SYSTEMIZATION OF ENGINEERING TRACK QUALITY PLAN

FOR

BUSINESS DEVELOPMENT AND INTEGRATION

SASOL CASE STUDY

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Systemization of engineering track quality plan for business development and integration: Sasol case study

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ABSTRACT

The role that quality management plays in business development cannot be overemphasized. Most of the products and services that we enjoy are results of good quality management efforts. Some of these efforts are so subtle that we take no note of them. When a product or service does not meet acceptable standards it is as a result of failure or shortcoming in the quality function. Companies that consistently deliver good product and services in a timely fashion succeeded mainly because of the efforts they commit to quality management.

There is now a proliferation of high technology projects and advanced production endeavors in the world. The issue of quality must therefore follow a deliberate course of planning if any desirable result will be achieved.

This research dissertation addressed the problem of managing the quality process of high technology development projects in the petrochemical industry. A systemized process was developed which led to a scientific control system. It described the methodology used, which permitted a free flow of operations and better control of concurrent activities. This facilitated the analysis of individual performances for better management control. The relative merits of performing duties concurrently were discussed. The problems associated with implementing standard operating procedures in quality management processes were addressed and where possible solutions proposed, which could be tested in a live setting.

It is worth noting at this point that this research work provided a standard operating workflow through systemization for *engineering track quality plan* only. Other tracks do exist in the business development and integration models for high technology development projects.

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CHAPTER ONE

INTRODUCTION

CHAPTER ONE

1.0 INTRODUCING THE RESEARCH THESIS

1.1 INTRODUCTION

Quality has increasingly become appealing over the years, and its growth has been exponential (Feigenbaum A.V., 1983; DOT 2006). It has played a key role in business development for centuries. Good quality management efforts result in acceptable products and services that satisfy the end users. As stated by Akao Y. and Mazur G.H. (2003), therefore, companies that consistently deliver good product and services in a timely fashion succeeded mainly because of the efforts they commit to quality management.

The "systemization of engineering track quality plan (ETQP) for business development and integration" is a research study conducted to elicit knowledge on the ETQP process in the petrochemical industry. This study shall aim to develop an interconnected framework that integrates into an existing petrochemical business development model derived through known systems techniques.

1.1.1 PROBLEM STATEMENT

In recent past, quality has been seen as a vital aspect in every organisation's development and continuous improvement. It contributes to the total reliability of the system and enhances the maintenance function of the organisation. The profitability that comes with having global acceptance as a result of consistent quality has made engineering quality process enticing to many.

From small and medium scale investments to large multi-national corporations, all desire this type of global quality acceptance. The very nature of engineering quality in the petrochemical industry has unleashed a spectrum of directional concerns and associated focus problem (RMA, 2006). This involves the application of numerous standards from an entire repository of well researched guidelines, in a domain where two **project implementations seldom apply the same set of standards** (Anon-IOS, 2006; MWM, 2006).

The inspiration for this research, therefore, emanated from the **pivotal need** to:

- Address the variability of implementation

- **Create an open ended framework that will continuously leverage** this undulating **approach** over time

This research will therefore look into the systemization of an engineering track quality process that will address the variability in implementation (Pall G.A, 1987) and the resulting concerns with focus, direction, time, and cost of control (Caplen R.H, 1987). Much of these concerns become inevitable when, for every project, the plan compilation resumes from zero level.

1.1.2 RESEARCH OBJECTIVE

Presently, the BD&I model (Refer Figure 2-5) defines a comprehensive framework for business development and implementation and is proprietary to Sasol. Sasol, being a key player in the petrochemical business in the world today, provides a good platform for carrying out a study of this nature.

Using Sasol as a case, this research work, therefore, **aims to develop a systemized ETQP framework that will seamlessly integrate with the existing BD&I model**. This, if refined and subsequently adopted by top management, will result in establishing a standardized process for ETQP implementation, as well as an integrated framework with the BD&I model. The latter will further ensure an open ended structure that could be improved on continuously.

Considering the rapid growth experienced in quality management processes (Refer Figure 1-1, Section 1.2.1), the "systemization of ETQP for business development and integration" **aim to present a process that could bridge any possible gaps created and ensure quality continuity, much like keeping this growth in check**.

In addition, it is intended that this work **shall provide an entry point for non-Sasol petrochemical organisations to implement the systemized engineering track quality plan framework, with minimal constraint**.

1.2 MOTIVATION FOR THIS STUDY

A number of factors motivated this research study.

- The rapid growth of quality process development
- Quality systemization characteristics vis-à-vis the possibility that the components of a systemized process could help in addressing inherent problems of standardization
- Mitigating the effect of failure on non-standard quality management processes

Aside the above mentioned, another key motivation is to document a systemized framework for ETQP, which is a specialised area in facility quality management process that requires elicitation in the academic domain.

The following sections discuss these factors.

1.2.1 RAPID GROWTH OF QUALITY PROCESS DEVELOPMENT

The escalating pace of industrialization, and the complexity of engineering designs and constructions in corporate business ventures, places increasing demand on quality [management processes], so as to reflect the realities of today's production place. Feigenbaum A.V (1983) says this ongoing demand continually leaves a *gap*, which the quality function strives to narrow. Systemizing ETQP for business development in the petrochemical industry aim to provide a platform whereby this gap is kept at its minimum, at all times. This shall employ universally accepted techniques that conform to global standards in managing processes.

Recent years have seen the growth of an unprecedented new kind of market place of quality (Feigenbaum A.V, 1983). A historical pattern can be seen in the way quality management has developed over the years. According to Kuhn (1970) as quoted by Dooley K., page 9, change in quality control takes place relatively rapidly over a period of time. A collection of events can be identified that indicate significant change from one form of practice to another.

One of the earliest movements in established quality models was the guild of medieval Europe which was followed by industrial manufacturing practitioners from the 13th century till the 19th century (ASQ, 2006-11). The 20th century saw the

introduction of quality processes in quality practice [1]. Before this time emphasis has been on product inspection (Kennedy C.W et al, 1987).

The change from inspection-based to total quality systems has been referred to by some as an evolution (Feigenbaum A.V, 1983; DOT, 2006). It started with inspection. As the job grew bigger more functions were created for these inspectors bringing about the role of a quality control manager (DOT, 2006). The 1920's saw statistical process control coming into quality control (Anon, 1998). By the 1960's, after some key revolutionary approaches to quality, inspired by the Japanese, quality control was given a management face (ANON, 1998). This further transformed into *total quality management* in the 1980's, and today *total quality management* has become part of a much wider concept that addresses overall organisational performance (DOT, 2006).

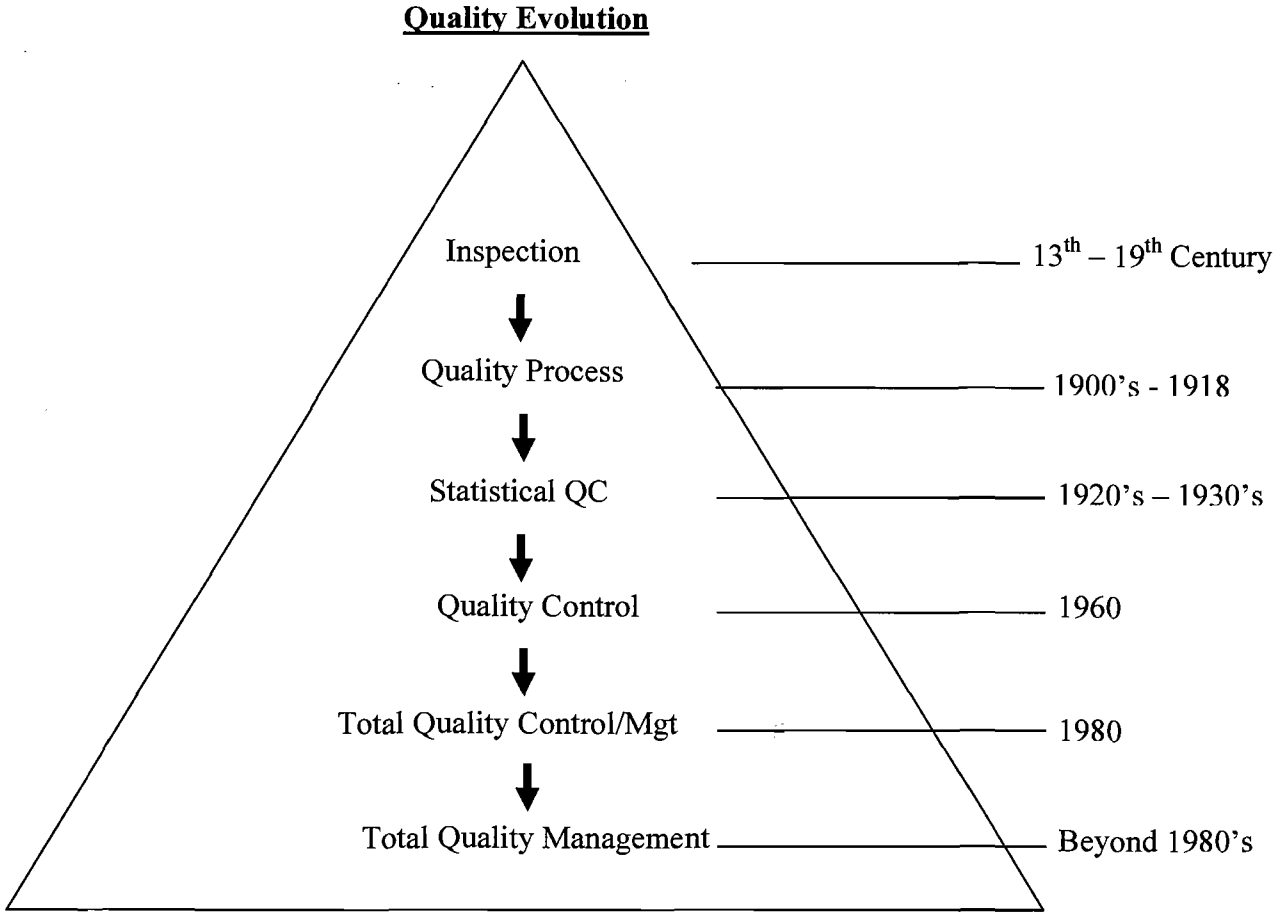


Figure 1-1: Adapted from expositions in preceding paragraph

Some key individuals in the historic paradigm include Juran, Deming, and Feigenbaum (Dooley K.). During this time quality standards were developed to govern the function of quality in the new born concept (Dooley K.). Some of these

standards such as the British standard (BS-5750) published in 1979, and the ISO standard (Anon-IOS, 2006), are recognized internationally for quality management systems.

The trend indicated in figure 1.1 attest to the fact that quality is a fast growing function. It is therefore crucial to address the interrelations of engineering track quality plan functions; and within the context of this research, quality management process in business development within the petrochemical industry. This led to the next motivating factor for this dissertation.

1.2.2 QUALITY SYSTEMIZATION CHARACTERISTICS

Quality control and monitoring thrives where there is a total quality system (Feigenbaum A.V, 1983). This requires an engineered process to make such system work (Pall G.A, 1987). A systemized quality process comprises of associated characteristics that identify it as the nucleus of an effective control system (Anon-CQ, 2006:1); the degree of systemization present in a quality management system determines the level of conformance of its deliverables to set objectives (Halpin V.C: 1).

A systemized quality process must work with associated quality standards such as can be seen in Anon-IOS (2006), Anon-IIQMS (2006), Rao K.O (1994), Anon-CQ (2006) etc. These standards should only be applied to working quality management systems. If they are directly addressed on an individual basis, with little or no consideration to the *interaction of each distinct sectional requirement*, it will have a lot of negative impact on the organisation. The impact level is dependent on the amount of *systemization* in the quality system (Halpin V.C).

Considering the foregoing, a systemized quality process, therefore, must represent **a centralised point of view for everyone in the quality team** (Oxford, 2004). This "point of view" synergizes the different organisational components where quality is expected. It addresses how well each person, each machine, and each organisational component "works individually", and "how well they all work together". (Feigenbaum A.V, 1983)

In systemized processes, **decision as to what level of quality is satisfactory is based on reference to overall system performance** (Feigenbaum A.V, 1987).

Although, meeting engineering specifications is vital and important in itself, in the petrochemical industry, just like in the production industry, "the quality of the entire system portends to be more critical" (Juran & Gryna, 1980).

To create a common platform for decision making, the systemized process becomes the **primary domain for documentation**. Talking about documentation systems, Rao K.O (1994:275) stated that "...it is vital to log all procedural codes and practices to establish a standard quality system. In a systemized process such documentations should reside centrally in repository. The resulting knowledge base should therefore be handled with engineering judgment. The prohibition of use of engineering judgment by professionals can cause safety problems as well as raise the issue of ethics."

Furthermore, such a process becomes the foundation for making the broader scope quality activities realistically manageable (Feigenbaum A.V, 1983). This is especially so in petrochemical facility development since key focus is placed on monitoring various levels of service providers (ECP, 2006). Monitoring, in this context, is an "ongoing systematic process" for ensuring conformance. "It focuses on questions like *how much information is enough, when is it needed and for what purpose?*" (RMP, 2006).

A systemized quality process should be a profit center for the organisation (Harrington H.J, 1987). Section 1.2.3 presents a brief overview of this aspect of systematic quality practice.

Interweaving these components and creating an interconnection that presents a standardized interface for all the seemingly unique applications of quality management processes in the petrochemical industry, is inevitable, if engineering quality is to be adequately systemized (Halpin V.C).

The need to implement these characteristics in the *engineering track quality process,* and therefore creating a systemized quality management process, where work control is better focused, is one of the key motivations for this research dissertation.

1.2.3 MITIGATING THE EFFECT OF FAILURE ON NON-STANDARDIZED QUALITY MANAGEMENT PROCESS

Deploying proper measures can improve quality management processes to an acceptable level (Juran & Gryna, 1988). It is, however, vital to justify the deployment of the existing quality measures as well as the business incentives of the research dissertation, through a systemized ETQP implementation. The prime deliverable of a systematization process is the identification of related components for interweaving the characteristics that has been identified during analysis (Anon-SSU, 2006: 3). This indicates that it is necessary to conduct a comprehensive systematization exercise, which will facilitate the proposition of suitable measures to improve the quality process to a satisfactory standard level.

1.3 RESEARCH QUESTIONS

The motivating factors discussed above led to the following research questions:

1.3.1 HOW SHOULD A SYSTEMIZATION RESEARCH BE CONDUCTED?

This research question requires an expository overview of the current ETQP procedures with a view to establishing a more systemized quality process.

1.3.2 HOW CAN ENGINEERING TRACK QUALITY SYSTEMIZATION PROVIDE A GLOBAL SOLUTION?

One of the burning desires of a corporation is to be world acclaimed. It is therefore necessary to elaborate on the measures the research will take to implement the characteristics presented in section 1.2.2 to an acceptable standard within and outside Sasol, so as to meet international standards of systemization.

1.3.3 DO EXPERTS BELIEVE THAT ENGINEERING TRACK QUALITY SYSTEMIZATION IS APPROPRIATE FOR SASOL AND THE PETROCHEMICAL INDUSTRY IN GENERAL?

For any work to be acceptable in any field of endeavour, the views of renowned authorities are very critical. As such this research dissertation aim to obtain the views of key ETQP personnel in Sasol, and highly placed engineering quality professionals in similar facilities outside Sasol, to appraise the credibility of this study.

1.3.4 WHAT STEPS MUST ORGANISATIONS TAKE TO ENFORCE THE RESULTS OF ENGINEERING TRACK QUALITY SYSTEMIZATION?

A researched systemization solution terminates at the point where recommendation is made to senior management to improve the quality posture of the organisation. The actual step of taking heed of the results entails examining the follow-up activities of the systemized quality process.

1.4 WHAT NOT TO EXPECT (RESEARCH LIMITATIONS)

This dissertation focuses on ETQP implementation within Sasol; however, because of the proprietary nature of such level of information the actual implementation of the proposed systemized ETQP did not take place. Validation of the proposed solution was done through interviews conducted with experts in the petrochemical quality management process. In the same vain the Benchmarking was based on responses drawn from experts.

1.5 TERMINOLOGIES AND ABBREVIATIONS USED IN THIS DISSERTATION

1.5.1 ETQP

Acronym for Engineering Track Quality Plan; It is a tool for quality process management outlining the set of activities of associated engineering professionals that handles the various quality assurances in design and construction of petrochemical facilities

1.5.2 CASE

Acronym for Computer Aided Systems Engineering

1.5.3 Computer Aided Systems Engineering

An iterative process of top-down synthesis, development, and operation of a real world system that satisfies, in a near optimal manner, the full range of requirements for the system (Howard E., 1988:17)

1.5.4 Concept Development

One of the early stages of business development as specified by Sasol's Business Development and Implementation Model (BD&I)

1.5.5 Design Review

A check process that is aimed to identify any deviations in plant design so that appropriate action to revise the plan can be taken, following the early warning call of the review team

1.5.6 Engineering Track

The build-up of associated engineering professions that handles the various functions in quality assurance

1.5.7 Systemization

The Systematic arrangement and design of related components in such a way that information is available in an ongoing basis to make sound management decisions

1.5.8 EPC

Acronym for Engineering Procurement and Construction

1.5.9 Service Providers

Contractors who are used by EPC contractors to carry out the various work defined for a project

1.5.10 Punching

This is the process of checking for completeness and conformance to standard of any engineering installation in a petrochemical plant based on approved design specifications

1.5.11 Systems Analysis

The study of an existing system for the purpose of designing a new or improved system (Raymond M, George S, 2001); It focuses on the business problem, independent of the technology that can or will be used to implement a solution (Whitten et al, 2001)

1.5.12 Random Checks

Indicates that random quality control will be done on deliverable items where incorrect work has a low probability of delaying the project. The quality control will start with one example of each typical item and will extend to more examples governed by the number of errors encountered.

1.5.13 Detail Checks

Indicates that detail quality control will be done on all deliverable items where incorrect work has a high probability of delaying the project.

1.5.14 Hold

This is an action in a checklist that indicates that an activity is subject to formal review and approval by owner engineer. Work may not continue until a formal release is issued.

1.5.15 Systems Engineering

Systems Engineering can be defined as an interdisciplinary approach and means to enable the realization of successful systems (INCOSE).

1.5.16 Cost

The effort or loss necessary to achieve desired quality

1.5.17 Documentation

Written specifications or instructions and the system of maintaining them

1.5.18 Risk

A situation that could lead to an incident or accident

1.5.19 Time

The instance of time it takes or the duration from start to finish of ETQP process

1.5.20 Global Standard

A definite set of defined procedures created for a quality process that is universally acceptable

1.5.22 Turnover

The rate at which professionals leave the ETQP team and are replaced

1.5.23 Team Work

The combined effective action of a group (Oxford, 2004)

1.5.24 Focus

The core of specific ETQP set of activities that defines the goal of the project

1.5.25 Control

The degree of direction of ETQP activities

1.5.26 Continuous Improvement

The progressive evaluation of activities of ETQP throughout the life cycle of an investment

1.5.27 Business Development

This is the process of designing and building a petrochemical facility to a point where it is ready for production

1.5.28 Integration

A union of the component elements of the resulting ETQP framework with the existing Business Development and Implementation (BD&I) model

1.5.29 Standards

A common set of procedures established within ETQP process

1.5.30 BD&I

Acronym for Business Development and Integration

1.6 STRUCTURE OF THIS DISSERTATION

This dissertation consists of five chapters. Each chapter is started with a brief introduction and ends with a short conclusion, in order to align the reader with the objective of each chapter and possible inferences drawn where necessary.

Chapter 1 is the introductory chapter where the motivation for the research dissertation is presented along with some basic understanding of systemization and possible gray areas in non-systemized processes.

Chapter 2 presents the exposition of literary works available on general submissions in quality management processes. It further establishes the need for the study, as earlier highlighted in Chapter 1.

Chapter 3 contains the actual research work. It first discusses the current practice on ETQP in Sasol. Afterwards the framework of the systemization process was presented.

Chapter 4 Analyzed the result of the research work carried out in Chapter 3 and established a conclusive argument based on evidence presented.

Finally, a wrap up of the research work was presented in Chapter 5 by itemizing the key deliverables obtained and how these aligned with the objectives of the research dissertation. Recommendations were made for further research and possible implementation options for the systemized process were outlined.

CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO

2.0 LITERARY EXPOSITIONS

2.1 INTRODUCTION

Corporate quality processes have associated systems that need to be addressed (Halpin V.C). Quality monitoring and tracking analysis, and systemized procedures need to be considered as integral elements in business development plans. The level of control should be proportional to the degree of its systemization.

Organisations tend to place little concern on the fact that cost can be "minimized and controlled" through systemization. Important aspects such as system analysis and system management, are least considered. This should be contrasted from information analysis and information management.

The objective of this chapter is to promote an understanding of these vital processes in terms of addressing the systemization of ETQP operating environment.

2.2 STRUCTURE OF THIS CHAPTER

This chapter commences by defining the concept *systemization* and addressing the importance of developing a systemized ETQP. Thereafter, the definitions and objectives of ETQP will be presented with the view of standardizing the meaning and objectives of this process. It is necessary to have a basic understanding of this process before embarking on ETQP systemization exercise.

The current ETQP procedures are discussed as it will be the bedrock upon which ETQP systemization exercise will be established. This chapter concludes by critically examining the ETQP process and highlighting areas that need improvement, in order to conduct a workable systemization exercise successfully.

2.3 CONCEPT OF QUALITY PROCESS MANAGEMENT SYSTEMIZATION

With a view to implementing a global engineering track quality plan solution that satisfies the characteristics outlined in section 1.2.2, the systemization process will involve system analysis and management. "'System analysis is the breaking down of complex problems into component parts, examining those parts and creating a more efficient system" (Anon-SSU, 2006). A system here refers to related components

working together within ETQP environment, carrying out specific functions in order to achieve a given objective. System management on the other hand "coordinates the resulting systems to minimize the use of excessive resources and to address overlapping requirements of performance balancing" (Anon-IS, 2006; Define-That, 2003).

The concept of systemization in the information realm is defined as the *systematic arrangement and design* of the related components in such a way that information is available in an ongoing basis to make sound management decisions (W1913D; RMA, 2006).

In quality process management context, the following concepts require further elucidation: Systematic can be seen as the consideration of *the interaction of the distinct components* of the quality process (Halpin V.C). Juran & Gryna (1988) speaks of a *"systems approach"* referring to the improvement of the fitness for use of the entire quality progression instead of the refinement of certain elements within the progression.

Design, on the other hand, is the act or action of planning (COED: 388). It is a purposeful and creative activity (Anon-APPCI, 2006). This suggests that there has to be a deliberate act of *creating a working quality management process* and *apply it* to the associated quality standard requirements as adopted by the organisation (Halpin V.C). The resulting system should have been structured to fit the elemental attributes of a systemized process.

In analyzing the ETQP environment a scientific approach for systems modeling will be followed. This will involve obtaining required information from the current system users (Whitten et al, 2004). The systemization process will:

- Follow the Systems Engineering approach
- Draw up phase activities for standard ETQP operations
- Model the framework of the activities
- Integrate the phase activities into existing Business Development & Implementation model of Sasol.

Before proceeding it is worth mentioning some basics in systems engineering.

2.3.1 SYSTEMS ENGINEERING PROCESS & PHASES

According to Steyn H. et al (2006) and INCOSE (2004), the basic tasks in Systems Engineering process that could be carried out are as specified hereunder:

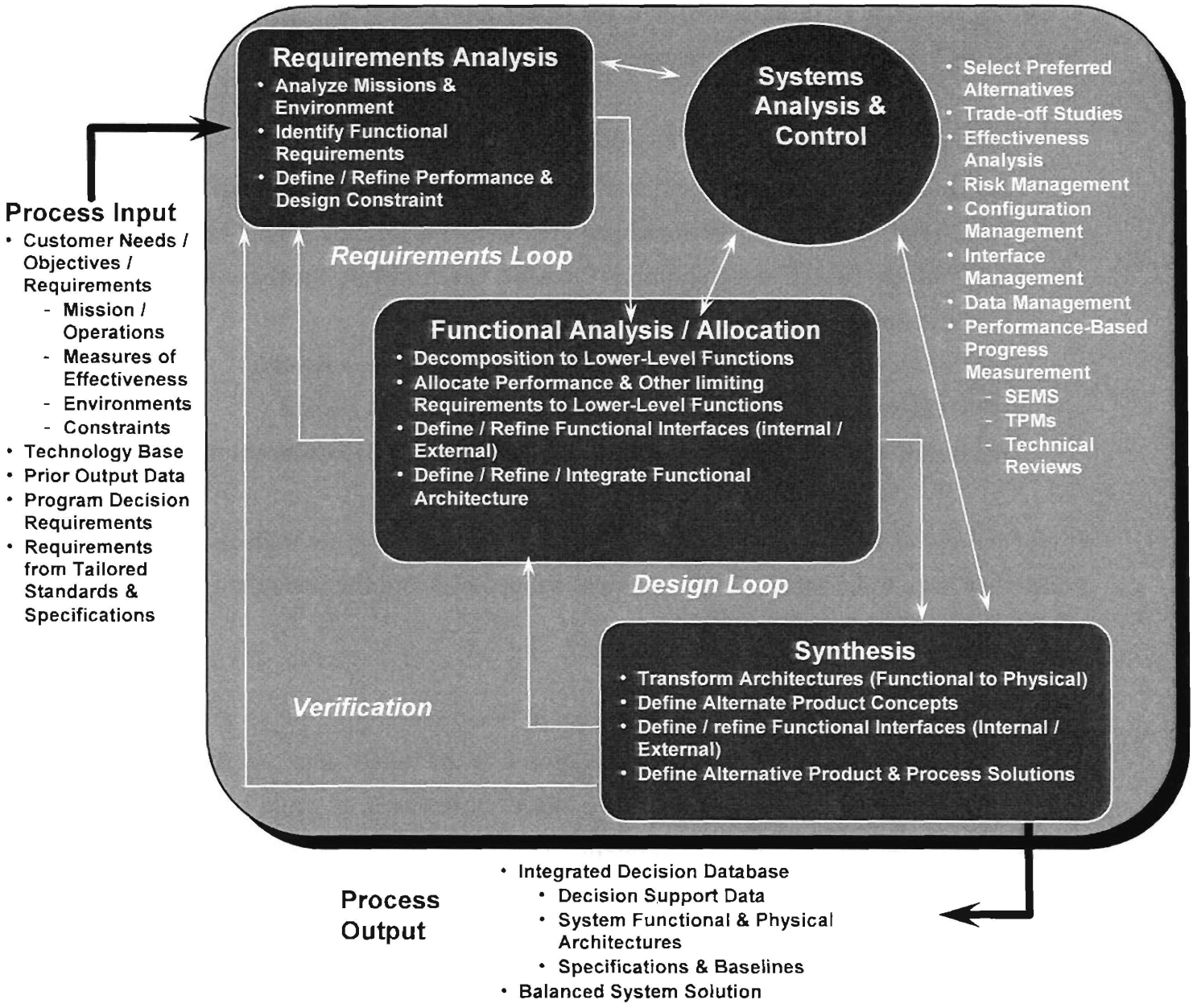
(1) Definition of the System Objectives (User's Needs)
(2) Establishment of the Functionality of the system (Functional Analysis)
(3) Establishment of the Performance Requirements (Requirements Analysis)
(4) Evolving Design and Operations Concepts (Architecture Synthesis)
(5) Selecting a Baseline (Cost/Benefit Analysis)
(6) Verifying that the Baseline Meets Requirements (User's Needs)
(7) Validating that the Baseline Satisfies the User (User's Needs)
(8) Iterating the Process through Lower Level Analysis (Decomposition)

In the context of this dissertation, the "user" referred to represents both the owners (since they have to be satisfied with the final deliverable) and the personnel that will eventually use the system.

