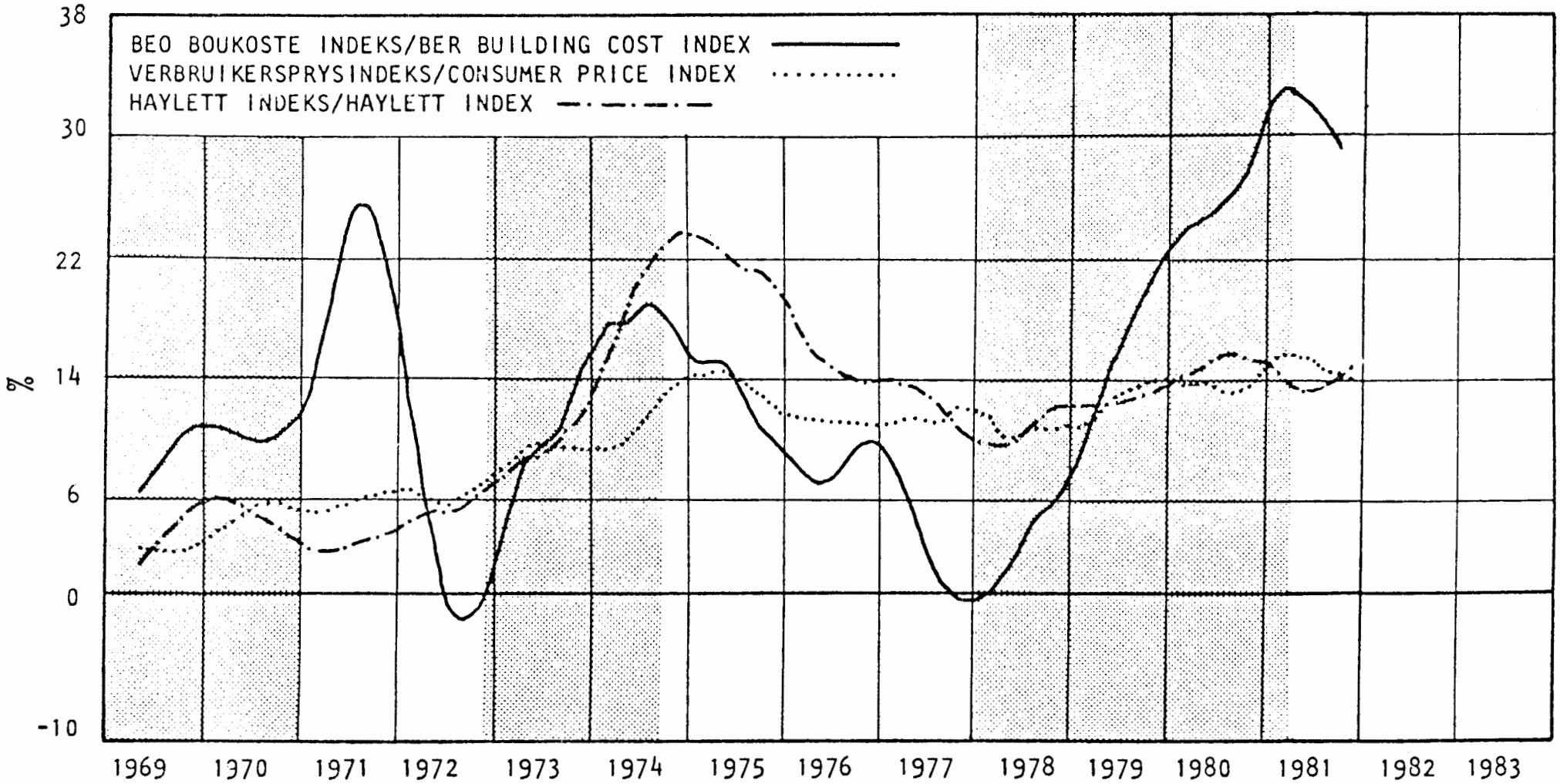


FIG. 14

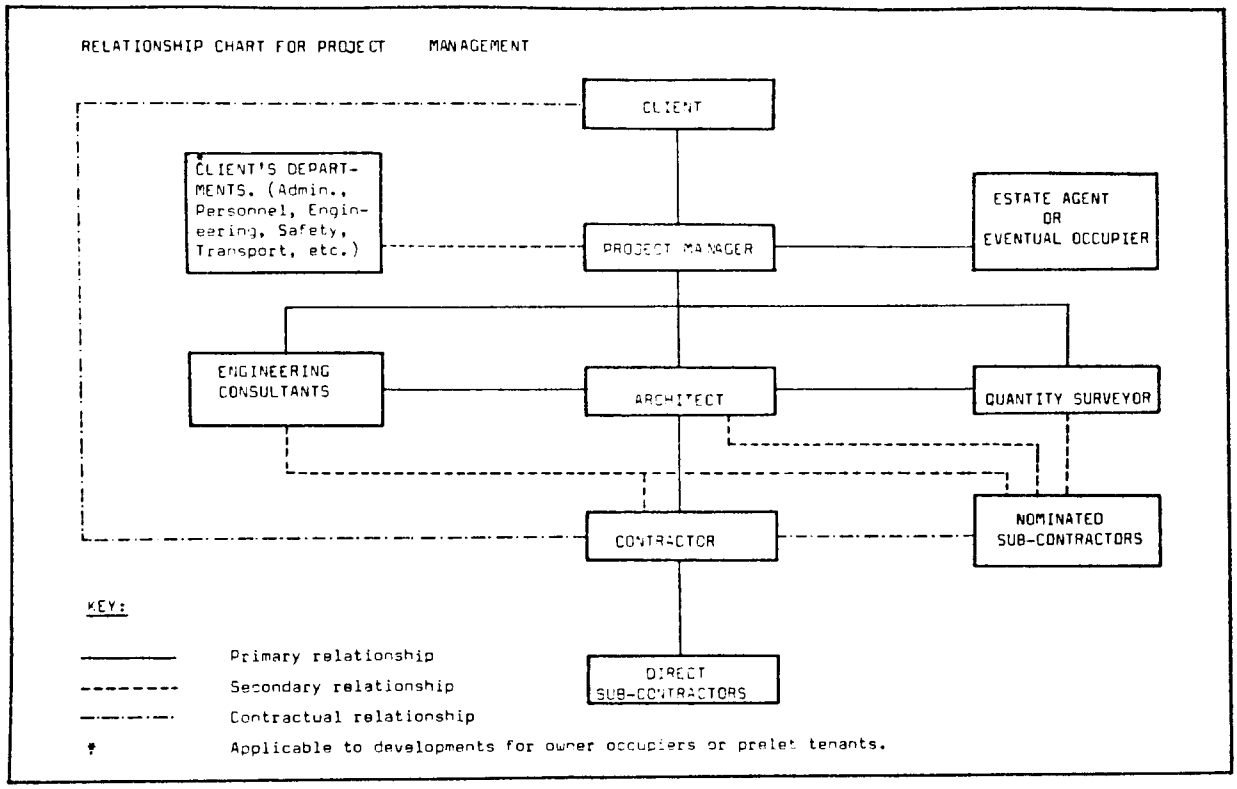