In developing a standard solution as proposed in this dissertation the researcher will attempt to follow this scientific process, though not in the fullest sense because of the limited time and resources available for this study. Only task 1, 2, 3 and some aspect of 4 are used. Before then, let me highlight some other key concepts pivotal to this work.

A typical SE process has inputs, a set of processes, and outputs (Meshel D.C, 2007). These are properly captured in figure 2-1. An integrated systems engineering environment consist of the elements pictured.

Figure 2-1: Systems Engineering Process as presented by Meshel D.C (2007)



The diagram in Figure 2-1 specifies in a nutshell the process of systems engineering as explained in open literature.

These elements help to define the *Why, When, What, How, Where, and Who* of the solution process. A graphical depiction of these elemental groupings is shown in figure 2-2.

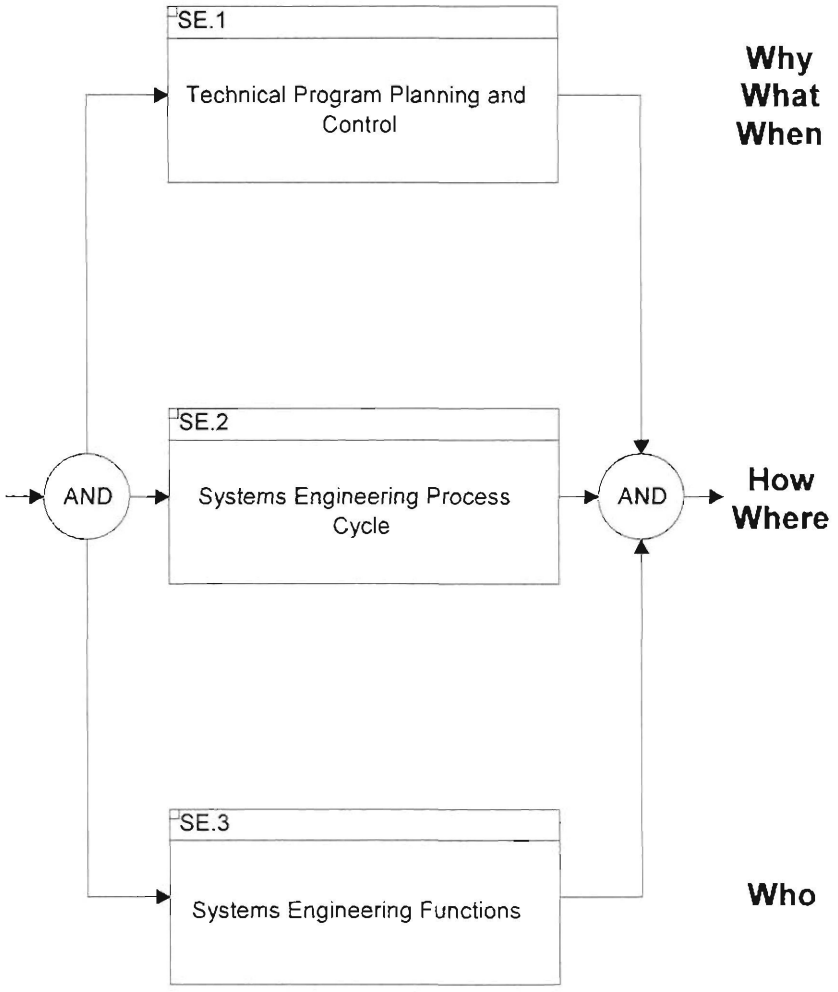


Figure 2-2: Elements of Systems Engineering Integration Process (Meshel D.C, 2007)

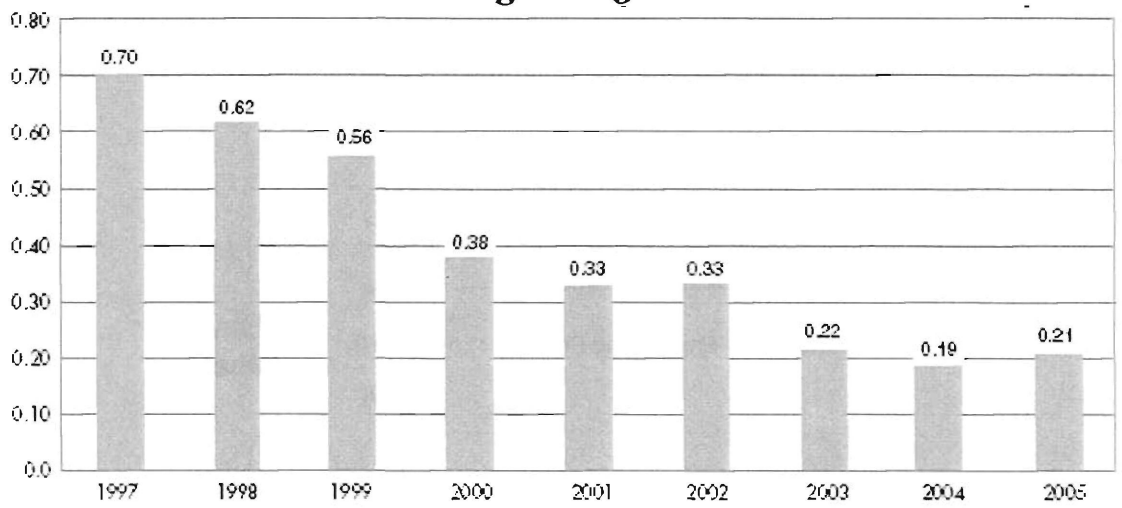
Using the details presented in the SE process diagram a standard process shall be created. The format of this standard shall consider each aspect of the process and provide the input, process, and output that produce the desired deliverable. The aim is to define a set of systemized standards that integrates all functional areas. The activities specified are not taken in isolation. They are obtained from the investigation process and by consulting authoritative sources.

2.4 ADDRESSING THE NEED FOR COST OF QUALITY

The "cost of quality" isn't the price of creating a quality product or service. It's the cost of NOT creating a quality product or service (ASQ, 1999). Operating a quality management process without a fully systemized functionality could in itself be an inherent quality cost.

The case of CRC industries in 1997 (CRC, 1997) shows that huge savings could be realized by implementing the techniques of cost control in a quality system. Figure 2 below shows the performance record for eight years period.

Figure 2-3



CRC Industries cost of quality graph showing reduction in dollar loss between1997-2005

There is a decline of *dollar cost* from 1997 to 2005 - a drop of approximately 30% in cost of operating quality.

Cost of quality could be recorded as either the cost you gained as a result of applying good quality practice or the cost you incurred through poor quality application or failure to apply quality (Harrington H.J, 1987).

ASQ (2006-11) identifies the cause of poor quality performance as lying with appraisal and Inspection, internal failure costs, and external failure costs. These causes could be conveniently interpreted; the activities resulting from poor quality could also be identified; and a decision could be made on how to estimate the cost in order to account for quality functions properly (ASQ, 2006-12; ASQ, 1999). Feigenbaum A.V (1983) splits the cost of operating quality as shown.

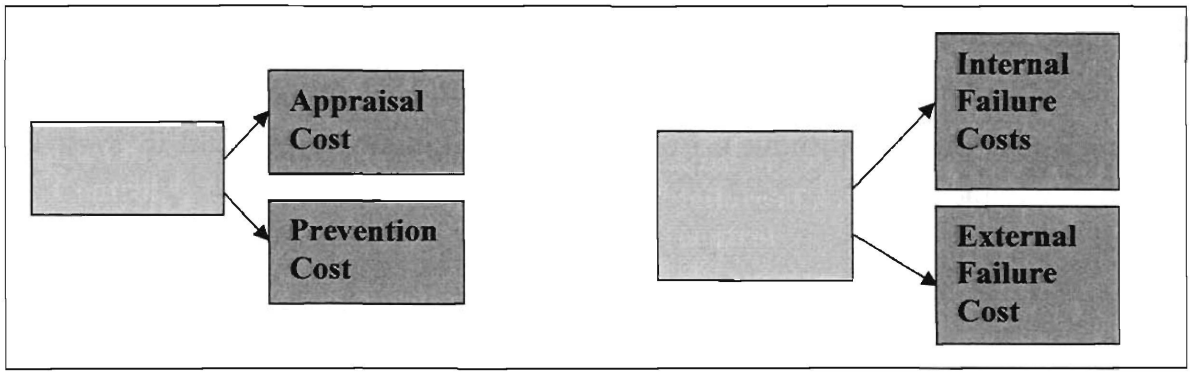


Figure 2-4

The engineering track quality process could realize huge benefits if the various operational functions are costed using the resources of quality cost control technique.

Cost of quality if not addressed will have an adverse effect on the adequate functioning of the quality process. This is not to say that this research aims to delve into cost implications within engineering track quality activities. However, the resulting framework could be a tool for costing the quality process.

Juran & Gryna (1980) pointed out several problems that have caused cost-of-quality approaches to fail. I'll mention two of the main ones here. First, "it's unwise to try to achieve too much, too fast. For example, don't try to apply a quality cost system to every project until you've applied it successfully to one project. And don't try to measure all of the costs, because you probably can't".

Secondly, "beware of insisting on controversial costs". Juran & Gryna (1988) points out several types of costs that other managers might challenge as not being quality-related. If you include these costs in your totals (such as total cost of quality), some readers will believe that you are padding these totals, to achieve a more dramatic effect. Gryna's advice is to not include them.

This realization led to the next factor discussed.

2.5 THE IMPORTANCE OF DEVELOPING A SYSTEMIZED ENGINEERING TRACK QUALITY PLAN

Systemizing and controlling the quality management process is paramount to the preservation of organisational resources (Crosby F.B, 1979). The paramount importance of systemization can not be emphasized too strongly. Not only do you need a quality system, but you need a system by which the quality system can grow or shrink without upsetting the other operations of your business (Anon-IOS, 2006).

The very need for systematic processing gave rise to specific regulations to enforce or manage quality practice. The government of the United States of America, through the department of Energy, gave specific regulations on Design and performance review (DOE, 2000). The Government of South Africa through the JSE SRI Index launched by the JSE required that companies listed in the stock exchange should balance their performance with compliance to the "Triple Bottom Line" method of doing business. This entails maintaining an economically, socially and

environmentally sustainable standard in their operations (JSE, 2005). To encourage conformance the *social and environmental responsibility* award was organised (AWARD, 2000).

These efforts are to underscore the importance of aligning organisational practices with acceptable levels of quality, while fostering investment. A systemized approach to quality management process will not only ensure that the right project deliverables are met but that real value for money is realized (Crosby F.B, 1979).

With a systemized process, therefore, the focus of all participating professionals is aligned, the direction of the quality process is better placed, and the operating cost could more conveniently be controlled and calculated (Harrington H.J, 1987).
Prior to embarking on the systemization exercise it is important to have a basic understanding of ETQP and BD&I.

2.6 UNDERSTANDING ETQP DEFINITION AND OBJECTIVE

The following sections survey the literature to elicit the definitions and objectives of ETQP and BD&I. Recurring key terms are *italicized* for emphasis. This exercise serves to determine if these terms are distinct, synonymous or interrelated.

2.6.1 DEFINITION OF ENGINEERING TRACK QUALITY PLAN

The definition of engineering track quality plan is summarized in section 1.5.1.
Business development engineering in the petrochemical industry encompasses the assurance of quality in the entire development process. The build-up of associated engineering professions that handles the functions in quality assurance is what is referred to as "engineering track" (QMS/941-Rev1, 2003). On the other hand "quality", as referred in this dissertation, is the degree to which a set of inherent characteristics fulfill requirements (Anon-IIQMS, 2006).
ETQP forms part of the deliverables, among many others, that the engineering management team works to achieve.

ETQP is not a quality system but a tool used on projects to direct the focus of the team toward the set objectives (EP, 2006). Such a tool if rightly applied directs the focus of the project team towards achieving laid down objectives in target time. In the context of the definition of quality (degree to which a set of inherent

characteristics fulfils requirements), ETQP defines the critical activities and interventions on which the project team (per discipline) should focus their limited resources to ultimately achieve their objective of conformance to requirements. Critical activities and interventions are those that, when executed properly, have the greatest influence on the overall quality of the deliverables (QMS/641-Rev1, 2006; QMS/941-Rev1, 2003).

It should be emphasized here that ETQP is internal to Sasol's project team. "ETQP exists separately from (but could be influenced by) the quality manuals, procedures, quality control plans, etc of the contractors and suppliers" (EP, 2006: 4); every project must follow the BD&I framework, but depending on the contract type or project type, the details of implementation will surely differ.

BD&I is the Business Development and Implementation model of Sasol. It is a comprehensive model for project execution. The BD & I model serves as a toolbox for project execution. Figure 2-5 gives a brief overview of the BD & I model.

It consists of seven gates. Each of the phases within the gates has special guidelines. ETQP is a piece in the Engineering Track. Each phase must meet up with the gate readiness reviews before being allowed to proceed to the next phase (GRR, 2006).

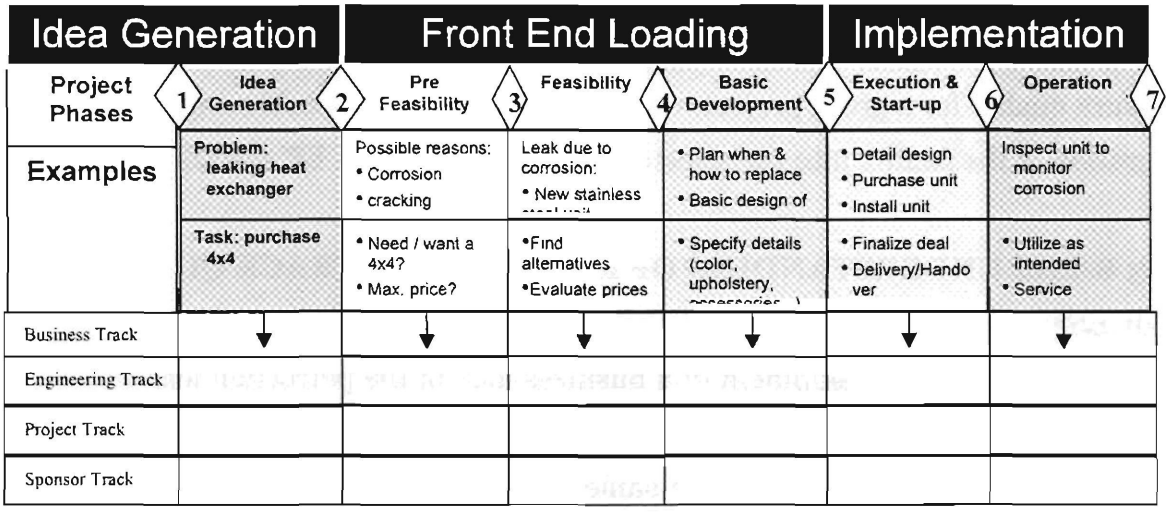


Figure 2-5: Brief Representation of Sasol's BD & I Model

A graphical summary of the BD&I model deliverables are shown in figure 2-6.

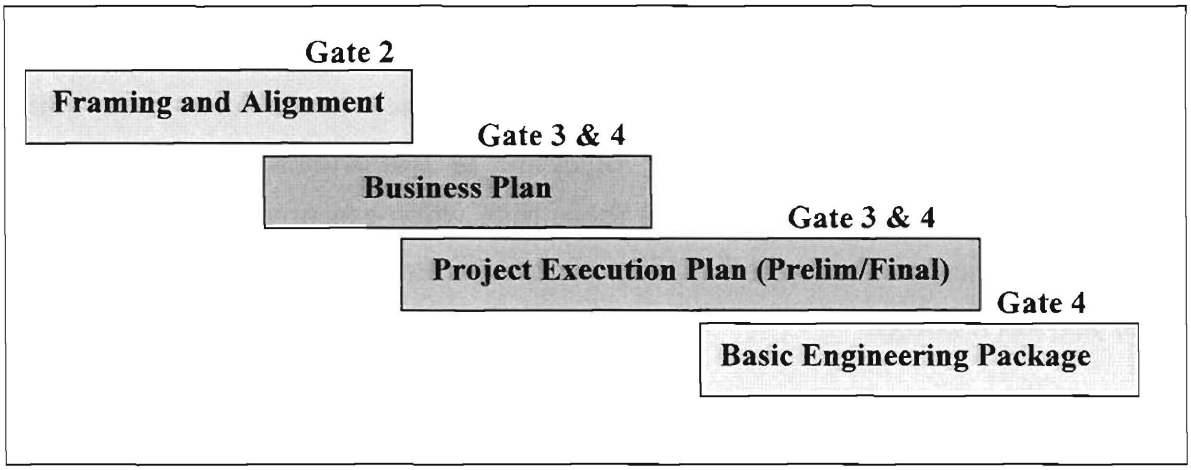


Figure 2-6: ETQP Formation Phases

From Figure 2-6 the project team for a given project will have to *frame* the set of procedures and policies that apply. Next they *align* the selected set to the project goal. Afterwards they draw up a *business plan* for the project, draw up *execution plan*, and carry out the *engineering* activities as outlined in the plans. The extent and complexity of this entire process depends on the risks the project team identifies (PPE, 2006; PEP, 2006).

2.6.2 OBJECTIVE OF ENGINEERING TRACK QUALITY PLAN

ETQP supports business intent. The key objective is to ensure that the optimal technical scopes for projects are met (EP, 2006;PPE, 2006). With this tool, the quality engineering team should be able to manage the technical deliverables as well as the safety, health and environmental risks (RMP, 2006).

ETQP aims to "align and interface the various engineering resources" pulled together to ensure quality for a given project, with the "ultimate goal of achieving the technical integration of the facility into the selected site" (MWM, 2006; EP, 2006).

2.6.3 BASIC UNDERSTANDING OF ENGINEERING TRACK QUALITY PROCESS

Every project for the development of a business idea in the petrochemical industry is unique (Lombard F, 2006). The set of procedures adopted as the Engineering Track Quality Plan for project A is not the same as that for project B, or any other. The complexity of this feature of the engineering track quality plan becomes more challenging when big projects are executed (GBU, 2006). It's almost like starting from scratch for every new project.

A complete business development and implementation plan in the petrochemical industry addresses the following key functional areas to translate an idea into a physical installation: Research & Development, Engineering, Procurement, and Construction Management (ED, 2006; PP, 2006; ECP, 2006).

The contractor embarks on the actual development of the facility, taking up the bulk of the risks off the owner. Such contractor is referred to as an Engineering Procurement and Construction (EPC) contractor. The EPC Contractor will be required to provide single source process and schedule guarantees to minimize the risks to the parent company and investors (ECP, 2006). Some EPC contractors serving the global petrochemical industry include Fluor Corporation, Technip SA, Tecnicas Reuindas SA, Progress Energy Florida, ABB Group, and Betchel Corporation.

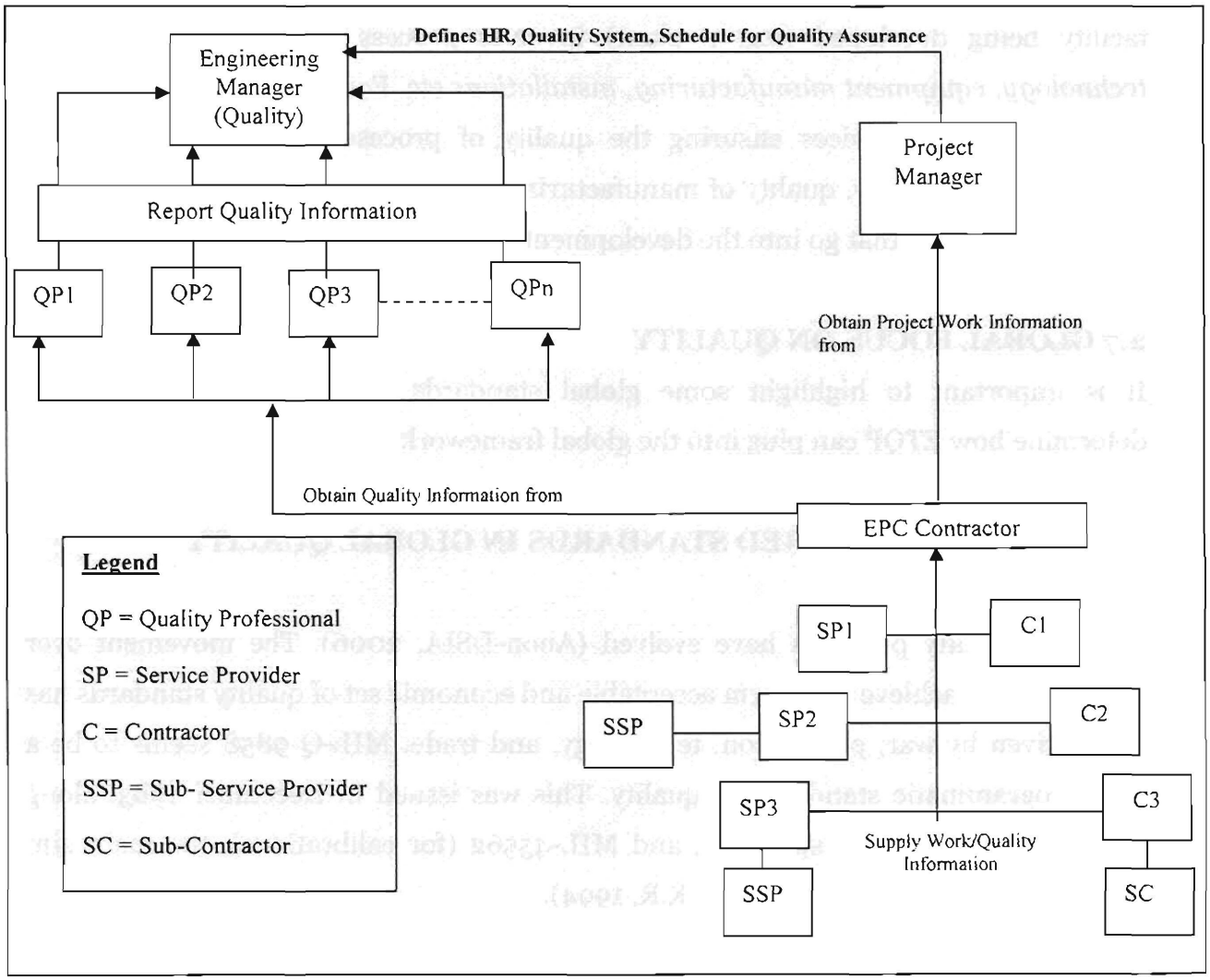


Figure 2-7: ETQP Work Structure

At the conclusion of the Front-End Engineering Design (FEED) an EPC contractor is hired to handle the rest of the development process (Wikipaedia, 2006). This leaves the owner company with the vital task of managing and tracking some/every supplies, services, work processes, and installations, which goes through a series of review and punching procedures (MWM, 2006). The resulting structure, as depicted by the researcher, is represented as seen in Figure 2-7 above.

As indicated in Figure 2-7, the sub levels, or sub-sub levels as the case may be, handles the physical manufacturing and quality assurance based on specifications given. To ensure that what is specified is actually what is made the owner company establishes a quality management process (ECP, 2006). Information obtained is then delivered to the manager in charge of quality for further processing.

Specific procedures and work guidelines must be adhered to (MWM, 2006). The facility being developed (e.g. a plant) involves *process technology, equipment technology, equipment manufacturing, installations* etc. For all these there has to be series of quality services ensuring the quality of process technology, quality of equipment technology, quality of manufacturing and installations. There are various quality assurances that go into the development.

2.7 GLOBAL FOCUS ON QUALITY

It is important to highlight some global standards developed for quality and determine how ETQP can plug into the global framework.

2.7.1 SOME ESTABLISHED STANDARDS IN GLOBAL QUALITY PLANNING

Standard quality practices have evolved (Anon-DSIA, 2006). The movement over many years to achieve a uniform acceptable and economic set of quality standards has been driven by war, production, technology, and trade. MIL-Q-9858 seems to be a very programmatic standard for quality. This was issued in December 1963, along with MIL-45208 (for inspection), and MIL-45562 (for calibrations), the main aim being management of quality (Rao K.R, 1994).

Standards such as these are developed to handle the "inherent variability in product or service quality as a result of *loss functions*". Product and services can vary in a

number of ways such as variability of functions and harmful side effects (Taguchi, 1986:2). Therefore strict definition of guidance to the functions that define quality management process for any given product or service should be outlined in order to reduce variations.

ASME plays a key role in bringing about and enhancing the knowledge of standardized operations within the framework of *codes and standards*, and regulatory environment for complex engineering projects, especially for pressure vessels and piping (Rao K.R, 1994). A number of presentations were made in this regard to promote codes and standards. To establish an effective regulatory system, ASME created codes and manuals to guide the general procedures for work, thereby ensuring quality.

In RAO K.R (1994:249), the procedures for plant design, changes and repairs by welding followed a programmatic approach, which implemented ASME code sections I, II, III, IV, V, VI, VIII, IX, and Natural board inspection code contained in NSP's welding manual.

It further stated that the basic approach is to use the original code of construction. This manual gets updated regularly and provides options to create a project specific application (GBU, 2006). This means that each work is viewed as a project and the manuals and codes serve as basis for creating specific applications for work to be done (MWM, 2006). This invariably ensures consistency, which in itself is a primary factor for good quality.