FIG. 15

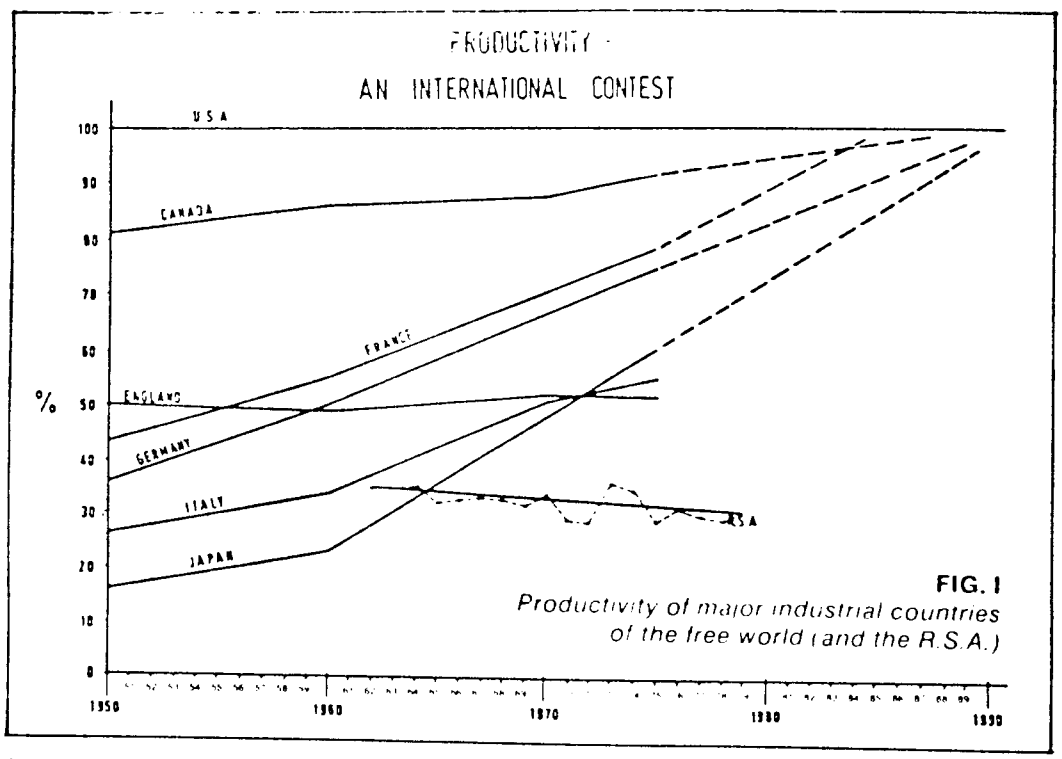


FIG. 1
Productivity of major industrial countries of the free world (and the R.S.A.)