International Standards Organisation (ISO) over the years has evolved a number of reference codes applicable to diverse organisational needs for quality assurance. These codes cover, among many things, specifications for quality, documentation, design, safety etc. (Anon-IIQMS, 2006).

Talking about documentation systems, Rao K.R (1994:275) stated that it is vital to log all procedural codes and practices to establish a standard quality system. The resulting handbook should therefore be handled with engineering judgment. The prohibition of use of engineering judgment by professionals can cause safety problems as well as raise the issue of ethics.

Furthermore, those involved in quality must understand their profession very well in detail in order to assure that they are consistent with the designs. Reviews must be carried out and understanding applied to measure their impact on the design. There should also be just one interpretation to the entire body of any document. Careful selection of words and language construct is demanded. (Rao K.R, 1994)

2.7.2 EVALUATING ETQP IN THE GLOBAL PERSPECTIVE

The process of quality planning could be traced back to the 13th century (Refer section 1.2.1; DOT, 2006). Considering the nature of the petrochemical business development process, a fitting tool is required to manage the process of ensuring quality. This is where the idea of *ETQP* was born. It's like "using a small cup to fetch water from a bigger bowl" or "using the right tool you need from a toolbox" (GBU, 2006).

The primary factor, according to Lombard F. (2006), militating against the establishment of a standard process is the peculiarity of every project, due mainly to the risks. However, this does not deny the fact that having a *relative standard toolset* will save up time in implementation.

It is worth noting here that other key players in the petrochemical industry may have similar systems and call it by different names, but the need for a study is born from the following factors:

- From reliable expert information, Sasol has gone into Joint Ventures with major players in the petrochemical industry such as Chevron, Exxon Mobil, Qatar Petroleum etc (Sasol, 2007). Sasol's BD&I model, with ETQP, was considered as more comprehensive in these cases and was used in developing the Joint Venture facilities.
- As the world tends towards clean fuel production, information regarding engineering quality in the process industry will be invaluable, and this dissertation will serve to inform the global community of this growing process.

ETQP as defined in the BD & I model, therefore, possess global recognition. Systemizing this process will bring about great gain to the petrochemical business development community.

Besides the benefits accruable to the business development community by systemizing ETQP, the exposition here presented will bring before the public domain a comprehensive review of the engineering track quality process, and will set the stage for further research in this area.

2.8 CONCLUSION

Systemization has been defined within the context of this study. The basic understanding of ETQP as practiced by Sasol has also been highlighted. A global viewpoint was also presented, which could serve as a footprint towards achieving a worldwide acclaim in engineering track quality systemization.

Although, the existing system is successfully being applied in facility developments, a number of factors point to the need for a systemized operation for ETQP. These are:

- Establishment of a "take-off point" *relative* set of standard procedures so as to reduce the time in implementation
- Creation of interconnections for all component operations encapsulated by the EPC contractors (Refer Figure 2-7, Section 2.6)
- Unification of operational documentation to better align the focus of the entire quality team (Owner, EPC contractors, and sub/sub-sub alliances)
- Establishment of centralised activities and management processes, that could help the owner engineering manager in better monitoring and tracking costs, performances, and project progressions

The following Chapter will present the research methodology used and the systemization research process for this dissertation.

CHAPTER THREE

INVESTIGATING ETQP

CHAPTER THREE

3.0 ESTABLISHING ENGINEERING TRACK QUALITY PLAN PROCESS

3.1 INTRODUCTION

At the end of this research it shall be outlined that a systemized ETQP can standardize the process. This underlines the importance of having a basic understanding of the BD&I model, particularly the quality track issues as poor quality is perhaps the biggest concern of executed projects.

A non-standard quality environment has several vulnerabilities that do not exist in standardized operations. Such vulnerabilities if exploited could manifest into risks. It is therefore crucial to understand and mitigate the risks. A systemization assessment can aid in managing potential risks within projects.

This chapter commences with the assessment of ETQP procedures. The objective is to uncover all operational issues prevalent in ETQP operating environment that may lead to a successful systemization.

3.2 STRUCTURE OF THIS CHAPTER

This Chapter begins with the conduction of the ETQP process analysis. The preliminary activities as well as the activities required to elicit knowledge for operational evaluation are covered.

The fact-finding phase encompasses three aspects, vis-à-vis: *facts about the environment, facts about the roles, and facts about the people.* This chapter is therefore structured to cover these aspects. This will elicit knowledge about ETQP functions, roles, personnel, information structure, and process.

The first aspect, facts about the environment, entails studying the ETQP operating environment. It commences with a brief highlight on ETQP, elaborating on aspects such as work initiation, data collection, storage systems, and work control. The underlying architecture of the current system along with the most common standards in ETQP planning will be elucidated.

Facts about the roles consist of a study of the work execution cycle to obtain an understanding of the information flow pattern.

Finally, there will be an expository overview on people involved in engineering track quality planning to determine how qualitative the ETQP operating environment is in terms of workforce configuration.

3.3 RESEARCH METHODOLOGY

A mind map is developed to give a directional focus to this research process. Figure 3-1 below represents the map. Figure 3-2 is a comprehensive breakdown of the various phases.

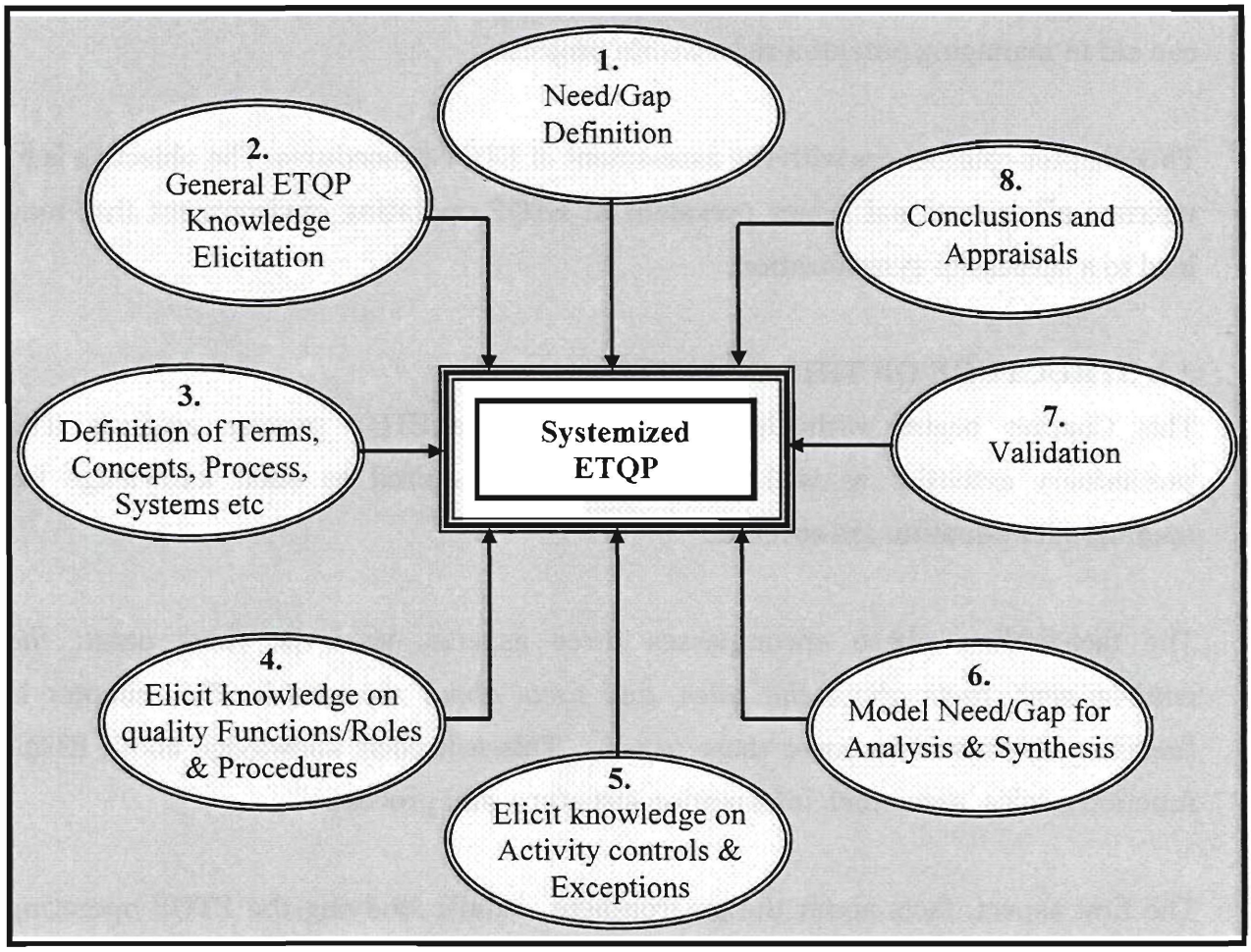


Figure 3-1: Research mind map

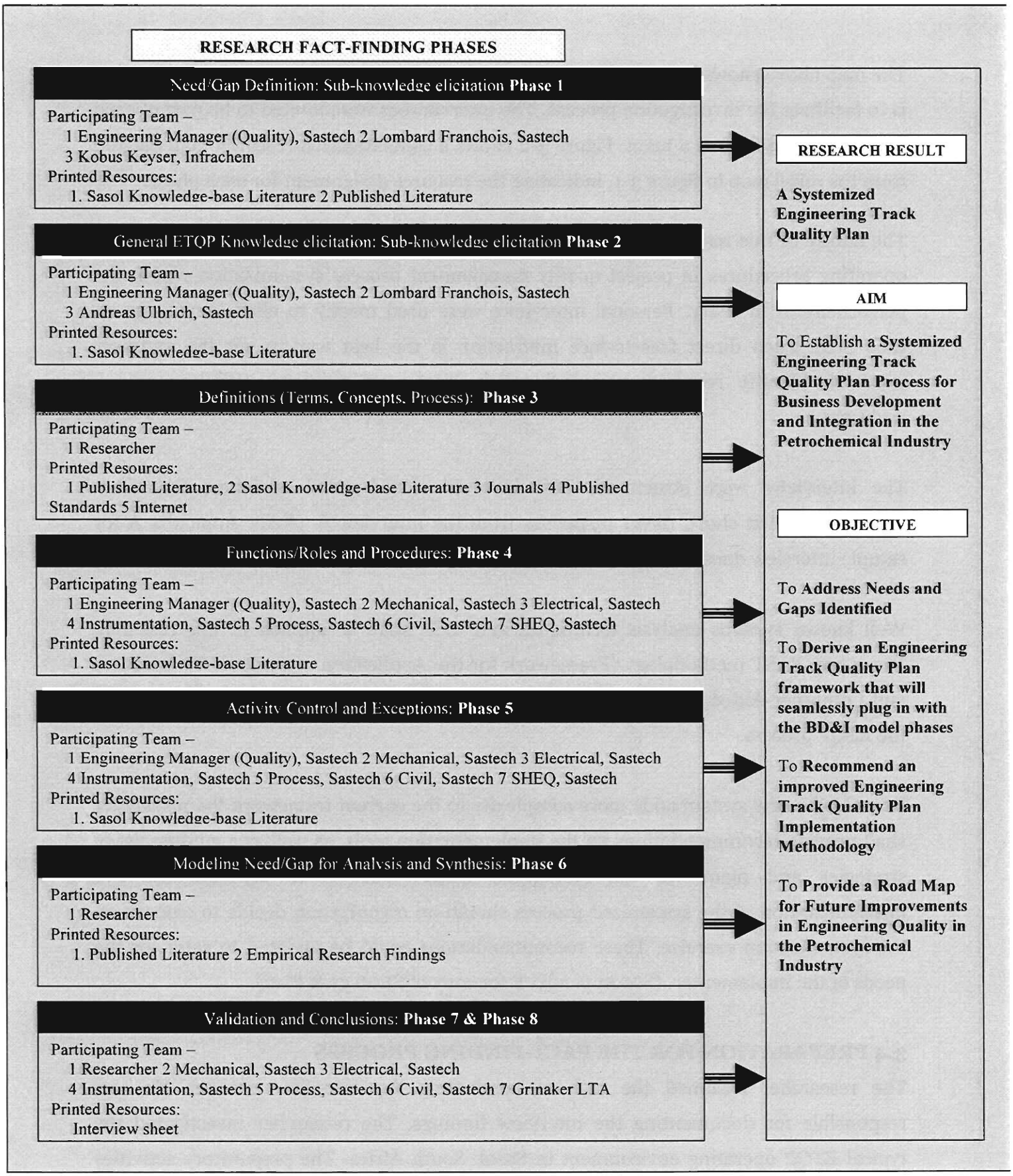


Figure 3-2: Research Map Fact-Finding Phases

The map above shows how the fact-finding has been broken down into sub-phases. This is to facilitate the investigation process. The interviewees were invited to be part of each phase of discussion, as a team. Figure 3-2 shows a contextualized research map derived from the mind map in figure 3-1, indicating the resource assignment for each phase.

The nature of this research, therefore, was empirical and intended to establish the best operating procedures in project quality management process systemization within the petrochemical industry. Personal interviews were used mostly to elicit knowledge on each area. Such direct face-to-face interaction is the best way to get the end-user involved, identify requirements, and solicit ideas and opinions. (Whitten et. al, 2004:250)

The interviews were structured. This involved closed-ended questions that were designed to elicit short, direct responses from the interviewee. (Refer Appendix A for sample interview questions used for this research)

Well known systems analysis techniques and tools shall be applied in this research. These are: FAST methodology (Framework for the Application of Systems Techniques) and Computer-Aided Systems Engineering (CASE) tools. These shall be used to model the ETQP process.

Because the new system adds more complexity to the current framework the researcher shall provide recommendations on the implementation tools, as well as a guiding list of strategies and plans for the systemized ETQP. This is to facilitate the live implementation of the systemized process should an organization decide to embark on the systemization exercise. These recommendations could be updated to cater for the needs of the implementer. (See Appendix E for copy of Strategy & Plan)

3.4 PREPARATION FOR THE FACT-FINDING PROCESS

The researcher assumed the task of conducting the interview process. He was responsible for documenting the interview findings. The researcher investigated the typical ETQP operating environment in Sasol, South Africa. The preparatory activities for the exercise included soliciting management participation. The researcher obtained

the necessary permissions from those responsible and limited the scope of the study to ETQP only.

The next section covers the findings from the knowledge elicitation phase.

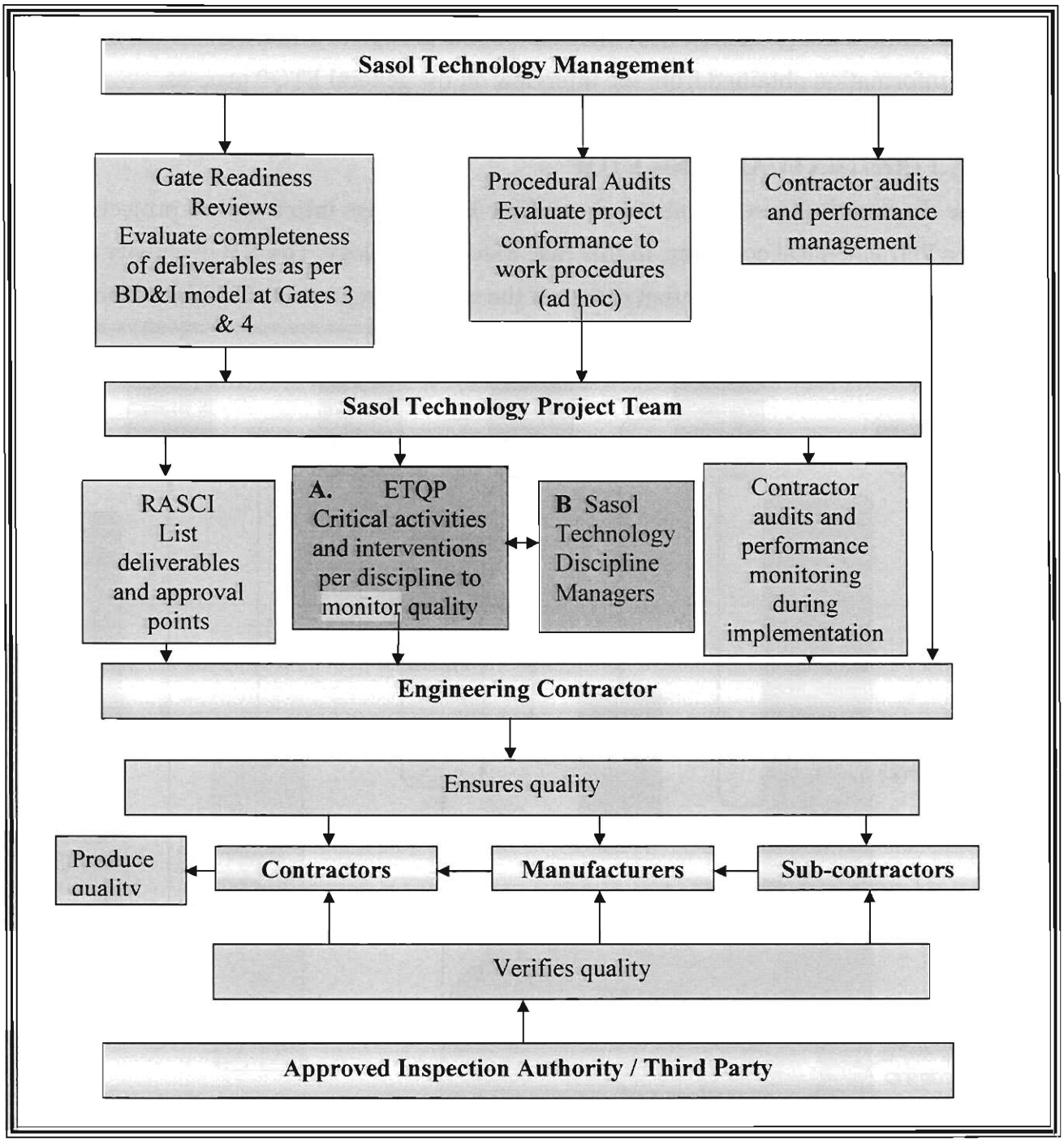


Figure 3-3: ETQP in context (EP, 2006)

3.5 FACTS ABOUT ENGINEERING TRACK QUALITY PLAN ENVIRONMENT

The ETQP process is a group of quality activities that focuses on checking for completeness and conformance to standards based on the following quality functional areas: Electrical engineering, Mechanical Engineering, Civil Engineering, Control Engineering, and Safety Health & Environment (SH&E). The facts about the ETQP environment are presented with these functional groups in mind. First is the overview of the information obtained from the interview on the general ETQP process.

3.5.1 CONTEXTUALIZING ETQP

The diagram in figure 3-3 above shows how ETQP plugs into a typical project executed by a Petrochemical company, in this case Sasol Technology. The ETQP activity is labeled A. The discipline engineers that carry out the work are represented in block labeled B.

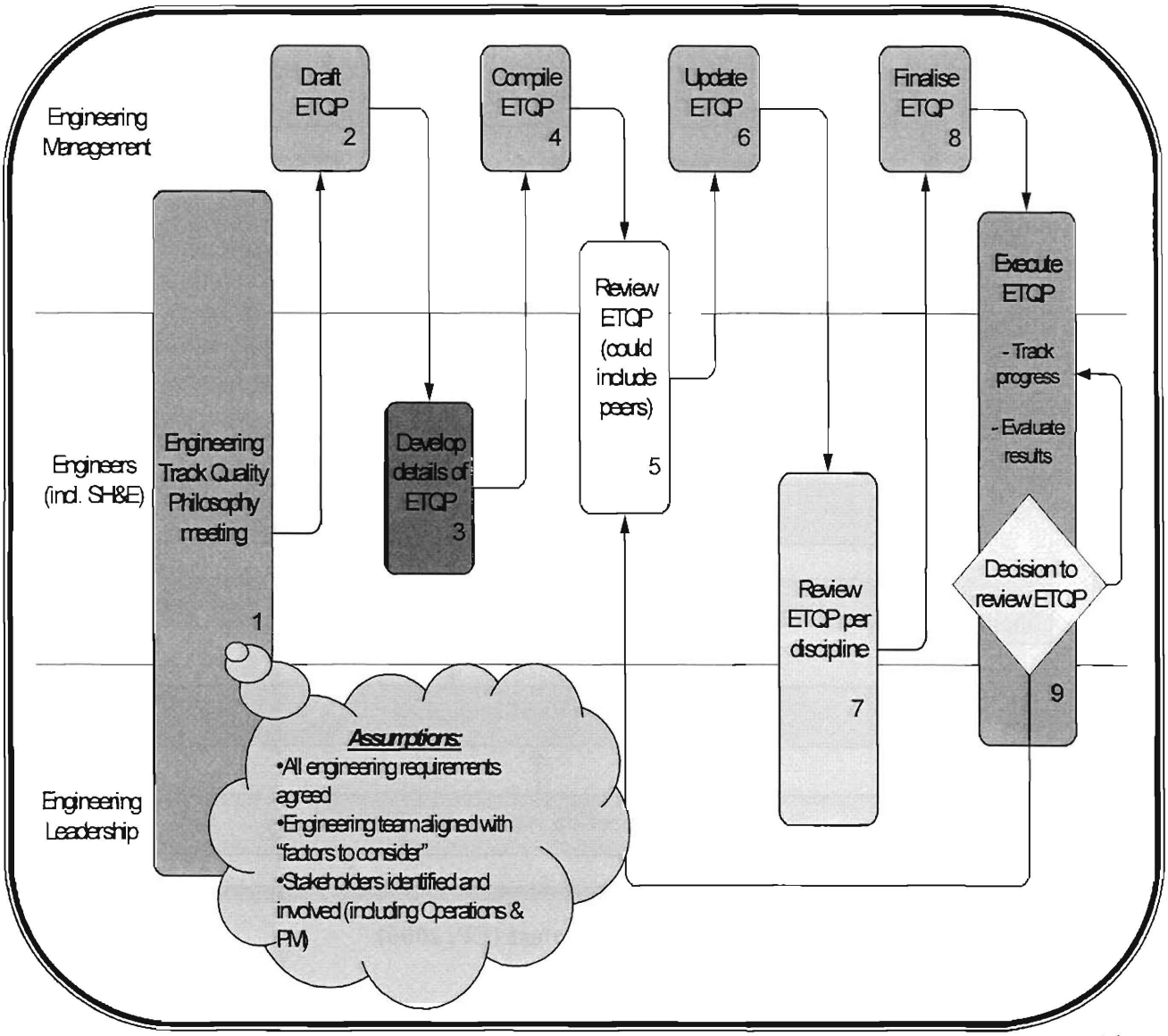


Figure 3-4: The ETQP Compilation Process (EP, 2006)

The flow diagram in figure 3-4 represents the compilation process of ETQP. It starts with a philosophy meeting and ends with tracking and evaluation during which a review decision could be taken. The next section elaborates further facts obtained about ETQP.

3.5.2 GENERAL ENGINEERING TRACK QUALITY PLAN FACTS

From Phase 1 and Phase 2 of the knowledge elicitation exercise, as represented in figure 3-2, it is obtained that the engineering track quality process starts with a Project Framing Meeting and ends with the endorsement of the final quality deliverables. Responses from the team interview sessions and review of related documentation gave rise to the ensuing guidelines on ETQP process. Appendix D.1 indicates the context environment and Appendix D.2 shows the activity sequence headers.
The following section expounds on the guidelines for ETQP.

3.5.2.1 ENGINEERING TRACK QUALITY PLANNING

QMS/336-Rev1 (2006) and QMS/941-Rev1 (2003) are good sources for ETQP quality planning. This along with responses from interviewees gave the comprehensive knowledge elicited here below. ETQP is by nature a customized tool packaged to suit the needs of specific projects. It consists of the following procedures:

3.5.2.1.1 IDENTIFICATION OF STAKEHOLDERS

The stakeholders in the context of ETQP are those with an interest in the quality of the engineering track deliverables of the project. This includes the project manager, owner engineering manager, discipline managers and plant owners or operations representatives.

3.5.2.1.2 FRAMING (PREPARATION)

This activity entails a formal workshop or well structured communication session – for ETQP not the project framing. It is called a framing meeting. This meeting is conducted as soon as project framing is completed. This meeting is one of the most important meetings that the owner engineering manager will conduct. Careful consideration must be given to getting the right stakeholders involved (PFA, 2006).

The owner engineering manager facilitates the preparation in whichever way is appropriate for the specific project. He determines the agenda and participation for this meeting. He sets and documents the meeting. He gets the right stakeholders involved in the meeting.

To help him in this process he could consult the project frame established by the business owner. He also uses the framing meeting minutes, the project objective, the project execution plan, the framing checklist and the BD&I model to address the various complexities of this function. After the meeting, the completed framing meeting checklist is used to produce a roadmap for the BD&I application in the project implementation. (See Appendix B for a sample quick framing checklist)

3.5.2.1.3 COMPILATION OF ETQP

The owner engineering manager initiates this action. He facilitates the engineering track quality philosophy meeting and subsequently compiles the general section of the ETQP (see section 3.5.1.2) He further facilitates the participation of the various stakeholders in providing the specific contents for inclusion into the ETQP (QMS/941-Rev1, 2003). It is the responsibility of the discipline engineers to ensure that the content of each discipline is appropriate to the projects objectives and constraints (QMS/336-Rev1, 2006).

3.5.2.1.4 ETQP IMPLEMENTATION

According to QMS/941-Rev1 (2003), once the ETQP has been compiled it should be implemented as planned by all involved. The details of the plan are documented in the ETQP and signed into the contract as a baseline for execution.

3.5.2.1.5 TRACKING ETQP PROGRESS

It is recommended, as stated by QMS/941-Rev1 (2003:11), that a practical means of tracking progress and compliance against the plan should be followed. This could be to manage identified actions as typical next steps which are planned and signed off upon completion. **The owner engineering manager should institute whichever means are appropriate to the project.** High level critical deviations from expected quality and proposed actions are reported by the owner engineering manager to the Project Steering Committee (PSC).

3.5.2.1.6 UPDATING THE ETQP

For any changes or deviations observed at the lower level, this should be reported by the project team to the Owner engineering manager, and any possible revisit of the ETQP should be made and updated if required, and as stated in preceding paragraphs the owner engineering manager intimates the PSC of the changes.

3.5.2.2 MINIMUM REQUIREMENT FOR ENGINEERING TRACK QUALITY PLAN DOCUMENT

As a starting point guide and a tool, the following are the minimum required sections in an ETQP.