FIG. 16

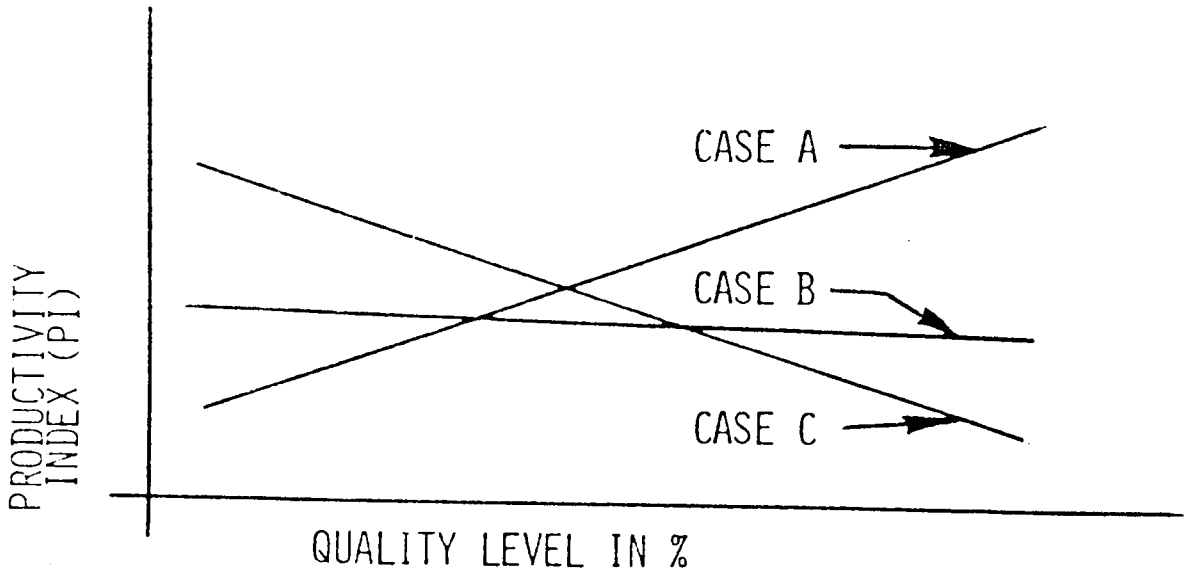


FIGURE - PRODUCTIVITY INDEX VERSUS QUALITY LEVEL

FIG. 17

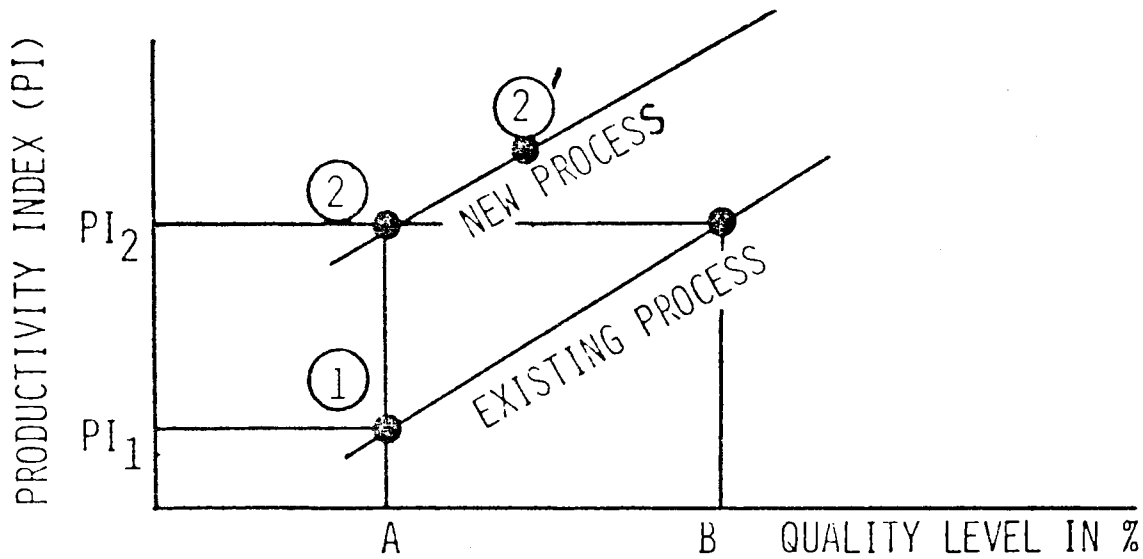


FIGURE - PRODUCTIVITY INDEX VERSUS QUALITY LEVEL
COMPARISON BETWEEN EXISTING AND NEW PROCESSES

FIG. 18

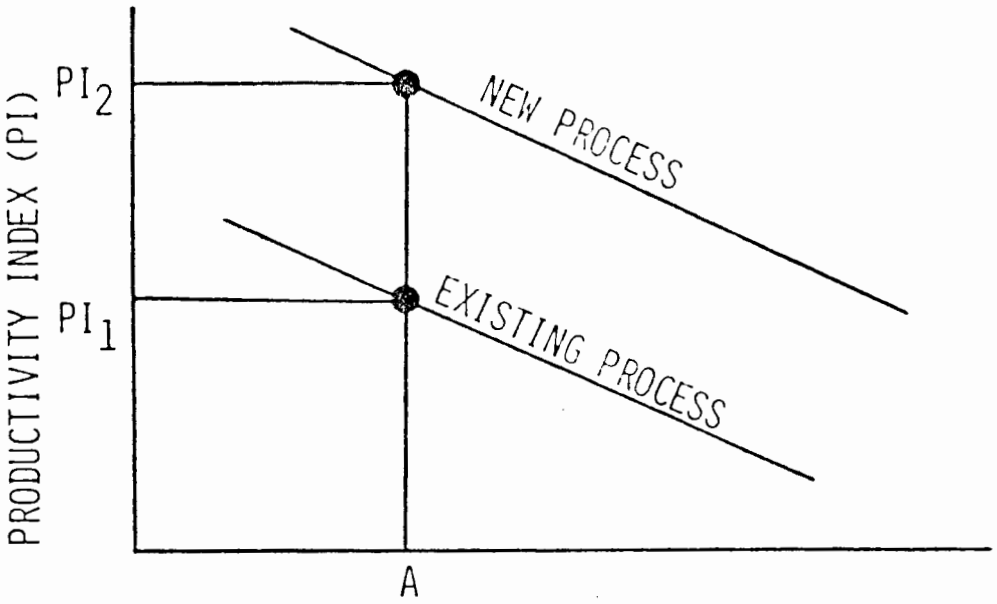


FIGURE - PRODUCTIVITY INDEX VERSUS QUALITY LEVEL
COMPARISON BETWEEN EXISTING AND NEW PROCESSES

FIG. 19

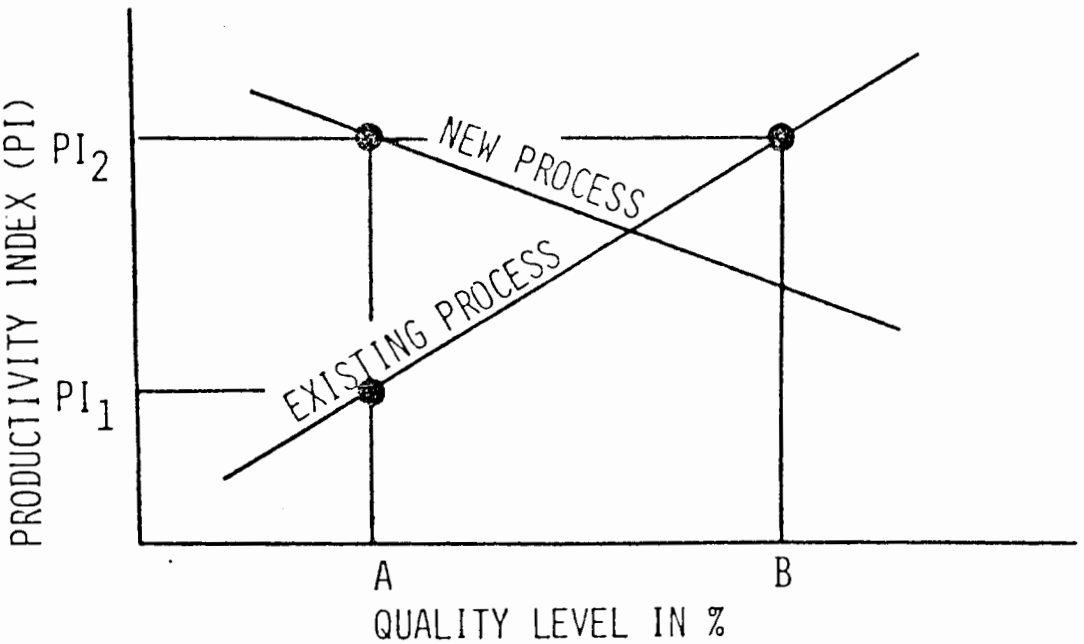