3.5.2.2.1 GENERAL SECTION: This, like every other project plan, contains amongst other things, the background, the quality management philosophy, definition of terms, purpose, scope etc (QMS/941-Rev1, 2003:12). Other aspects to be addressed are the engineering contractor's quality plan and the project teams internal and external audits.

3.5.2.2.2 INTERVENTIONS AND ACTIVITIES: This involves the various reviews carried out. It applies to all or most disciplines, but listed in separate sections in the plan from those which apply to individual disciplines. The Owner engineering manager is responsible for separating the cross-discipline interventions. Formulation of interventions and activities should be done with at least a verb and a noun (QMS/941-Rev1, 2003) and could contain details like equipment numbers, tags, vendors, level of involvement or participation, depth of review etc. (Refer Figure 3-6)

3.5.2.2.3 ROLES AND RESPONSIBILITIES: Clearly defined roles and responsibilities should be defined using a proper RASCI chart or in narrative form within the general as well as the specific discipline sections. (See Appendix C for a sample RASCI chart)

3.5.2.2.4 PLANNING: Interventions and Activities should be planned properly. This should emanate from the project's overall plan so that it will tie up with predetermined milestones and the gates in the BD&I model.

The Owner engineering manager and the project manager are responsible for the compilation of the plan, known as ETQP. They ensure that the Project and ETQP interfaces, and complements each other.

3.6 ETQP FUNCTIONAL DISCIPLINES

The various disciplines involved in ETQP are: Electrical Engineering, Mechanical Engineering, Civil Engineering, Control Engineering, Safety Health & Environment, and Legal.

Each of these has got detailed operating procedures as set out in their respective quality manuals. During the preparation and compilation phases of ETQP, the various heads affected by the project participate in the framing and plan development. (Refer section 3.5.2)

The following section outlines the activity glossary for these disciplines.

3.6.1 GLOSSARY OF ETQP FUNCTIONAL ACTIVITIES

The glossary is contained in table 4-1 section 4.3. It is obtained from the standard control checklists in Sastech's work procedure manuals and forms the interface procedures for quality checks. The RASCI chart for the activities is in Appendix C. The engineering disciplines in the RASCI represent all the personnel in the engineering department involved in ETQP. This is usually headed by an engineering manager, and has one or more discipline engineers and/or technicians.

The glossary shows the *Actor* (the person that carries out the action), and the *Activity Description*. It is worth noting here that the activity modeling is kept at the high-level because the low level activities are implementation specific. The researcher is leaving out this detail since organisations have different implementation approaches well outlined for their peculiar environment.

3.7 EXECUTION FLOW

ETQP execution follows the recommended flow in the quality management plan (QMS/336-Rev1, 2006). The adaptation is shown in figure 3-5. The framework

mentioned in section 4.3 chapter 4 is representative of these workflows. The Quality Review process is depicted by the diagram in figure 3-6.

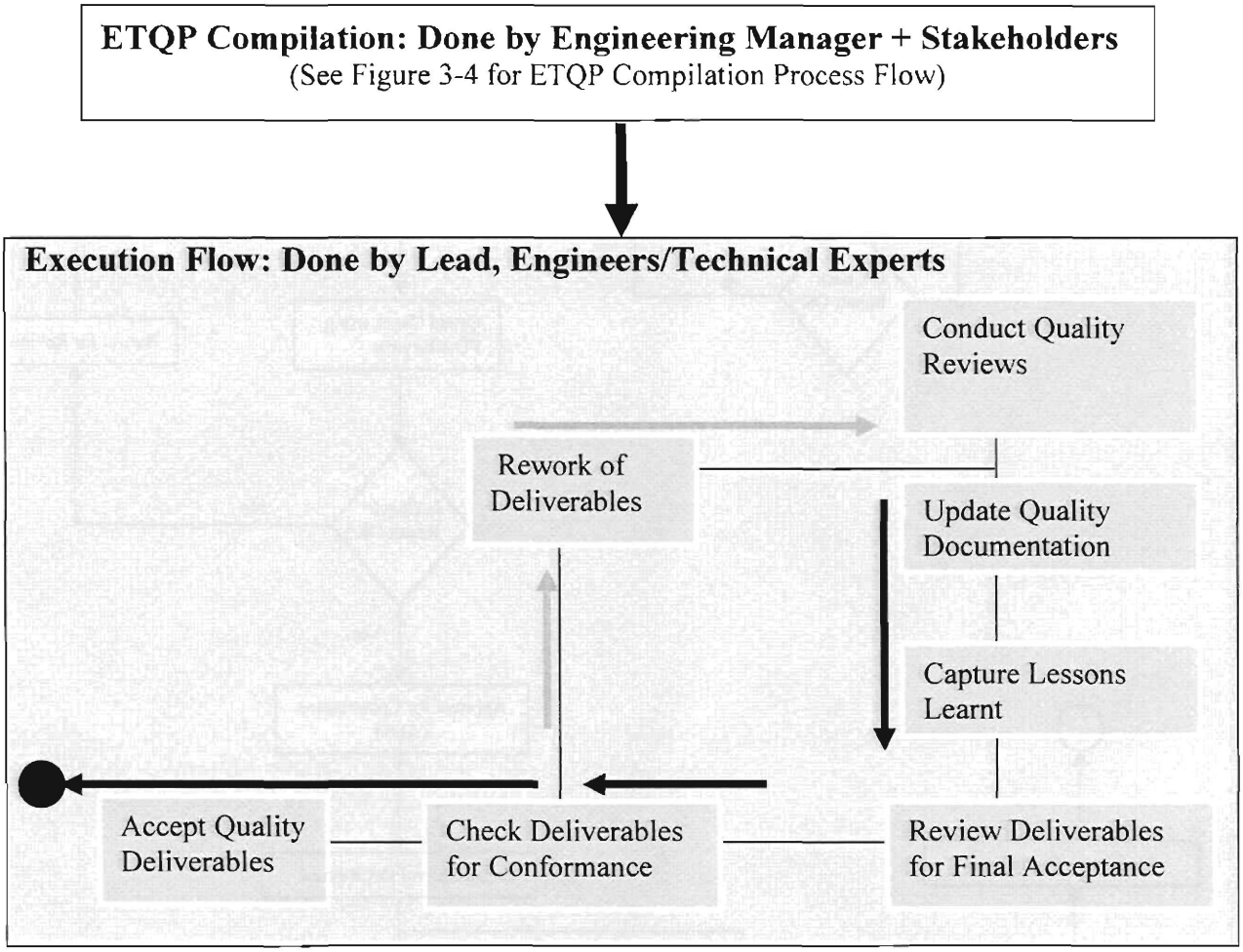


Figure 3-5: ETQP Execution Flow

3.8 CONCLUSION

Information presented in this chapter covers the details obtained from the fact-finding teams in Phase 1 through Phase 5 of the mind map (Refer figure 3-2, section 3.3). The overall quality review process as obtained from the various fact-finding teams gave rise to the Quality Review Process depicted is figure 3-6. It is the researcher's graphical description of the review process and has been certified by the Owner engineering manager Quality (Sastech) and other participating professionals (Kobus Straus, 2006).

The next chapter covers the 6th Phase, where the analysis and synthesis of the procedure is carried out and solution provided for the systemization framework.

Quality Review Process

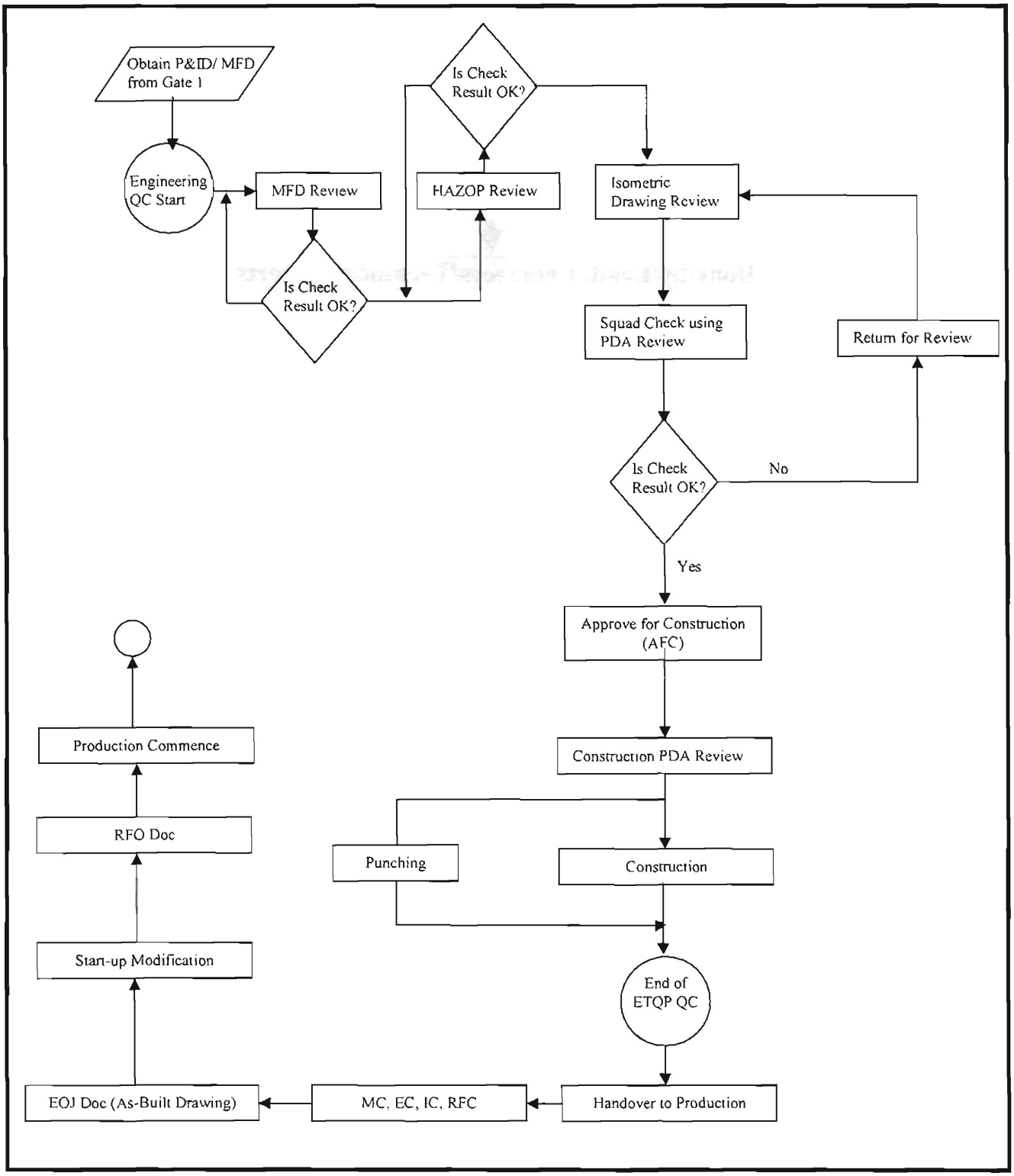


Figure 3-6: Created from research Information on quality and checked by Quality Manager (Sastech)

CHAPTER FOUR

DEVELOPING THE QUALITY MANAGEMENT PROCESS FRAMEWORK

CHAPTER FOUR

4.0 ANALYSIS OF ETQP SYSTEMIZATION

4.1 STRUCTURE OF THIS CHAPTER

This chapter presents a logical development of a systemized quality process by first highlighting the scientific methodology applied in the research process. Afterwards a solution system is presented that aim to systemize the current decision making cycle for ETQP as outlined in chapter 3. This then gave rise to a systemized ETQP.

An integration of the current practice into the systemized framework shall be made. Finally, a structured approach is followed in creating a systemized framework where-in all associated engineering quality professionals and service providers could optimize their potentials through simplified controls and aligned operational focus. The resulting ETQP process shall aim to align with the existing BD&I Model. This Integration will be the concluding part of the standardization[1] exercise.

The framework for this study is structured to accommodate the key disciplines - electrical engineering, mechanical engineering, civil engineering, control engineering, and SH&E system. Knowledge on each area shall be elicited and proper technical orientation defined to align with the objectives of this work. To aid the decision making, appropriate strategy and plan was outlined to support the desired action of all affected parties. (See Appendix E)

4.2 ANALYSIS OF ETQP PROCESS

The researcher carried out this exercise by employing scientific tools and techniques. For the purpose of this research, the FAST technique was used, and the modeling was carried out using a CASE tool. For the modeling of the solution, a system modeling tool called *Event Studio* was used (other alternatives are *System Architect or Visual Analyst*). Reason being that these tools has well researched quality management tools for Rapid Application Development (RAD) (Whitten et. al, 2001: 108-109).

The researcher decided to consult a number of individuals making up an analysis team. A small analysis team comprising Sastech IMS personnel, and two ETQP personnel was

[1] *The ETQP process is being standardized through systemization*

consulted. The team was informed of the true meaning and objective of ETQP systemization (see sections 1.1.2, 1.2.2 and 2.3) and introduced to system analysis modeling techniques used. Further, they were enlightened on the use and function of the modeling software.

The next section covers the information analysis phase of this research work.

4.3 MODELING KEY INFORMATION STRUCTURE AND ROLES

To systemize the ETQP process the next work that has to be done is to model the key information structure and procedure. In chapter 2 the details of the fact-finding phases were presented as a background to analyzing the system. Following the information the researcher gathered from that process, the activity glossary, as depicted in table 4-1 was deducted.

The glossary was derived from the RASCI chart in Appendix C. The engineering disciplines in the RASCI represent all the personnel in the engineering departments involved in ETQP. This is usually headed by a lead engineer, and has one or more junior engineers and/or technicians.

Table 4-1 shows the *Actor* (the person that carries out the action), and the *Activity Description*. According to the requirement for defining roles as specified in QMS/941-Rev1 (2003), (see section 3.5.2.2), the Actor (typically the first column) represents the *noun* and the Activity column (typically the second column) represents the *verb*.

Table 4-1: ETQP Activity Glossary

No.	Actors	Activity Description	Comments
1	Project Team	**Compiles** ETQP	
2	Factor Change	**Triggers** Revision of ETQP	Factors that influence trigger include: Business frame, Contracting strategy, Technology, Critical Deliverables, Project Risks, Contractors and Suppliers, Sasol Team, License Requirements, Statutory Requirements, Level of Integration with other contractors on the same

			site, Guarantee.
3	Project Team	**Revises** ETQP	
4	Owner Engineering Manager + Project Team	**Plan** ETQP Compilation Date	Before a project phase is started, the ETQP framework for that phase should be ready i.e. Feasibility Phase, Basic Development Phase, and Execution Phase.
5	Owner Engineering Manager	**Compiles** ETQP	Flow diagram in figure 3-4 Chapter 3 is for the work flow of compiling ETQP
6	Owner Engineering Manager	**Aligns** ETQP	
7	Owner Engineering Manager	**Implements** ETQP	
8	Each Project Team Member	**Develops** his/her disciplines ETQP content	Discipline include: Electrical, mechanical, Control, Civil Engineering, and SH&E
9	Discipline Managers	**Accounts for** content of discipline Engineer's portion of ETQP	
10	Discipline Managers	**Participates in** review of Compiling and Implementing ETQP	
11	Discipline Managers	**Participates in** the approval cycle of compiling and implementing ETQP	
12	Discipline Managers	**Ensures** discipline engineers possess required skill to fulfill their functions	
13	Owner Engineering Manager	**Facilitates** Framing Meeting	
14	Owner Engineering Manager	**Obtains** deviation Report from low level officers	
15	Owner Engineering Manager	**Reports** deviation to Project Steering Committee	
16	Owner Engineering Manager	**Reports** proposed actions to Project Steering Committee	
17	Owner Engineering Manager	**Creates** new revisions in ETQP	He is part of the project team in activity No. 1

18	Owner Engineering Manager	Separately **Lists** cross discipline Interventions and activities	E.g. Mechanical Flow Diagram Review with Engineering contractors (Figure 3-6)
19	Owner Engineering Manager	Separately **Lists** individual disciplines Interventions and activities	E.g. Review Datasheets of Centrifugal Pumps
20	Owner Engineering Manager	**Compiles** RASCI chart of responsibilities and Roles	Appendix C
21	Owner Engineering Manager	**Formulates** Interventions and activities	Uses Verbs and Nouns. This should include details like equipment tag numbers, vendors, quantities of deliverables to be reviewed, level of involvement or participation in an intervention, depth of review etc.

The modeled framework for the above activities is shown in appendix D. These were created using Event Studio. It shows the activity flow pattern for ETQP.

4.4 HIGHLIGHTS FROM INVESTIGATING THE ETQP PROCESS

Having defined the activity flow model in section 4.3, this section aims to highlight a key observation that gave rise to the proposed solution. This will help establish the flow of the systemized activities. (Section 4.5)

It is often known that processes could be too long, too short and unrealistic, demonstrate a poor awareness of the issues, have a fear of failure built in them, or reveal a poor perception of the real issues needing to be addressed (Holt J., 2006); as such it has to be developed to an acceptable level (Juran & Gryna, 1988). From the study so far the non-systemized process currently being practiced contains one or more of these attributes.

Systemization provides a framework to combat complexity, lack of understanding, and communication problems. The systemization of ETQP and the integration thereof made this process standout through out the development cycle. The resulting structure

ensured that ETQP activities receive needed attention and are continuously being improved.

It was also observed during the course of this research that ETQP activities stop before the business development process gets to the production phase (See figure 3-6, Chapter 3). The owner business implements a quality process of choice to manage the long term operations.

4.5 DEVELOPMENT OF THE SYSTEMIZED SOLUTION

Having come this far in the research process, it is vital to say here that the vulnerabilities identified in chapter 1 as highlighted in section 4.4 above were addresses in the new system as modeled in section 4.3, appendix D. To be able to address the constant growth in quality that will continuously bridge the gap created by quality demands, there has to be operational re-alignments. This is because it is obvious that:

- The current system does not have an optimum approach for handling unprecedented requirement that grows and shrinks with changes. For instance, personnel turnover can slow down workflow because of the *forming, storming,* and *"norming"* phases of development (Steyn H. et al, 2006);
- The current system needs a relatively fixed set of standards as a take-off point for implementation;
- With the aforementioned, there is an inherent risk of loss which attracts cost (either in terms of cash or resources); this has to be addressed so as to align the deviations that could occur with expected performance.
- ETQP does not run through to production, which is vital for total quality management.

Following this, the ensuing sections presents a structure that is aimed at addressing these concerns and positioning the engineering track quality process as a standardized activity, with all the systemization characteristics listed in chapter 2.

Because ETQP defines new combination of solution steps for every project, it's imperative that every project follows a different development route to completion

(Lombard F., 2006). This being the case, as verified by the Engineering Manager in charge of ETQP in Sastech, a model shall be developed to define the building blocks for this process structure. The sequential build up of concepts that led to the development of this framework is presented next.

4.5.1 DEFINITION OF THE PROPOSED SOLUTION

As mentioned earlier the solution proposed will now be developed. This will be done by mapping the ETQP activities against the SE process. At the end a further integration shall be done by defining the ETQP process as a standalone track plugged into the BD&I model.

4.5.1.1 ETQP PROCESS INPUT AND OUTPUT

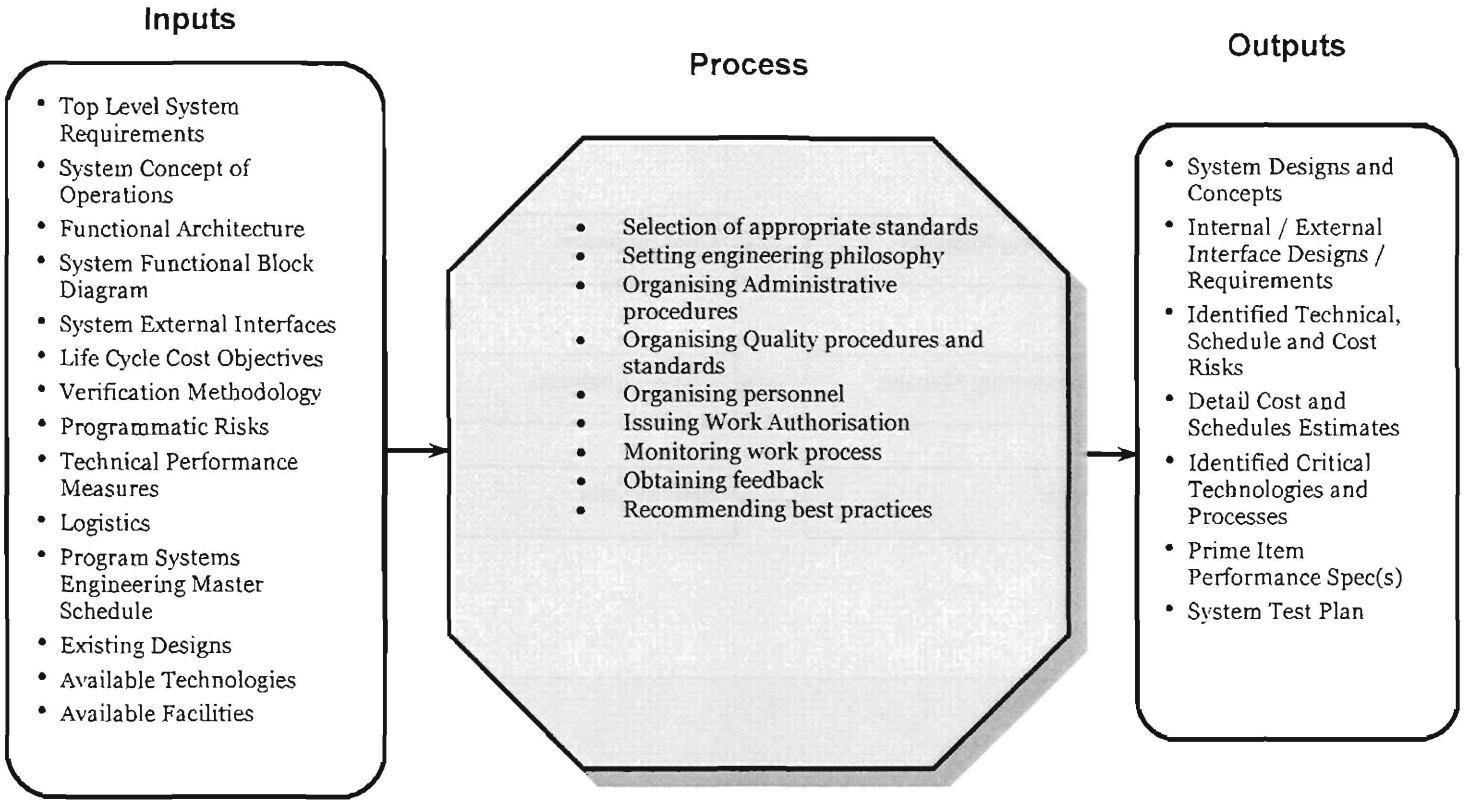


Figure 4-1: Adaptation based on original model from Meshel D.C (2007)

This is an overview of the proposed ETQP process. At this level of analysis a general view of the inputs, outputs, and the process are apparent. Subsequent sections will expound on these.

4.5.1.2 ETQP FUNCTIONAL BREAKDOWN

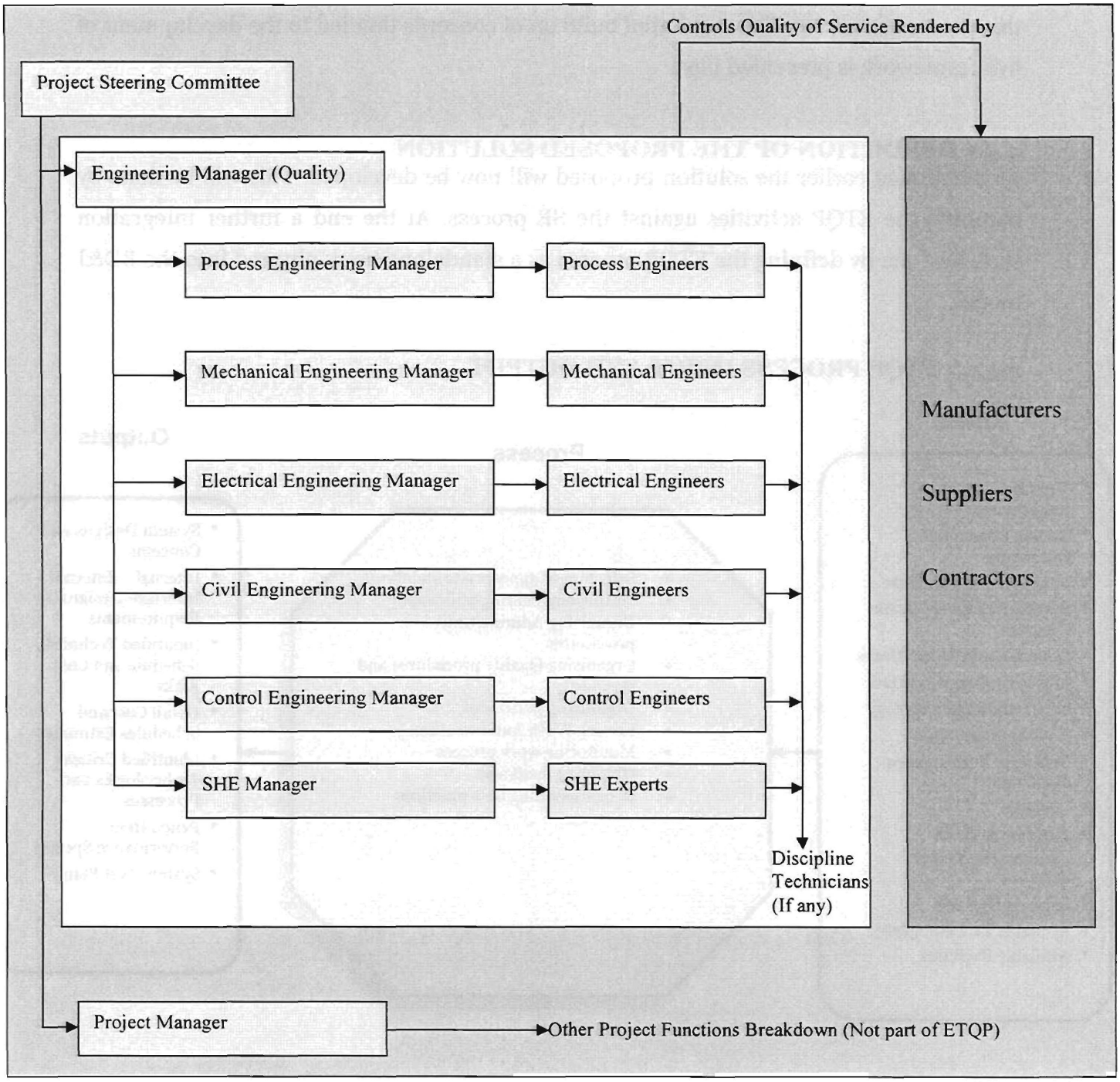


Figure 4-2

4.5.1.3 STANDARD ETQP FUNCTIONAL FLOW AND PHASE DEFINITION

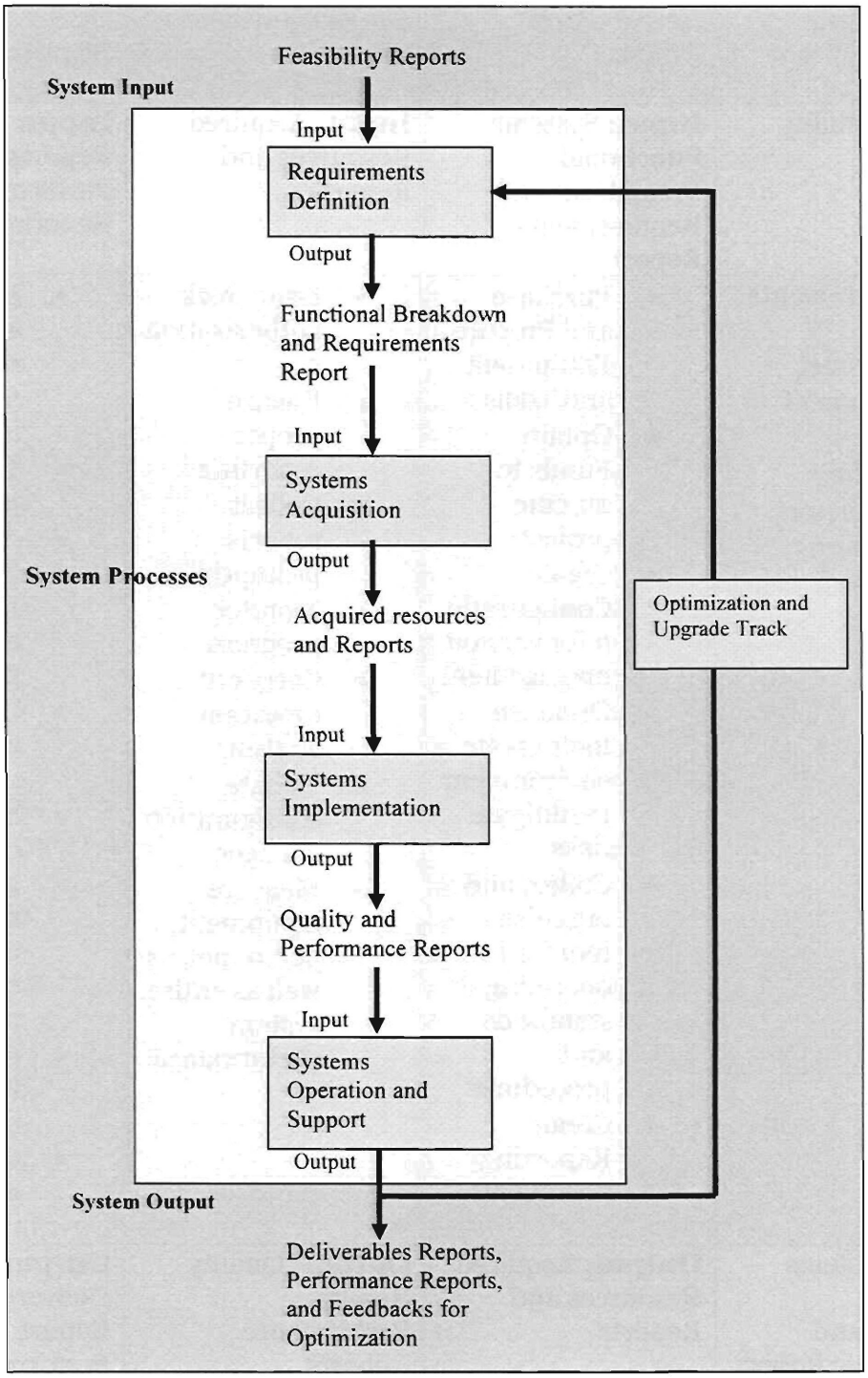


Figure 4-3

In the flow indicated, the output of one subsystem becomes the input of the next subsystem. The final output forms the deliverable expected from the entire process. A provision is made for redirecting any observations that could lead to optimization through the whole system again starting from requirements definition.

The details of the phase activities for the system defined in figure 4-2 are shown below.

Requirements Definition Phase	**Acquisition Phase**	**Implementation Phase**	**Operations Support Phase**
Input: Feasibility Report	**Input:** Systems Functional Breakdown and Requirements Report	**Input:** Acquired Resources and Reports	**Input:** Quality Reports, Performance Reports
Define requirements for: • Personnel • Equipment • Tools • Suppliers • Contractors • Standards • Finance • Risks	• Purchase and Procure Equipment and Tools • Obtain Funds to execute project • Create Configuration for version management • Organize tools create environment to mitigate risks • Collect and organize required operating standards and procedures • Create Reporting documents	• Issue work authorizations • Ensure proper reporting • Collect reports promptly • Monitor progress • Carry out deviation analysis • Update configuration changes • Measure equipment, personnel, as well as entire system performance	• Ensure adequate reporting of quality issues • Tune system makeup • Apply phases I – III in maintenance process • Update configuration changes • Measure equipment, personnel, as well as entire system performance • Collect feedbacks on deliverables • Optimize where necessary
Output: Systems Functional Breakdown and Requirements Report	**Output:** Acquired Resources and Reports	**Output:** Quality Reports, Performance Reports	**Output:** Deliverables Report, Performance Report, and Feedbacks for Optimization



Table 4-2: ETQP Phase Definitions

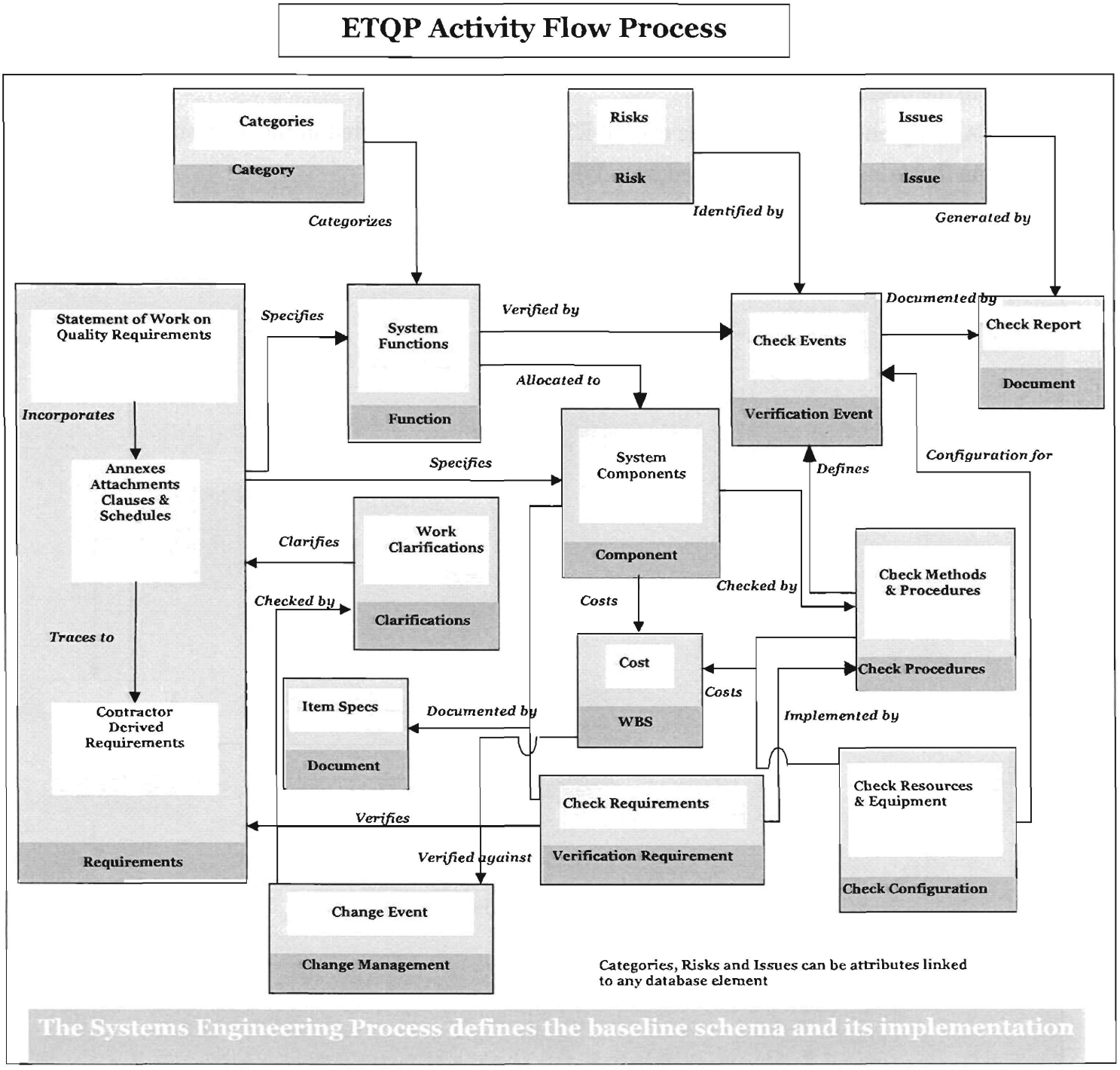


Figure 4-4: Adapted From Meshel D.C (2007)

In figure 4-4 flow diagram each component of the system is made up of an element that could represent a data store, and an overall activity element. The activity lines contain verbs that help describe the functions performed by each system component. The *Document* component represents the repository where specifications, check reports, standards, and procedures are stored. It is central to the system since any of

the system attributes could be linked to it at any point. This perspective is presented in the overall process.

A comprehensive view of the overall ETQP process is depicted in the diagram shown in figure 4-5 below as adapted from Whitten et al (2001).

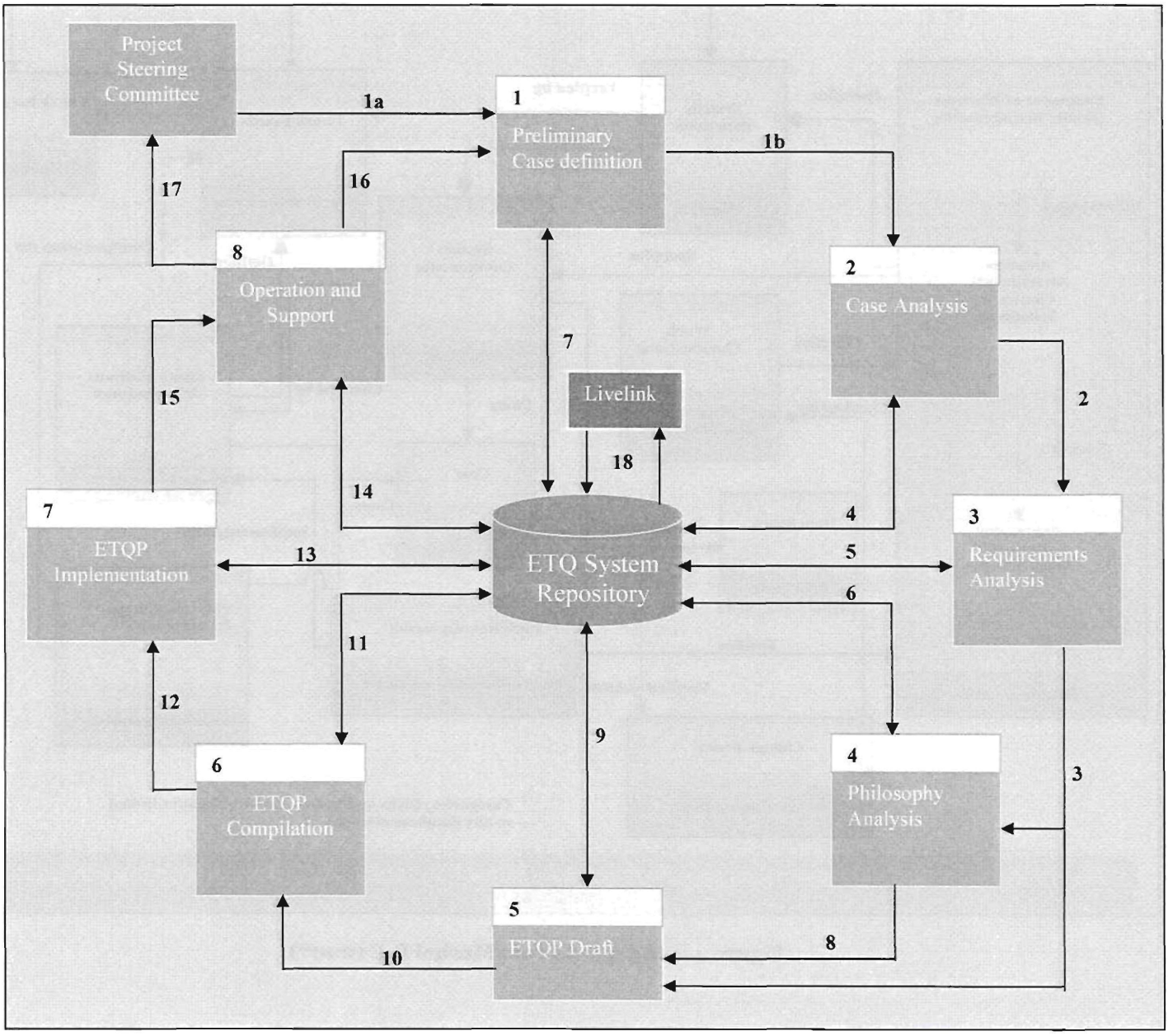


Figure 4-5

The activity glossary is presented in table 4-2, page 62. Appendix F shows a detailed process for any activity or function.

Table 4-3: Activity Breakdown

Activity No.	Actors	Activity Description
1a	Project Committee	Issues directives on work to be done
1b	Project Team	Documents work definition
2	Framing Committee	Draw-up deliverables and implementation objectives
3	Framing Committee	Compiles quality requirements statement
4	Framing Committee	Identify facts, causes and effects
5	Discipline Managers	Set discipline specific requirements and priorities
6	Discipline Managers	Outline ideas, presentations, procedures
7	Discipline Managers	Draft work scope, constraints, participation, budget, schedule
8	Owner Engineering Manager (Quality)	Outlines Approved Engineering Philosophies
9	Framing Committee	Specifies general standards, ideas and opinions
10	Owner Engineering Manager (Quality)	Obtains Engineering Track Quality Plan design specifications
11	Discipline Managers	Obtains Feedback, Reviews and Tests
12	Owner Engineering Manager (Quality)	Document compiled quality plan and implementation guidelines
13	Discipline Managers	Effect documentation of procedures for training and re-training
14	Discipline Managers	Relay feedbacks, deliverables problems, lessons to Engineering Manager (Quality)
15	Discipline Engineers/ Technical Specialists	Conduct quality activities
16	Discipline Managers	Rework deliverables feedback
17	Owner Engineering Manager (Quality)	Notes and Approves accepted deliverables, deviation notifications, and solutions obtained
18	Document Controller	Updates ETQP Repository

4.5.1.4 FUNCTIONAL DESCRIPTION

In general the following descriptions define the roles that ETQP activity actors should play in implementing the solution (Whitten et. al, 2006).

4.5.1.4.1 PRELIMINARY CASE DEFINITION: At this stage preliminary investigations should be carried to visualize the scope of the project. This is critical to estimating time and costs to complete the project.

4.5.1.4.2 CASE ANALYSIS: This should be a further investigation carried out to identify problems and opportunities for improvement. This will help to reduce inefficiencies and/or bureaucratic setbacks inherent in the system.

4.5.1.4.3 REQUIREMENT ANALYSIS: The result of this analysis shows what the system must be or do independent of any possible technical implementation.

4.5.1.4.4 PHILOSOPHY ANALYSIS: The documentation produced here show not only what the system is or does, but also how the system is physically and technically implemented. It should reflect Engineering philosophies, technology choices and limitations of those technologies.

4.5.1.4.5 ETQP DRAFT: This contains quality implementation standards, procedures, schedules, structures, which serves as a blueprint for compiling and constructing the final quality plan.

4.5.1.4.6 ETQP COMPILATION: All required list of documentation for the specific project are put together, signed, and ready for authorisation for implementation to begin.

4.5.1.4.7 ETQP IMPLEMENTATION: This translates the actions defined in the compiled ETQP into expected deliverables.

4.5.1.4.8 OPERATION AND SUPPORT: During implementation it is vital to have manuals updated, personnel's trained, activities controlled and coordinated etc. This

stage of the systemized process caters for that. This is where the activity flow process is fully applied.

The activities presented in Figures 4-4 and the process shown in Figure 4-5 represent the proposed systemized ETQP approach to addressing the needs identified for business development and implementation. It defines a standard process that furnishes a continuous improvement cycle as well as an improved documentation process.

4.5.1.5 ETQP VERIFICATION AND IMPLEMENTATION

For any system to remain effective there has to be a constant means of verifying its components for efficiency and appropriateness. The activity map shown below itemizes key procedures that could form a background for further verification and implementation functions for a system like the one defined above. This is an adaptation from Meshel D.C (2007).

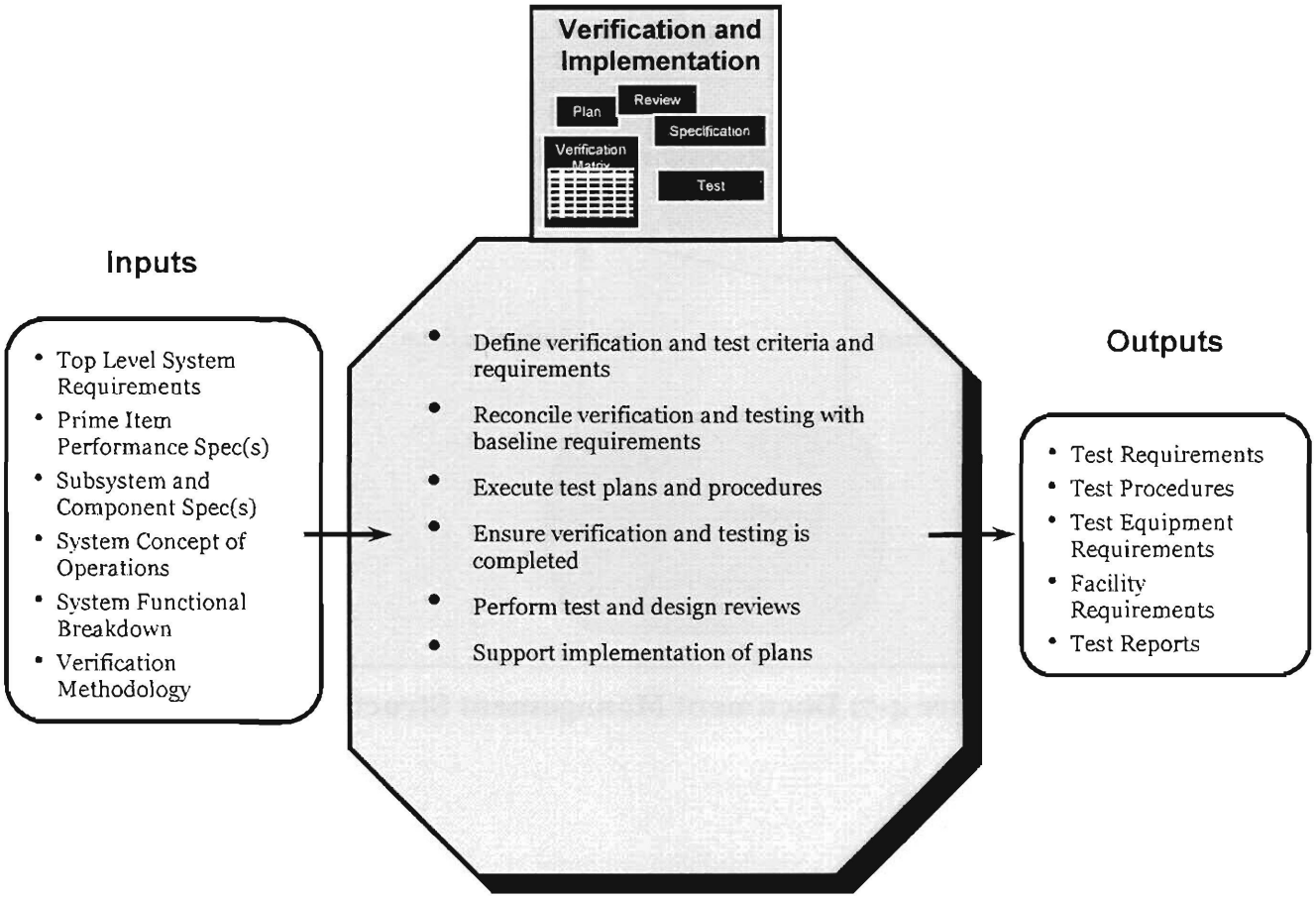


Figure 4-6: Verification and Implementation Activities (Meshel D.C, 2007)

4.6 DOCUMENT MANAGEMENT STRUCTURE

The diagram below shows the simplified structure of ETQP document management structure. As indicated in figure 4-5 the interface with "livelink" is shown relative to other activities in the process. Section 4.6.2 contains a small algorithm to maintain the configuration of the repository.

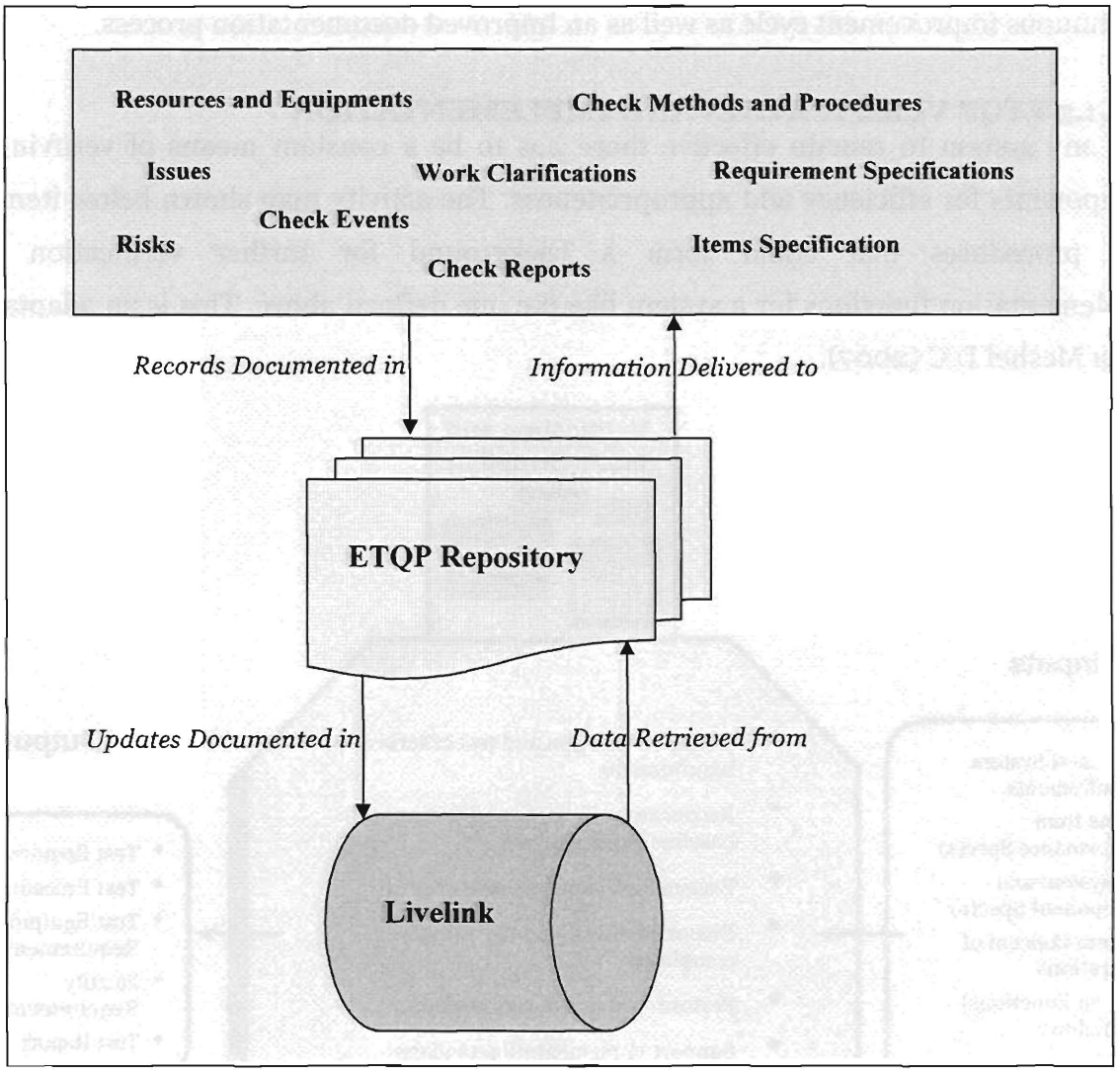


Figure 4-7: Document Management Structure

4.6.1 PROJECT INTERFACE MANAGEMENT

Framing meetings for ETQP (Refer section 3.5.2.1.2) could be used as an interface control measure to integrate the various activities taking place within the project frame. This is illustrated as shown below.

1. Business Owner (part of project committee) **establishes** the Project Frame
2. Project Manager **uses** the Project Frame + The Framing Checklist (see appendix B) + The BD&I Model to steer the Framing Meeting
3. The Project Manager
    a. **Determines** Agenda and Participation
    b. **Gets** the right stakeholders
    c. **Sets** and Documents Meeting proceedings
4. Framing Committee **uses** completed Framing meeting checklist to produce the application roadmap for the project

This should be convened at regular intervals amongst the project team to brainstorm on matters arising using the appropriate checklist.

4.6.2 REPOSITORY INTERFACE MANAGEMENT

With reference to Sasol's implementation, an interface should be designed to integrate the existing "livelink" repository with the ETQP system repository as indicated in figure 4-5 ("livelink" as used above could be any existing repository). A sample algorithm to achieve this integration is shown below. It is simply based on updating ETQP repository with regularly referenced documentations from existing repository for similar projects.

i. If a new project is **rated similar** to a previously handled project, all documentations referenced during previous execution are uploaded on ETQP repository (Framing committee will then check through and modify where necessary)
ii. If the new project is **not rated similar** to any previously handled project, all options referenced by framing committee and project team during execution are recorded against the new project and stored in ETQP.