FIGURE - PRODUCTIVITY INDEX VERSUS QUALITY LEVEL
COMPARISON BETWEEN EXISTING AND NEW PROCESSES

FIG.20

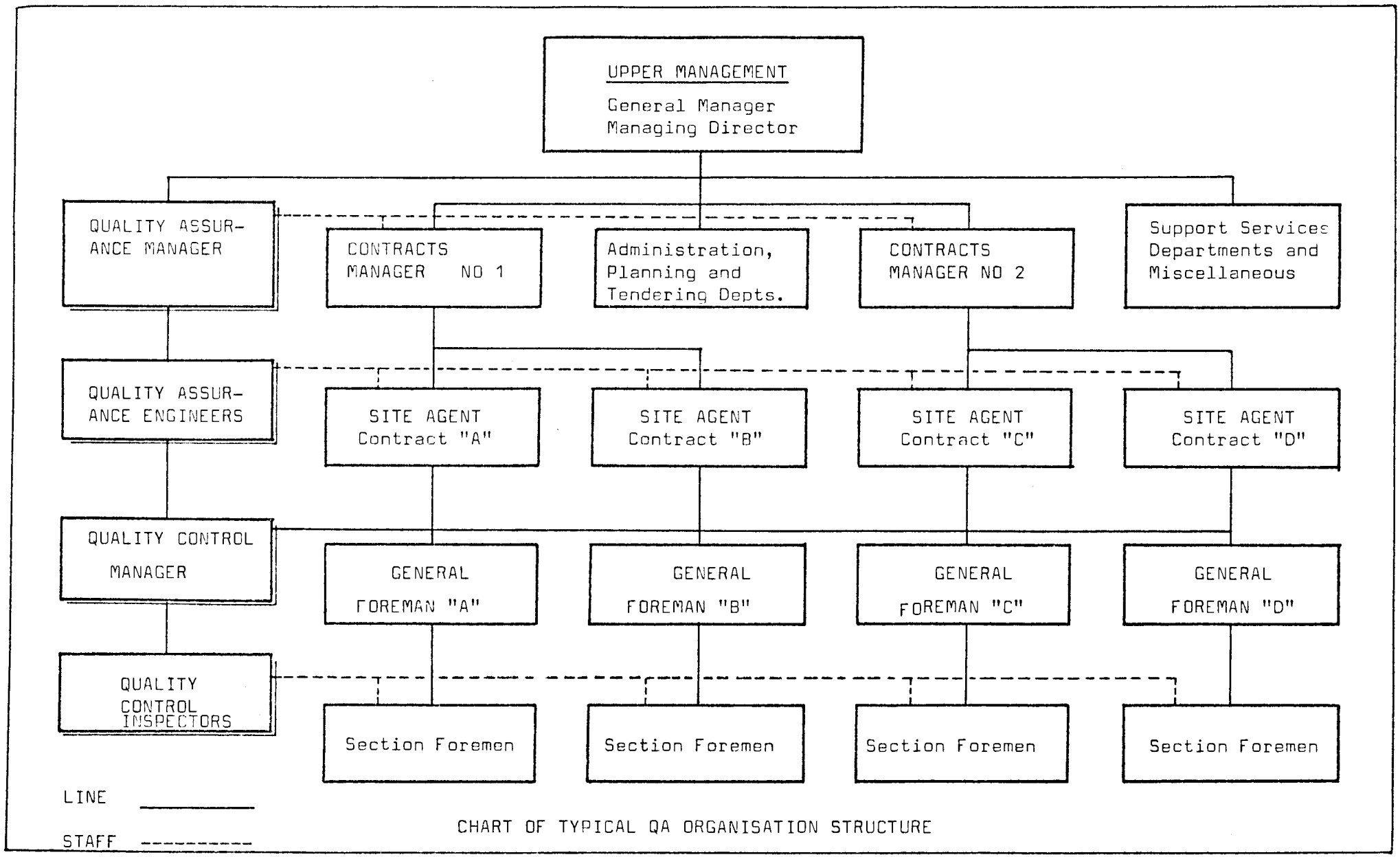


CHART OF TYPICAL QA ORGANISATION STRUCTURE

FIG. 21