With this, the ETQP repository will contain, at any time, an updated set of documentation that is representative of known ETQP procedures and standards.
The merits for this update are threefold.

1. Firstly, for similar projects there exist a relative set of standard procedures for the team to work with saving time and cost on framing.
2. Secondly, huge time will be saved if a new member is introduced into the team, either due to loss of an existing member or the need to increase labor force, since the systemized process has well documented set of procedures that will take a shorter time for the new entrant to acquaint himself.
3. Lastly, all participating professionals as well as the Engineering Manager will have a single view of the entire project execution. This will further enhance the focus of the project team even though the quality process grows or shrinks.

4.7 SYSTEMIZATION STRATEGY AND OPERATIONAL PLAN

The cost impact criteria, from the quality perspective, connote a high degree of impact (Refer figure 3), indicating the importance of developing a systemized strategy for ETQP. Systemized operations planning involve the actions and activities performed either to prevent poor quality or to reduce the impact or consequence of poor quality to an acceptable level. (Harrington H.J., 1987)

4.7.1 CREATION OF A SYSTEMIZED OPERATIONS STRATEGY

This activity entails the development of a long term operations strategy for the systemized ETQP framework for the company. This strategy is structured against the backdrop of the catalogue of practices already established. The ETQP systemized operations strategy appears in Appendix E.

4.7.2 CREATION OF A QUALITY LOSS MITIGATION PLAN

The focus of this activity is to reduce loss to the company's most valuable assets – *time & money*. This is a tactical action plan or countermeasure. One particular countermeasure is the systemized operations. This is planned along the activity breakdown in the work process. It is appropriate for shielding hidden losses and should be included as a fundamental countermeasure in the *quality management process infrastructure.*

The following section provides a justification for the development of the systemized engineering track quality process.

4.8 JUSTIFICATION FOR THE SYSTEMIZED ETQP

Refer section 4.5.1.4. Having come thus far, it is worthwhile highlighting the justification for this research exercise. For a fact, without belaboring the obvious,

- Quality demands within high technology projects are growing at a fast pace ;
- Quality demands could also grow or shrink, unprecedented, within short space of time;
- Systemizing operations improves performance, organisation, and reduces risk of loss (in time and/or money), thereby ensuring increased profitability.

It was also observed during the course of this research that ETQP activities stop after the business owner resumes long term operations (See figure 3-6, Chapter 3; Figure 4-9). With a well systemized ETQP process resulting from this study, possibilities exist for adequate recommendations to business owners as this will aid management of configurations and conformance to standards and accreditation (Anon-IIQMS, 2006).

It is justifiable, therefore, to propose such an effective, flexible, and profit centered quality management process that meets global standard in operations.

4.9 POST-SYSTEMIZATION ACTIVITIES

Subject to management approval, the next step involves implementing the solutions of the systemized process. This entails carrying out typical engineering track management plan activities as defined by the systemization solution. Engineering track quality management plan is a crucial activity because it succeeds the analysis phase and aids in reducing the loss of quality.

The objective of this section, therefore, is the enforcement of the systemized ETQP strategy and implementation of the systemized quality management process for business development in the petrochemical industry.

4.9.1 PLANNING HOW TO IMPLEMENT THE SYSTEMIZED ETQP

This subsection focuses on conducting the systemized ETQP management process whereby the result of the analysis could be implemented in a live project. This does not replace the current practice at the early stage of its implementation. It should only run in parallel with the existing procedure until such a time when change-over is possible.

The implementation of the systemized ETQP will involve engaging separate personnel to follow-up the quality activities using the systemized framework. The carefully designed countermeasures have to go into the deployment. At the initial stage, an organisation should develop a detailed well designed deployment plan. Chapters 3 and the preceding sections in this chapter present a comprehensive overview of such a planning process.

For the purpose of this research work, expert opinion will be sought through interviews to validate the credibility of the proposed solution for ETQP systemization. This is due to the fact that live implementation was not possible due to the sensitive nature of such operational implementations. However, the coverage of the validation process cleared all doubts as to the viability of the exercise.

4.9.2 IMPLEMENTING THE PLANS

This research presented the implementation plans, considering the constraints highlighted in section 1.4. The implementation plan for a live testing, if all conditions were right for it, was mentioned. On the other hand, the plan followed in obtaining expert views regarding this process is presented as an alternative means to validate the entire process.

4.9.2.1 LIVE IMPLEMENTATION

To implement the systemized plan it will entail:

- Setting up a project team for engineering philosophy framing activities
- Drafting a project plan of execution with well drawn up Responsibility Assignment Chart (Appendix C)
- Certifying the execution process framework, and the hierarchy of events generated (Appendix D)

- Creating awareness amongst participating parties on an ongoing basis (See section 4.11) on appropriate work procedures and strategy (Appendix E and F).
- Circulating the systemization work interface procedure documents to all ETQP personnel (see Appendix D and G for example interface procedure summary that could make up this document).
- Issuing work authorizations and monitoring activities to determine when quality of implementation deviates (Appendix G and Section 4.12)
- Continuously measuring performance and addressing feedbacks

4.9.3 EXPERT REVIEW PLAN

To obtain the view of experts the following were carried out:

- An interview was conducted
- A cross section of key individuals who represent authorities in the ETQP process were identified
- The interview instrument was used to obtain information from these experts
- Responses were analyzed and presented in chapter 5 while addressing the research questions

4.10 PROMOTING THE AWARENESS OF THE PLANS

User awareness is paramount to the successful implementation of the systemized ETQP. Users are sometimes oblivious of the quality policies, procedures and standards of the organisation. Quality boards could be introduced, where they are not already in use, to post vital information relating to the system. Emails and regular brainstorming sessions are also very helpful in creating awareness.

4.11 MONITORING THE PLANS FOR EFFECTIVENESS AND CORRECTNESS

A dedicated administrator should continuously monitor the process to see if any deviations occur. It is necessary to take reactive measures when deviations are detected. Event triggering facilities should be used to prompt for any deviations. This could also be used to monitor critical activities like gate reviews, before certain activities are allowed to proceed.

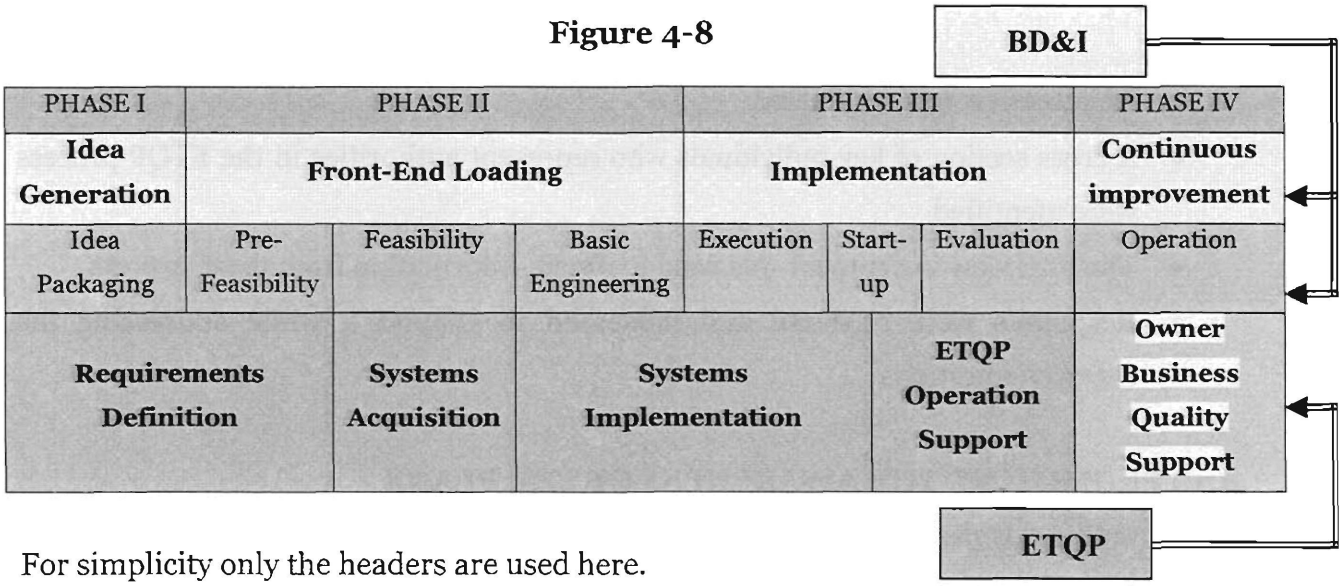
4.12 INTEGRATING THE SYSTEMIZED ETQP FRAMEWORK WITH BD&I MODEL

Having come thus far in this research process it is worth presenting a framework that aligns the new system with the existing business development and implementation model, typical of the structure used in the petrochemical industry. This will facilitate easy implementation without disrupting existing infrastructures.

The next figure shows a merge that the researcher is proposing for ETQP and BD&I.

4.13 PHASE INTEGRATION

Figure 4-8

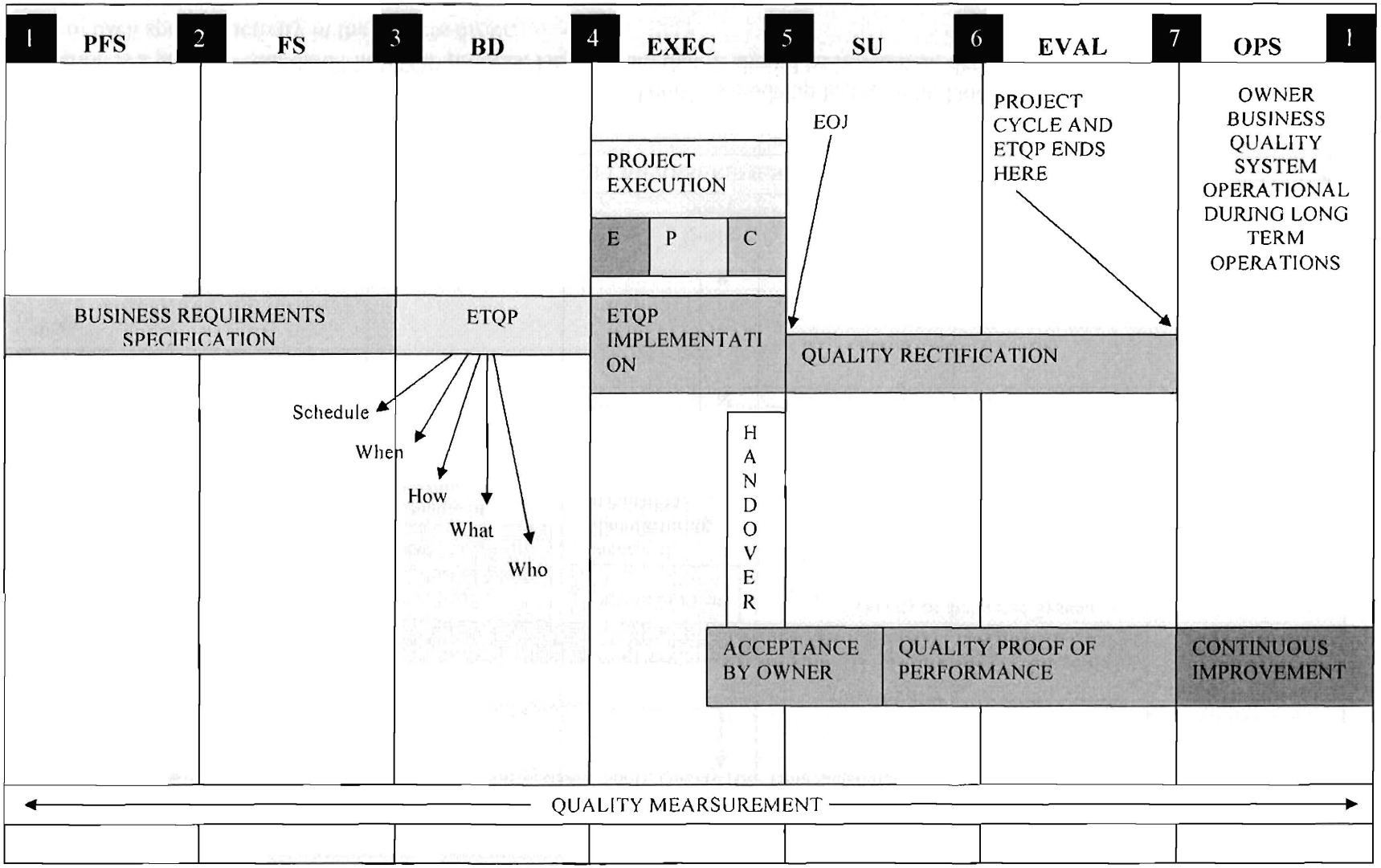


For simplicity only the headers are used here.

The headers labeled BD&I (second and third rows) are the BD&I phases while the headers Labeled ETQP (fourth row) represents the ETQP phases. The phase activities for the ETQP phases are in table 4-2. The activity flow process could be modified to match the activity profiles defined by Owner or any other implementers' quality department. The phase headers above are also subject to change to suit existing structures.

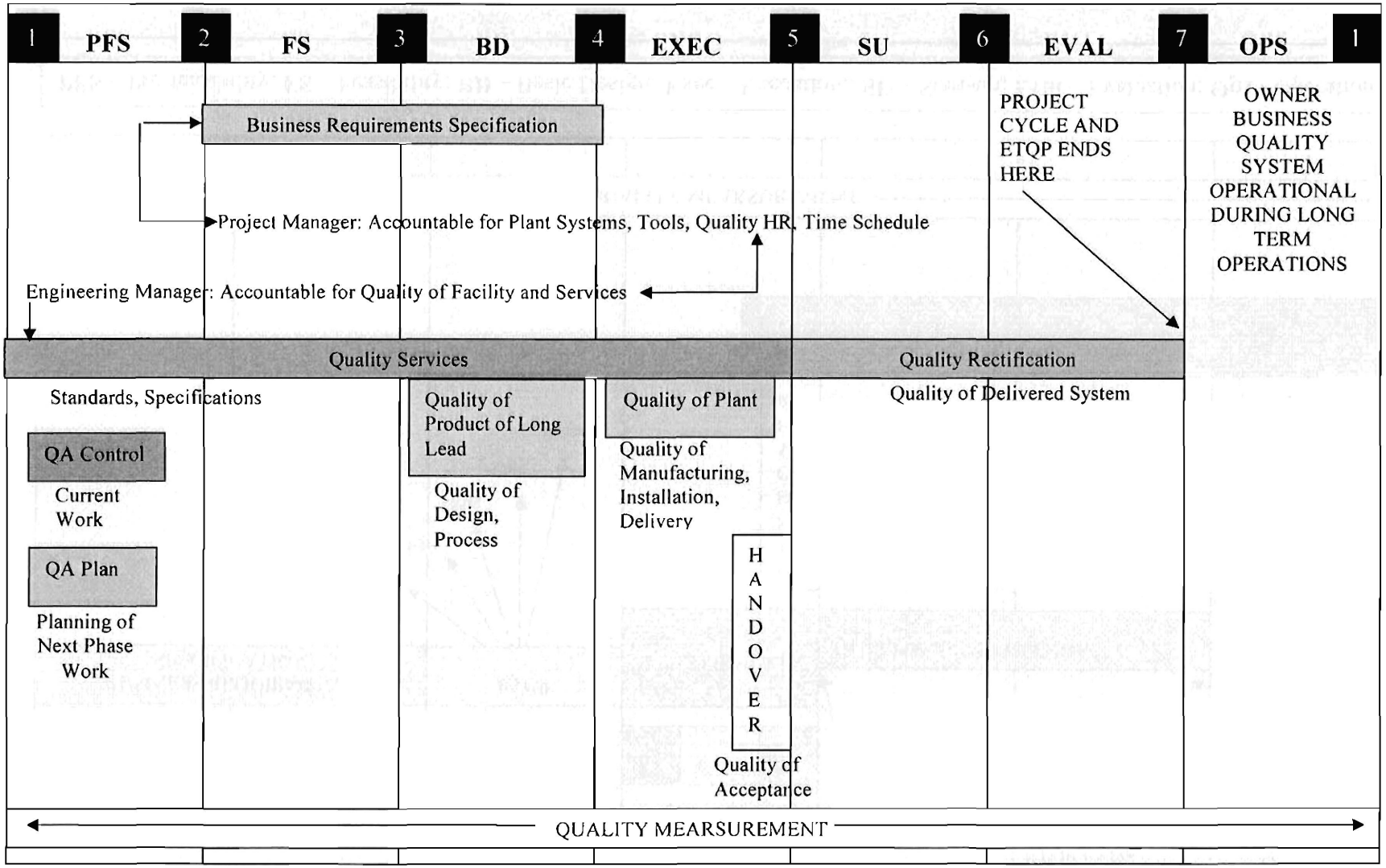
Following are further elaboration on the integration. It shows the interface between the business and project activities with ETQP. It further shows how ETQP plugs into the BD&I framework.

Figure 4-9: ETQP within BD&I Scope



PFS – Pre-feasibility; **FS** – Feasibility; **BD** – Basic Design; **Exec** – Execution,; **SU** – Start-up; **Eval** – Evaluation; **Ops** - Operations

Figure 4-10: ETQP in context with Project Management and Business Requirements Specifications



"Systems" is made up of Technology, People and Procedures. "Tools" is made up Equipment, Documents. The aforementioned proposition is a generic "Standard" in ETQP process. Having said that, it should be noted that, depending on the Contract type the details of each specific activity in the process differ.

4.14 SYSTEMIZED ETQP CONCLUDING ACTIVITIES

The following activities are the concluding activities for the systemization of ETQP for business development, and eventual integration into existing framework. It depicts some vital actions that should be taken for easy acceptance of the new system.

4.14.1 PREPARATION TO MEET WITH SENIOR MANAGEMENT: Senior management should receive the standardized systemization reports.

4.14.2 PRESENTATION OF THE SYSTEMIZED ETQP INFORMATION: Senior management should receive information regarding the modeled activities, the systemization requirements for these activities, as well as the areas of concern. Necessary reports should be generated for this purpose. The vulnerabilities will be highlighted during the demonstration. Documentation should be performed using interface procedures (See Appendix D). It would be advisable to discuss the impact of this exercise with management to facilitate improvements.

4.14.3 REVIEW AND REFINEMENT OF ETQP SYSTEMIZED PLAN: Senior management should receive the systemized ETQP strategy and plan for review and modification. This plan should be summarized as management might not have time to read voluminous reports.

4.14.4 CREATION OF SUBSEQUENT STEPS: This step terminates the ETQP systemization process. The ensuing chapter addresses the follow-up activities of this milestone. It is appropriate to review the objective of systemizing ETQP as outlined in Chapter 1 section 1.1.2 to see if the objective has been realized.

The objective of this ETQP systemization exercise is to establish an interrelated methodology for integrating the various functions in the quality management process within ETQP, with a view to improving the operational efficiency. More so, as the existing ETQP system profile indicated a low systemization impact, meaning the risk of non-systemized operation, as is most likely the case, should be mitigated (See section 1.2.3).

A systemized ETQP strategy and plan was proposed to integrate all functions and reduce risks to an acceptable level. A report on the justification for the implementation of countermeasures should be submitted to senior management for approval.

4.15 CONCLUSION

This Chapter concludes the systemization of ETQP and terminates the systemized ETQP management process for mitigating loss due to quality - loss of focus, loss of time and possible loss of money. The next chapter addresses the validation exercise carried out to reduce the credibility gap on the conclusions reached by this research. It also contains the final remarks about this process.

Having said that, it should be noted that, depending on the contract type the details of each specific activity in the process differ. By license type it means factors that could influence the level of details in the application of the entire framework. Examples are: Business frame, Contracting strategy, Technology, Critical Deliverables, Project Risks, Contractors and Suppliers, License Requirements, Statutory Requirements, and Level of Integration with other contractors on the same site. Further details regarding this could be found in Figure 4-10.

CHAPTER FIVE

CONCLUSION

CHAPTER FIVE

5.0 RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION: The principal aim of this research was to develop a systemized engineering track quality plan process for mitigating quality loss. In this chapter the researcher evaluated the degree to which this aim has been accomplished. The system requirements and specifications were highlighted. It also put in perspective the past, present, and future of ETQP. This dissertation terminates with a section reflecting possible avenues for further research.

In Chapter 1 an objective was defined to standardize the ETQP process through systemization. This was born out the motivation that a gap is constantly being created in the quality function as a result of rapid growth. There exists the need also to mitigate any effects that failure to standardize could cause.

Further in chapter 2, open literatures were exposed to define some key concepts pivotal to this study. At this stage it was established that a number of characteristics making up a systemized process fits the purpose of our standardization. In line with this, the scientific concept of systems engineering and its associated techniques sufficed as appropriate tools to achieve this aim.

In other to carry on with the desired task of systemizing ETQP for business development, the current situation was studied. This helped to elicit vital knowledge in this specialist area in petrochemical facility development. Chapter three concluded with a clear depiction of the current situation.

A systemized framework was developed for ETQP in Chapter 4. This was further integrated into the existing business development model. A key feature that was introduced in the systemized process, which added more value to the systemized process, is the document management system. This was interfaced with the existing document framework for compatibility.

5.2 ETQP IN PERSPECTIVE

In a nutshell the engineering track quality plan process has been analyzed and framed for transformation. The following description represents the history of engineering track quality plan, as is perceived by the researcher.

Table 5-1: ETQP Past, Present, and Future

PAST A plan compiled after project framing. Executed by discipline engineers and controlled in the best way approved by each Engineering Manager, non-systemized.
PRESENT A system with the attributes mentioned above plus a central Repository, Intelligent updater, Rapid implementation modeling, Interface procedure controls, and continuous improvement cycles
FUTURE Quality Intelligent Enterprise, encompassing PAST and PRESENT, deployed as a globally available platform, easily accessible by quality professionals worldwide, ensuring quality integrity and managing unpredictable factor changes, and bringing value to stakeholders

This entails, however, that information technology could be utilized fully. This may entail the possible translation of the ETQP system framework into a network of physical implementations.

5.3 ASSESSING THE DEGREE TO WHICH RESEARCH QUESTION HAS BEEN ADDRESSED

The research questions posed in chapter 1 will be re-examined to determine the extent to which they have been addressed in this dissertation.

5.3.1 HOW SHOULD A SYSTEMIZATION RESEARCH BE CONDUCTED?

This question was answered by the exposition made on the concept of systemization. It presented insight into systems analysis and management. A literature study revealed the consideration of the distinct components of the existing quality management process and led to the systemization of the process following standards adopted by the

organisation. To achieve this, scientific techniques were used to provide the solution process of a systemized engineering track quality plan (Chapter 2).

This entailed the extensive elicitation of knowledge of the existing system (Chapter 3) and the subsequent modeling of the systemized process (Chapter 4).

5.3.2 HOW CAN ETQP PROVIDE A GLOBAL SOLUTION?

A global solution can only be said to have been achieved if the system represents the typical systemized infrastructure as outlined in section 1.2.2. The ETQP solution proposed in this dissertation defined a central repository around which all activity components were connected. With this framework an organisation that implements the ETQP solution will have achieved the following:

- Centralised her information repository (Figure 4-5, Table 4-3)
- Based decisions on overall reports generated from lower-level activities as compared with systems performance
- Broken down activities into manageable components that easily interconnects (Figure 4-4)
- Created a framework for possible costing activities for profitability measurement (Appendix D)
- Established and integrated a systemized ETQP implementation (Section 4.14, Table 4-2, Figure 4-3)

These represents globally accepted standards of operations, and therefore, plugs the ETQP implementation into the global framework.

5.3.3 WHAT STEPS MUST ORGANISATIONS TAKE TO ENFORCE THE RESULTS OF ENGINEERING TRACK QUALITY PLAN SYSTEMIZATION?

Engineering track quality plan activities were critically evaluated and expounded (Chapter 3). These activities conform to the answer provided in research question 1 and are vital in the engineering track quality plan systemized solution for mitigating quality loss.

The systemization activities suggested that a detailed plan be created prior to the implementation of engineering track quality system (Chapter 4). It also identified the need for a system analyst (or quality administrator) joining the team of quality engineers in framing the engineering philosophy prior to the plan compilation process.

The post-systemization activities focused on the actual institutionalization of the engineering track quality system strategy/plan and the continuous monitoring thereof (Chapter 4). It was deduced that promoting awareness is an activity that requires attention.

5.3.4 DO EXPERTS BELIEVE THAT ETQP SYSTEMIZATION IS APPROPRIATE FOR SASOL, AND THE PETROCHEMICAL INDUSTRY IN GENERAL

For any work to be acceptable in any field of endeavour, the views of renowned authorities are very critical. As such this research dissertation obtained the views of key engineering track quality personnel's in Sasol, and a highly placed engineering quality contractor with Sasol. These views were used to appraise the appropriateness of this study. Appendix 13 contains a comprehensive list of the interviewee configuration.

The interviews tested the opinion of interviewees on specific aspects of the dissertation described in chapter 2. An initial oral interview was held and in my opinion the general response suggests that the resultant ETQP process addressed key concerns on standardization and integration. The following paragraphs contain some views.

Chris van den Berg (2007) is the Governance and Systems manager in Sasol Technology, and the owner of the BD&I model. During a post-research conversion with him he concurred that the systemization of ETQP as presented in this work is in tune with management focus on the improvement of the entire BD&I model. He mentioned his teams intention to setup a "Configurable BD&I model", which is in the planning phase at the moment. The concepts defined in this work, in his opinion, will be helpful in this course; and the researcher will be given the privilege, where possible, to be present at the "Configurable BD&I" briefings.

Further talk with Lombard Francois (2007), the manager, Engineering Integration and Quality, revealed that systemization enhances the ETQP process against the backdrop of difficulties in standardization. He currently manages the EHMS system. This system handles lead indications on processes but not quality measurement. The proposition in this work, in his opinion, could bring in that aspect of quality process management that not only provides lead indications but measures quality as well. He, however, asserted that systemization is not the only way to address the standardization issue, and may not be the best.

Other respondents made similar comments regarding the proposition, affirming the credibility of the approach in addressing the problems stated in Section 1.5.1.

Sequel to the aforementioned, formal interview mails were forwarded to the respondents (Appendix 13). It was expected that their responses shall be based on the interviewee's opinion as to how the dissertation answered the questions raised regarding a systemized ETQP as contained in chapter 1, and defined within the context of this research in section 1.5. It was intended also to address the objectives set out for this work as indicated in section 1.1.2.

However, given the tight schedule of the interviewees, majority of the mails has not been replied by the time of compilation of this section. A list of the interviewees and their contacts are contained in Appendix 13.

5.4 RECOMMENDATIONS FOR ETQP SYSTEMS REQUIREMENT AND SPECIFICATION

Since this research concentrated on the processes presently employed in Sasol, as a yardstick for measuring the petrochemical industry, in my opinion, the Systemized ETQP for business development should be tested in a pilot scale. If a positive outcome is recorded it should finally be integrated into the BD&I model and implemented in future projects.

Following this, since the systemized approach involves systems analysis techniques, the researcher is including the under-listed points to help bridge the knowledge and skill gap that may exist. This is in addition to the points mentioned in section 4.10.2.

1. Development tools such as Event Studio, System Architect, or Visual Analyst CASE tools are good considerations in other to implement the systemized process.
2. The use of CASE tools is a requirement for the proposed implementation.
3. To address this gap – knowledge of information technology in managing the quality process - a dedicated Quality System Administrator is required. This individual should be trained to possess the required skill in process modeling.
4. Since the solution now involves systems engineering techniques, the introduction of a systems engineer as part of ETQP discipline engineers, to participate in framing the engineering philosophies, is also of importance. This system engineer possessing the skills of an analyst could seamlessly assume the role of the quality administrator in point 3 above.
5. The functions of the quality administrator includes following through with ETQP activities down to the production stream and aligning concepts with owner business quality systems. He could also handle the systems engineering of quality updates and optimizations (See Figure 4-9 on page 75).
6. The reporting system for the systemized ETQP should follow the pattern generated from the ETQP system process framework (see Appendix D for attached summary of the process model). Reason being that all interface relations was catered for and this added improved control and monitoring functionality.
7. For easy implementation, the framework modeling code is attached (Appendix D.6 on page 112). Reading through and modifying as appropriate, a quality administrator

can use this tool to generate desired framework and documents for projects at hand. (Note: *EventStudio 2.5 is required to re-generate models shown in appendix D)*

5.5 RESEARCH EXTENSIBILITY

This work can be carried further by being implemented in a live project. There could be further research into the applicability of the systemized ETQP framework as a standalone model integrated into the entire BD&I model as proposed (Chapter 4). In my opinion, such a framework will be a very powerful tool for petrochemical business development and implementation projects, considering the strengths offered by Rapid Application Development techniques using CASE tools. Such application if developed will serve as a powerful tool to facilitate administration.

5.6 FUTURE RESEARCH CONSIDERATION

With the advent of Systems Engineering approach to solutions development, further research could be carried out to develop a framework for integrated engineering track quality system, wherein all *expert knowledge packages* will be organised into a common repository. Tools for required *skills* will then be made available on the same framework such that the quality function can be controlled and administered from anywhere in the world.

The long term result will be turning quality control into a key intelligent enterprise (INCOSE, 2007). This should exhibit all four key behaviors of key intelligent enterprises namely:

- Measuring both the value of the results to stakeholders and the conformance of results with respect to principles of systems and society,
- Being precisely aware of enterprise situation with respect to their enterprise goals
- Improving goal achievement and sustainable worth by adapting and aligning the enterprise to changes in its context and capabilities, and
- Ensuring enterprise integrity even when all factors are changing unpredictably.

5.7 CONCLUSION

So far, in my view, it has been established that systemization is an invaluable exercise in quality process management. It sufficed as a valuable tool in standardizing ETQP operations in this dissertation. In motivating this fact the need for this study was pointed out. The researcher consulted literature that exposed the background of the identified needs. Based on the understanding obtained a number of research questions were posed to serve as a guide throughout the exercise.

The systemized ETQP has been designed to capture documents, analyze (in other words, optimize and improve) the process; define operations, and map compliance and assessment of change. This design structure was motivated by the need to address the variability and gap that is constantly left as a result of growth in the quality function. This need was established through a detailed study of the current situation. The information obtained was framed into a network mechanism that addresses omissions, errors, and introduction of new requirements.

The resultant process therefore, focused on ensuring the interoperability of dependent components, and the integration with the "bigger picture" framework. Since processes are prevalent in everything we do, the systemized ETQP addresses the complexity, understanding, and communication gaps that are inherent in a non-systemized process. The resulting framework was modeled and if fully tested confidence in it could be assured.

Furthermore, a structured scientific approach for empirical investigations was followed to elicit vital knowledge about the existing system. This was done by creating a research mind map, sub-dividing the whole process into six phases. A solution was proposed that aimed at establishing a systemized quality process for ETQP.

The implementation of a tested systemized standard engineering track quality plan could allow organisations to proactively control their operating environment and reap the benefits of this promising process management methodology. This will not be without gaining new knowledge in quality systems analysis, which is what all participating professionals will engage in to align with the proposed approach.

APPENDICES

6.0 APPENDIX A: INTERVIEW SHEET (WHITTEN J.L, BENTLEY L.D, DITTMAN K.C (2004:253)

Interviewee:	Kobus Strauss
Position:	Engineering Manager (Quality)
Interviewer:	IGBE Victor
Date:	15/11/2006
Time:	13H00
Place:	Sastech
Subject:	General ETQP Knowledge

Time Allocated	**Interviewer Questions and Objective**	**Interviewee Response**
1 to 2min	Objective Open Interview • Introduce self • Thank interviewer • State purpose of interview, to obtain an understanding of existing practice	*1 My name is IGBE Victor. A Master Degree Student of NWU, currently working with section 8500, ATR Unit of Sasol Infrachem. Thank you very much for granting me audience, considering your tight schedule. I am presently carrying out a research study on the systemization of ETQP. The whole idea is to analyze the current system and come up with a process that that could ensure a higher level of interoperability between ETQP functions. I want to obtain some useful understanding of your role in the existing practice. I have come up with some structured questions which will guide our discussion.
Facts About ETQP Process		
3mins	What is the general procedure for ETQP?	
5min	Question 1 What conditions determine when ETQP should be implemented? Follow-up: Who approves it?	*2
5min	Question 2 What conditions determine when ETQP has concluded? Follow-up: Who signs it off?	*3

5min	Question 11: How are ETQP activities monitored and tracked?	*12
5min	Question 5 What are the activities that define the ETQP function? Follow-up: (1) Are there documented standard operating procedures for all functions? (2) If no which ones do not have?	*6
2min	Question 12: Do you think the present ETQP procedures needs improvement? Follow-up: What other things would you like added or removed to improve the current operation?	*13
Facts About ETQP Functions, Roles and Personnel		
2min	Question Who makes up the ETQP Team (Who are the individuals who perform ETQP functions)?	*4
1min	Question 4 How is the ETQP team formed?	*5
5min	What are the various ETQP functions there is?	
5min	Question 6 How do these functions interrelate?	*7
5min	Question 10 How are the various quality functions costed? Follow-up: Identify cost groups, const centres, accounts receivables and payables etc)	*11
Facts About ETQP Information Structure		
1min	Question 7: What documents are involved in ETQP?	*8
5min	Question 8: How is information generated and stored?	*9
2min	Question 9: Does the implementation of ETQP require making reference(s) to other organisations or body of experts	*10

	outside Sastech? Follow-up: What are their names and roles?	
44min	Time allotted for questions & objectives	
9min	Time allotted for follow-up questions	
53min	Time allotted for interview	
General comments & notes	* If space provided is not enough, additional information could be found on attached sheet with associated number.	

7.0 APPENDIX B: A SAMPLE FRAMING MEETING CHECKLIST

Quick Framing Meeting Checklist: Business Area _____

Project – Name**.....** Budget Year_____

Opportunity Framing**.....**

Business Objectives**.....**

Project Execution Objectives**.....**

Scope of work

In scope – .....
Out of Scope - .....

Risk management - *What are risks*.....

Organization – Who, stakeholders, representation, roles

Business Manager - .....
Technical manager – .....
SHE representatives - .....
Core Team – .....
Sponsor – .....

Implementation Plan (Project Plan of Execution)

Major milestones.....
.....
Resources needed.....
.....
.....
Schedule targets.....
Plan for next phase.....

.....

Cost targets**.....**

Funding**.....**

Contracting**.....**

Best practices**.....**

Communication**.....**

8.0 APPENDIX C: ENGINEERING TRACK QUALITY PLAN RASCI CHART

RASCI = *Responsible, Accountable/Approval, Support, Consult, Inform*

Process Description	*Engineering Manager*	*Electrical Engineering*	*Mechanical Engineering*	*Civil Engineering*	*Control Engineering*	*Steering Committee*	*SH&E*	*Comments*
Convene ETQP philosophy meeting	*R/A*	*I*	*I*	*I*	*I*		*I*	
Draft ETQP	*R*	*S*	*S*	*S*	*S*	*I*		
1.Develop Details of ETQP	*R*	*R*	*R*	*R*	*R*	*I*		
2. Compile ETQP	*R*	*S*	*S*	*S*	*S*	*C*		
3. Review ETQP	*R*	*S*	*S*	*S*	*S*	*C*	*S*	
4. Update ETQP	*R*	*S*	*S*	*S*	*S*	*C*		
5. Review ETQP per discipline	*R*	*R*	*R*	*R*	*R*			
6. Finalise ETQP	*R*	*S*	*S*	*S*	*S*			
9. Implement Quality Control Plan with hold points	*S*	*R*	*R*	*R*	*R*		*S*	
10.Conduct reviews of work deliverables	*R*							
11.Rework of deliverables	*I*	*I*	*I*	*I*	*I*	*R*	*I*	
12.Acceptance of deliverables	*I*	*I*	*I*	*I*	*I*		*I*	
13.Capture lessons learnt	*R*	*S*	*S*	*S*	*S*		*S*	

9.0 APPENDIX D: GENERATED ETQP MODELS AND ACTIVITY CHECKLIST

9.1 APPENDIX D.1: ETQP CONTEXT AND COLLABORATION DIAGRAM – pages 95 - 97

9.2 APPENDIX D.2: ETQP SEQUENCE DIAGRAM – pages 98 - 100

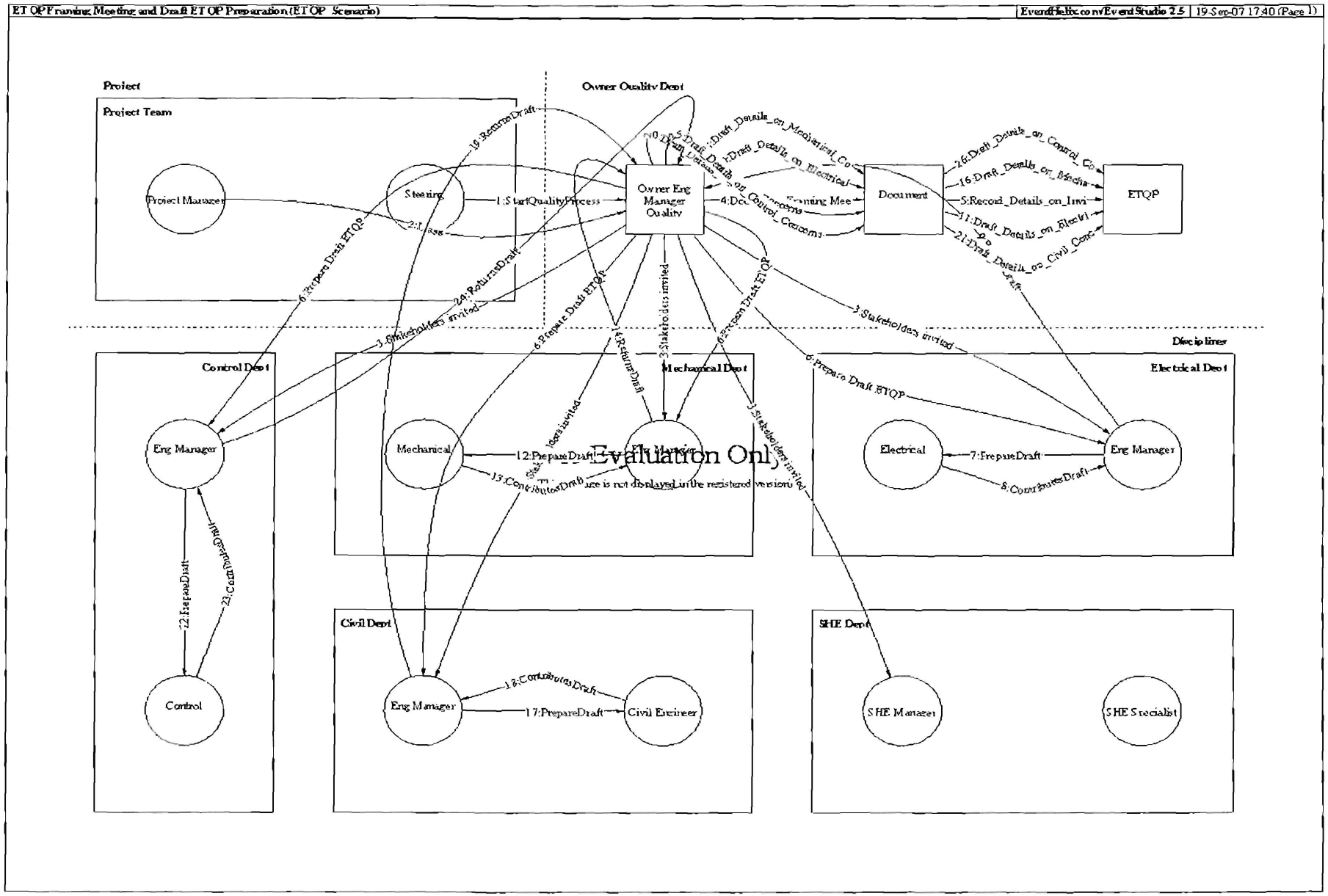
9.3 APPENDIX D.3 : ETQP INTERACTION SEQUENCE DIAGRAM – pages 101 - 103

9.4 APPENDIX D.4 : ETQP STATISTICS – pages 104 -105

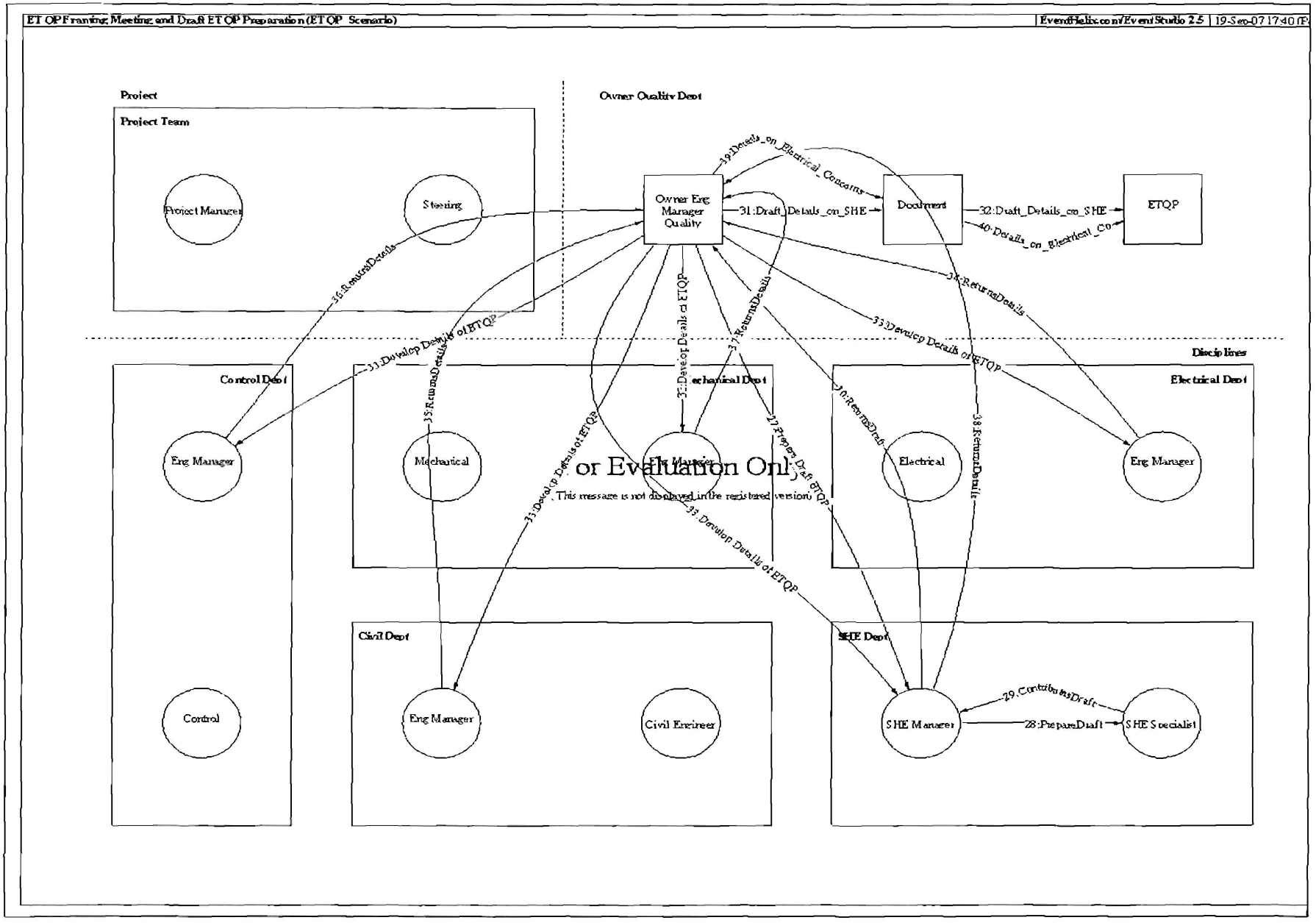
9.5 APPENDIX D.5 : ETQP SUMMARY – pages 106 - 111

9.6 APPENDIX D.6: ETQP FRAMEWORK MODELING CODE - pages 112 -114

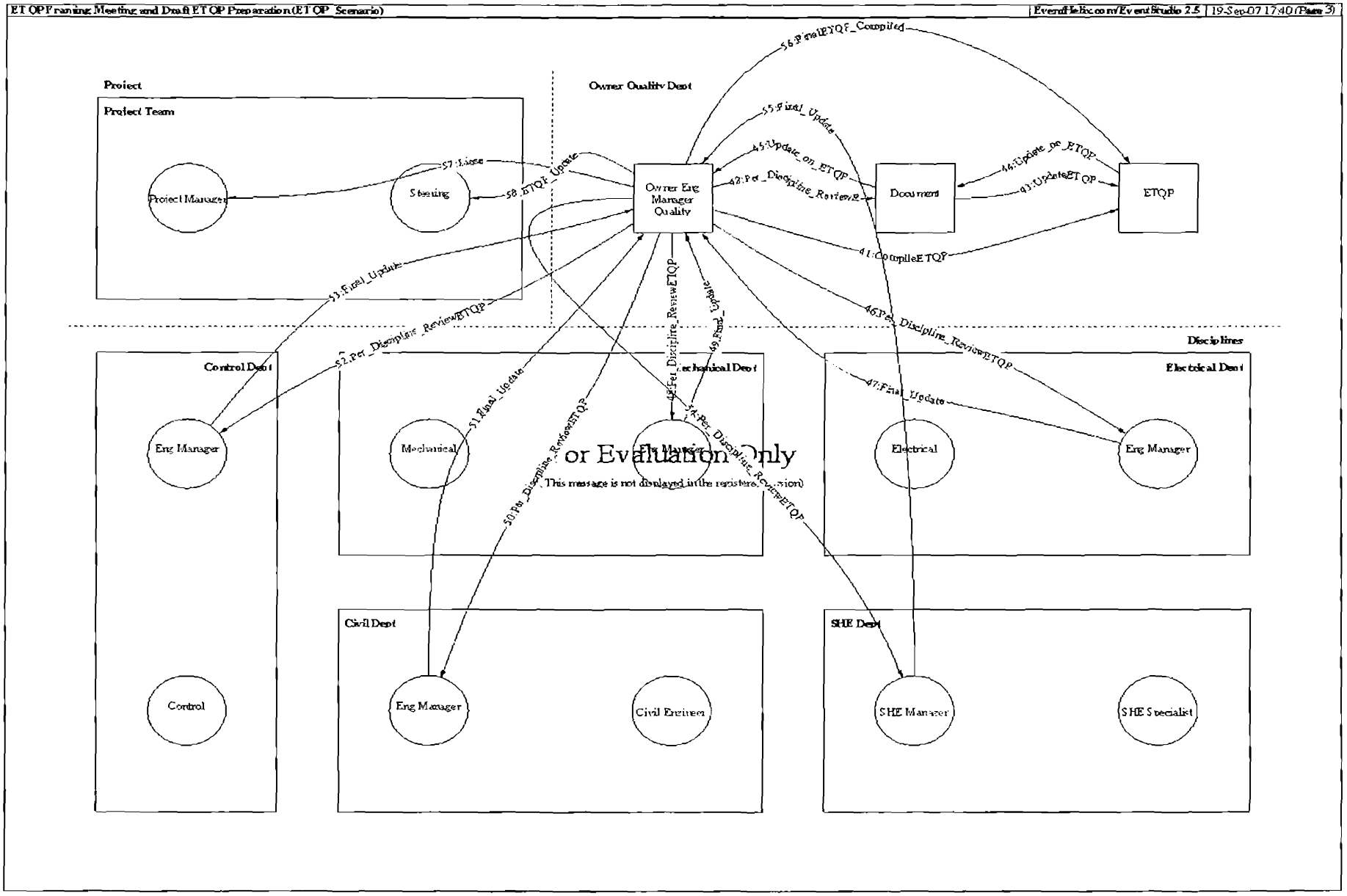
9.1 APPENDIX D.1: ETQP CONTEXT AND COLLABORATION DIAGRAM



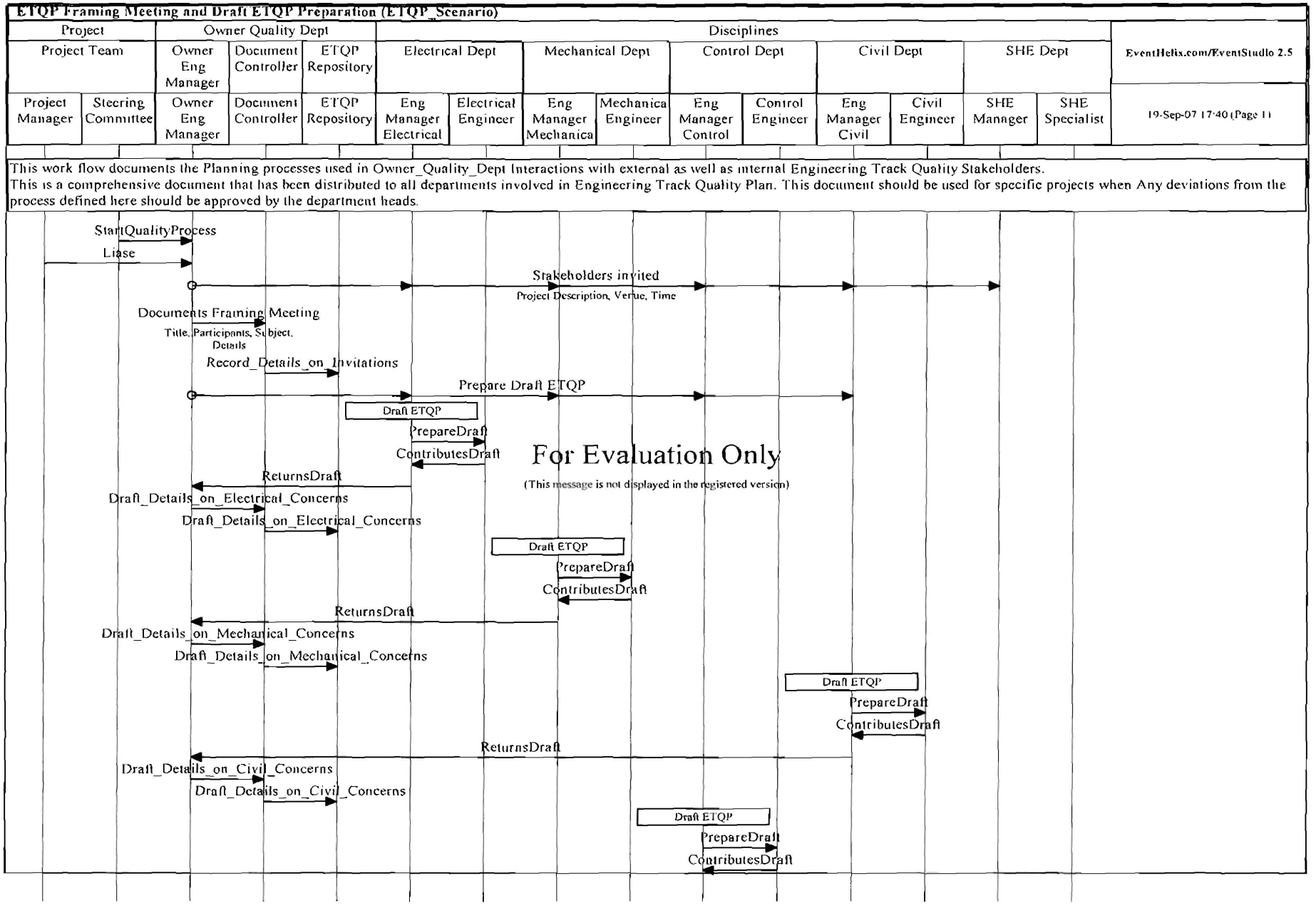
ETQP CONTEXT AND COLLABORATION DIAGRAM - *continued*



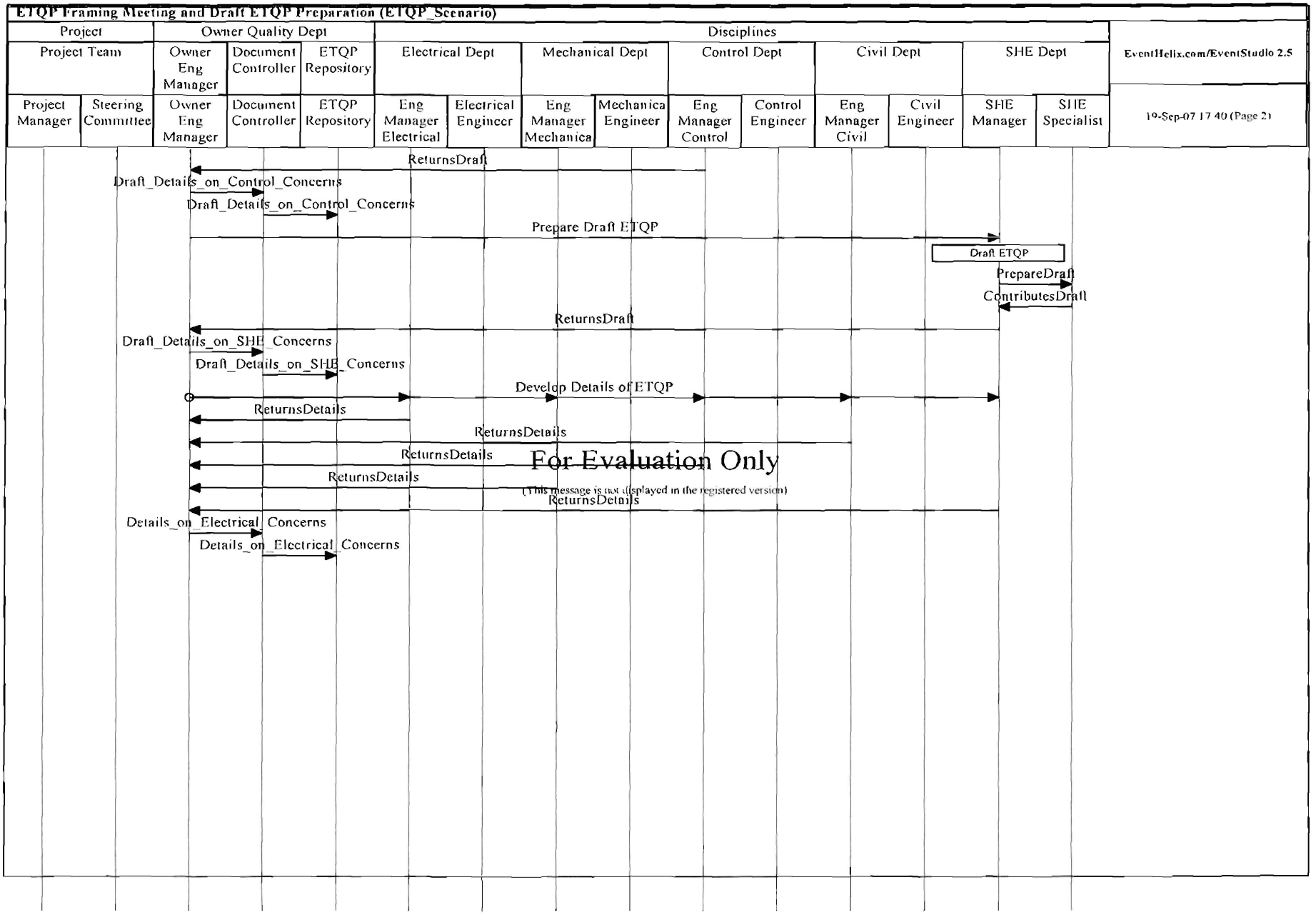
ETQP CONTEXT AND COLLABORATION DIAGRAM - *continued*



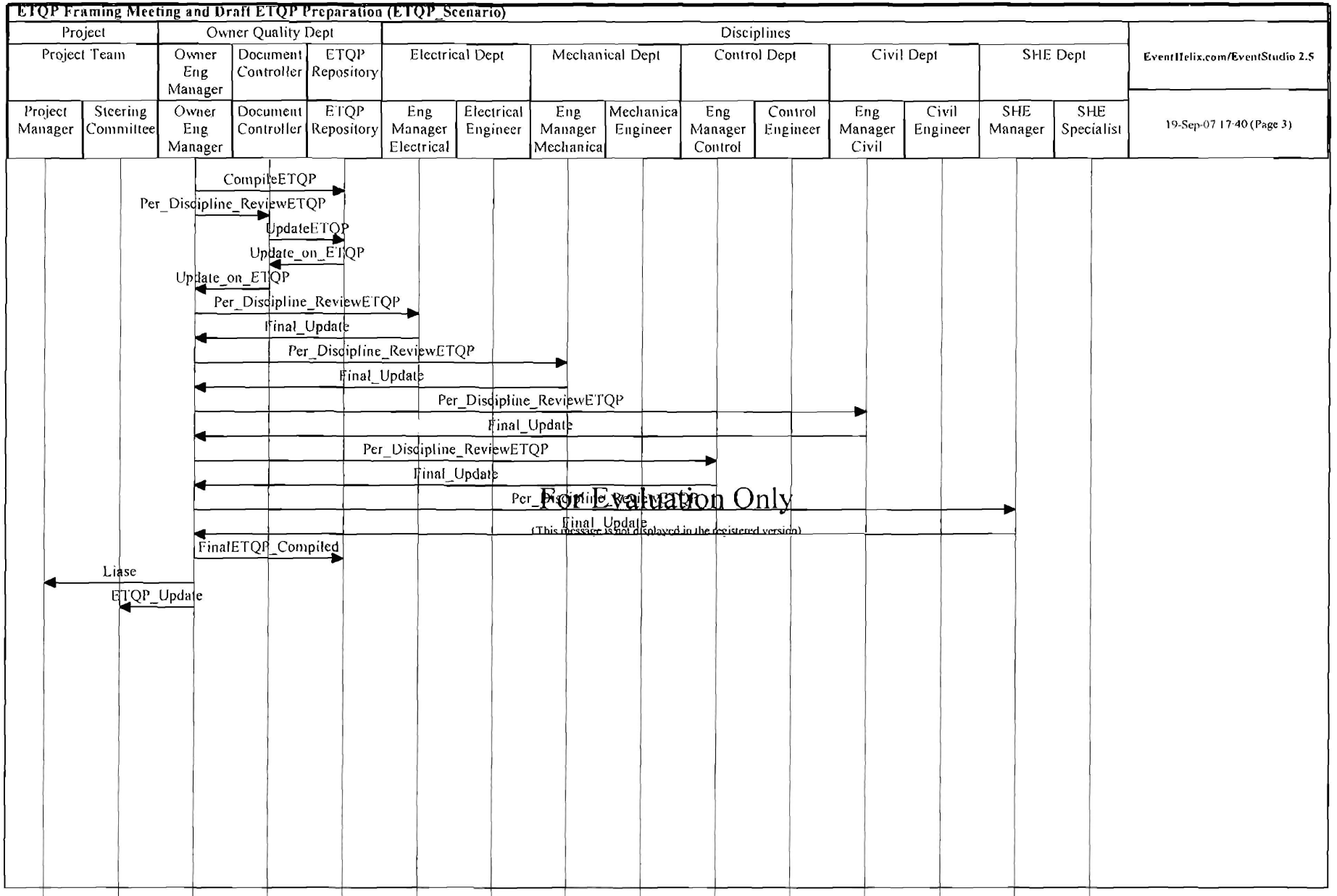
9.2 APPENDIX D.2: ETQP SEQUENCE DIAGRAM



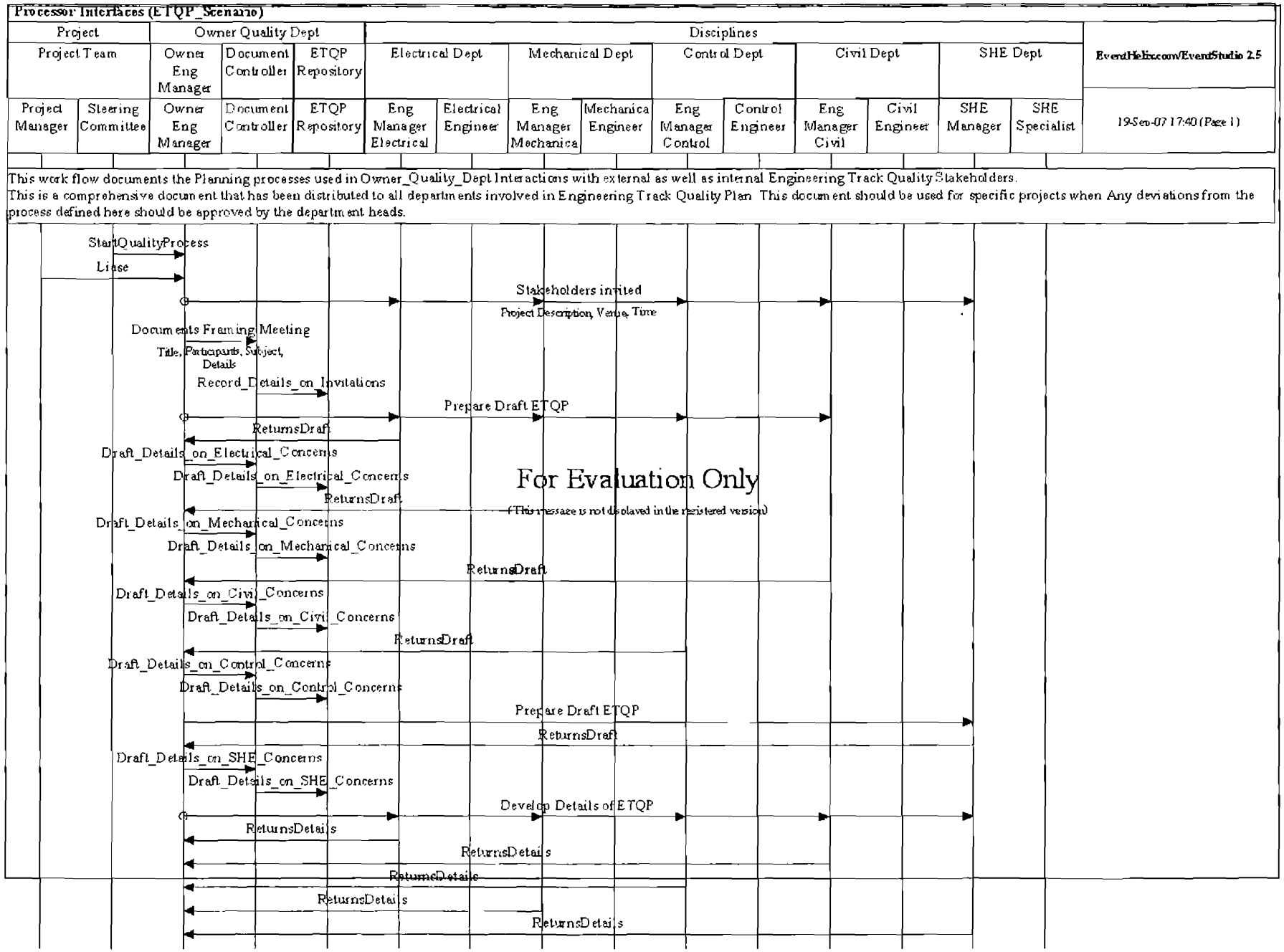
ETQP SEQUENCE DIAGRAM - *continued*



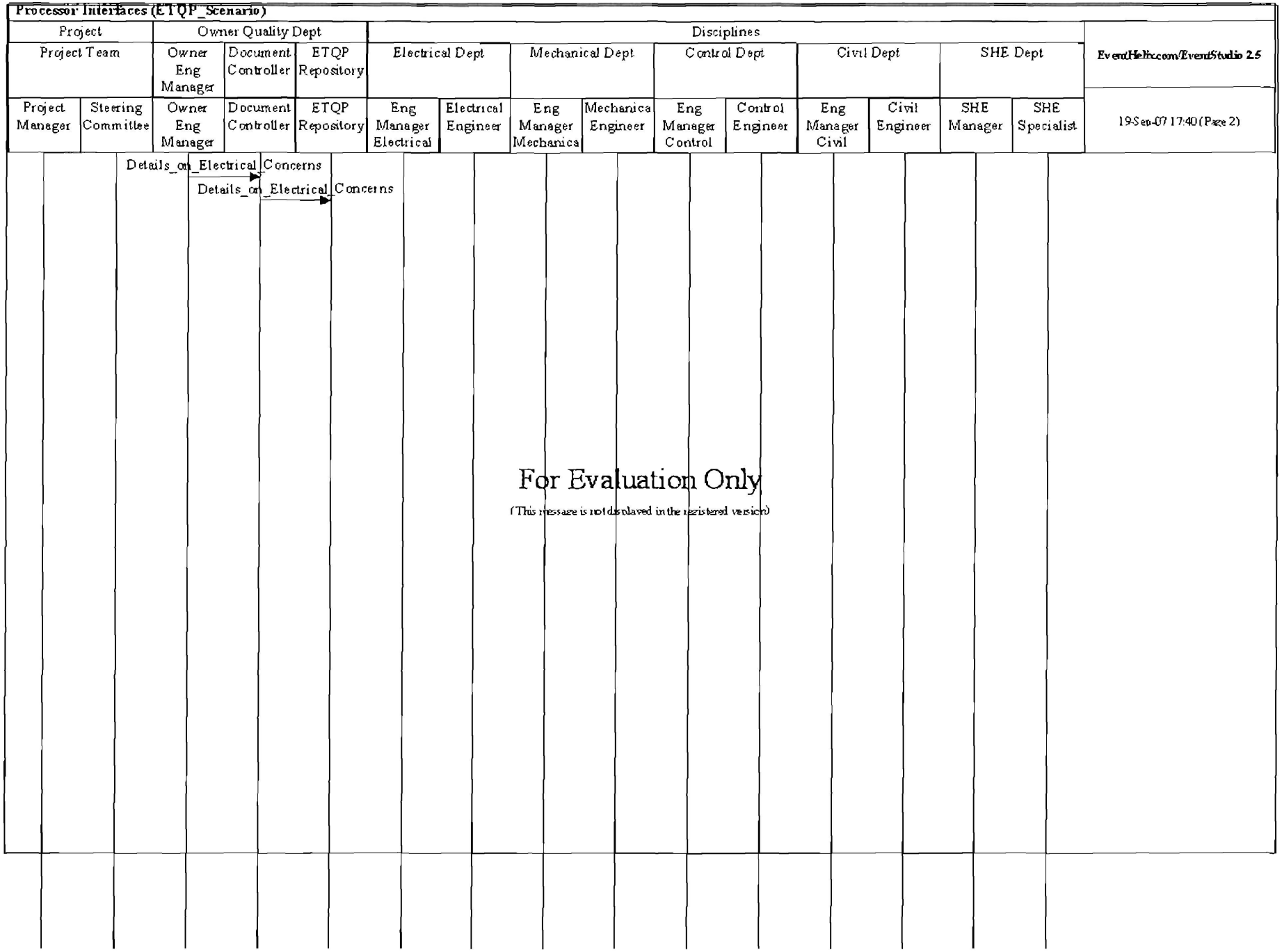
ETQP SEQUENCE DIAGRAM - *continued*



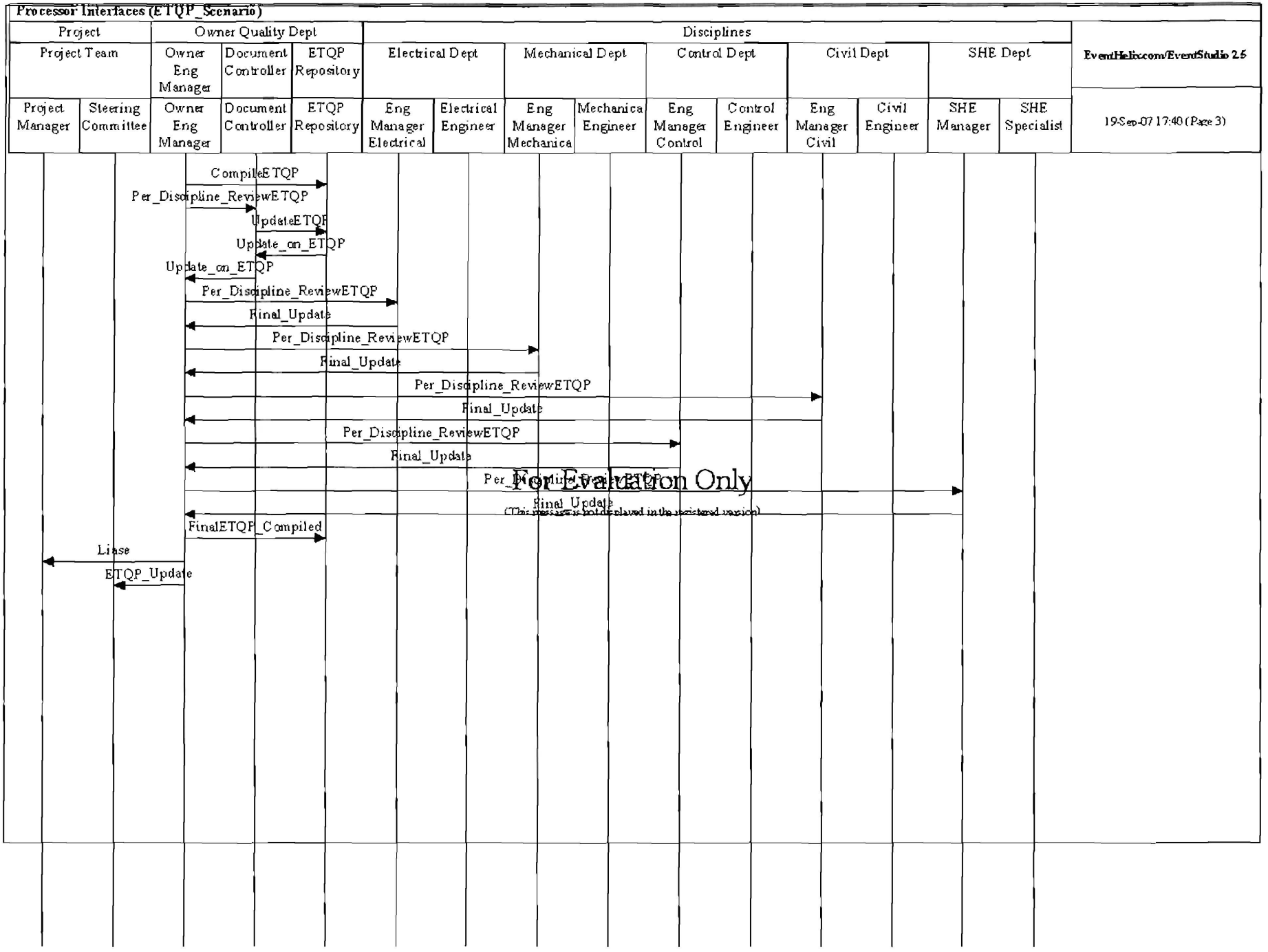
9.3 APPENDIX D.3: ETQP INTERACTION SEQUENCE DIAGRAM



ETQP INTERACTION SEQUENCE DIAGRAM - *continued*



ETQP INTERACTION SEQUENCE DIAGRAM - *continued*



9.4 APPENDIX D.4: ETQP STATISTICS

EventHelix.com/EventStudio 2.5
Generated on 19-Sep-07 17:40

ETQP Scenario

9.4.1: Inter Unit Message Interactions: Indicates the concentration of activity flow between operational units.

*	Project	Owner Quality Dept	Disciplines
Project		2	
Owner Quality Dept	2	20	20
Disciplines		15	10

9.4.2: Inter Processor Message Interactions: Shows expected activity flow concentration between the departments in the system. This can be used to control delays at departmental level. Document controller could be a person (s) or a program configured to carry out document control functions.

*	Project Team	Owner Eng Manager Quality	Document Controller	ETQP Repository	Electrical Dept	Mechanical Dept	Control Dept	Civil Dept	SHE Dept
Project Team		2							
Owner Eng Manager Quality	2		8	2	4	4	4	4	4
Document Controller		1		8					
ETQP Repository			1						
Electrical Dept		3			2				
Mechanical Dept		3				2			
Control Dept		3					2		
Civil Dept		3						2	
SHE Dept		3							2

9.4.3: Inter Object Message Interactions: Shown in table on next page. This represents the activity traffic metrics for actors within the departments and their dependencies. Could be used to control delays in the system; See diagrams in Appendix D.1 and D.2 for graphical links.

*	Project Manager	Steering Committee	Owner Eng Manager Quality	Document Controller	ETQP Repository	Eng Manager Electrical	Electrical Engineer	Eng Manager Mechanical	Mechanical Engineer	Eng Manager Control	Control Engineer	Eng Manager Civil	Civil Engineer	SHE Manager	SHE Specialist
Project Manager			1												
Steering Committee			1												
Owner Eng Manager Quality	1	1		8	2	4		4		4		4		4	
Document Controller			1		8										
ETQP Repository				1											
Eng Manager Electrical			3				1								
Electrical Engineer						1									
Eng Manager Mechanical			3						1						
Mechanical Engineer								1							
Eng Manager Control			3								1				
Control Engineer										1					
Eng Manager Civil			3										1		
Civil Engineer												1			
SHE Manager			3												1
SHE Specialist														1	

9.5 APPENDIX D.5: ETQP SUMMARY

EventHelix.com/EventStudio 2.5
Generated on 19-Sep-07 17:40

ETQP_Scenario: Individual responsibilities and actions – what is expected of, and what is to be given by, all stakeholders. Groupings help with clarity and simplicity. Lower level details – specific content of messages – are not shown here. Different quality departments have specifics that conform to their requirements.

9.5.1: Project_Manager Actions

1. Send Liase to Owner_Eng_Manager_Quality
2. Receive Liase from Owner_Eng_Manager_Quality

9.5.2: Steering_Committee Actions

1. Send StartQualityProcess to Owner_Eng_Manager_Quality
2. Receive ETQP_Update from Owner_Eng_Manager_Quality

9.5.3: Owner_Eng_Manager_Quality Actions

1. Receive StartQualityProcess from Steering_Committee
2. Receive Liase from Project_Manager
3. Send Stakeholders invited (Project Description, Venue, Time) to Eng_Manager_Electrical, Eng_Manager_Civil, Eng_Manager_Control, Eng_Manager_Mechanical, SHE_Manager
4. Send Documents Framing Meeting (Title, Participants, Subject, Details) to Document_Controller
5. Send Prepare Draft ETQP to Eng_Manager_Electrical, Eng_Manager_Civil, Eng_Manager_Control, Eng_Manager_Mechanical
6. Receive ReturnsDraft from Eng_Manager_Electrical
7. Send Draft_Details_on_Electrical_Concerns to Document_Controller
8. Receive ReturnsDraft from Eng_Manager_Mechanical
9. Send Draft_Details_on_Mechanical_Concerns to Document_Controller
10. Receive ReturnsDraft from Eng_Manager_Civil
11. Send Draft_Details_on_Civil_Concerns to Document_Controller

12. Receive ReturnsDraft from Eng_Manager_Control
13. Send Draft_Details_on_Control_Concerns to Document_Controller
14. Send Prepare Draft ETQP to SHE_Manager
15. Receive ReturnsDraft from SHE_Manager
16. Send Draft_Details_on_SHE_Concerns to Document_Controller
17. Send Develop Details of ETQP to Eng_Manager_Electrical, Eng_Manager_Civil, Eng_Manager_Control, Eng_Manager_Mechanical, SHE_Manager
18. Receive ReturnsDetails from Eng_Manager_Electrical
19. Receive ReturnsDetails from Eng_Manager_Civil
20. Receive ReturnsDetails from Eng_Manager_Control
21. Receive ReturnsDetails from Eng_Manager_Mechanical
22. Receive ReturnsDetails from SHE_Manager
23. Send Details_on_Electrical_Concerns to Document_Controller
24. Send CompileETQP to ETQP_Repository
25. Send Per_Discipline_ReviewETQP to Document_Controller
26. Receive Update_on_ETQP from Document_Controller
27. Send Per_Discipline_ReviewETQP to Eng_Manager_Electrical
28. Receive Final_Update from Eng_Manager_Electrical
29. Send Per_Discipline_ReviewETQP to Eng_Manager_Mechanical
30. Receive Final_Update from Eng_Manager_Mechanical
31. Send Per_Discipline_ReviewETQP to Eng_Manager_Civil
32. Receive Final_Update from Eng_Manager_Civil
33. Send Per_Discipline_ReviewETQP to Eng_Manager_Control
34. Receive Final_Update from Eng_Manager_Control
35. Send Per_Discipline_ReviewETQP to SHE_Manager
36. Receive Final_Update from SHE_Manager
37. Send FinalETQP_Compiled to ETQP_Repository
38. Send Liase to Project_Manager
39. Send ETQP_Update to Steering_Committee

9.5.4: Document_Controller Actions

1. Receive Documents Framing Meeting (Title, Participants, Subject, Details) from Owner_Eng_Manager_Quality
2. Send Record_Details_on_Invitations to ETQP_Repository

3. Receive Draft_Details_on_Electrical_Concerns from Owner_Eng_Manager_Quality
4. Send Draft_Details_on_Electrical_Concerns to ETQP_Repository
5. Receive Draft_Details_on_Mechanical_Concerns from Owner_Eng_Manager_Quality
6. Send Draft_Details_on_Mechanical_Concerns to ETQP_Repository
7. Receive Draft_Details_on_Civil_Concerns from Owner_Eng_Manager_Quality
8. Send Draft_Details_on_Civil_Concerns to ETQP_Repository
9. Receive Draft_Details_on_Control_Concerns from Owner_Eng_Manager_Quality
10. Send Draft_Details_on_Control_Concerns to ETQP_Repository
11. Receive Draft_Details_on_SHE_Concerns from Owner_Eng_Manager_Quality
12. Send Draft_Details_on_SHE_Concerns to ETQP_Repository
13. Receive Details_on_Electrical_Concerns from Owner_Eng_Manager_Quality
14. Send Details_on_Electrical_Concerns to ETQP_Repository
15. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
16. Send UpdateETQP to ETQP_Repository
17. Receive Update_on_ETQP from ETQP_Repository
18. Send Update_on_ETQP to Owner_Eng_Manager_Quality

9.5.5: ETQP_Repository Actions

1. Receive Record_Details_on_Invitations from Document_Controller
2. Receive Draft_Details_on_Electrical_Concerns from Document_Controller
3. Receive Draft_Details_on_Mechanical_Concerns from Document_Controller
4. Receive Draft_Details_on_Civil_Concerns from Document_Controller
5. Receive Draft_Details_on_Control_Concerns from Document_Controller
6. Receive Draft_Details_on_SHE_Concerns from Document_Controller
7. Receive Details_on_Electrical_Concerns from Document_Controller
8. Receive CompileETQP from Owner_Eng_Manager_Quality
9. Receive UpdateETQP from Document_Controller
10. Send Update_on_ETQP to Document_Controller
11. Receive FinalETQP_Compiled from Owner_Eng_Manager_Quality

9.5.6: Eng_Manager_Electrical Actions

1. Receive Stakeholders invited (Project Description, Venue, Time) from Owner_Eng_Manager_Quality

2. Receive Prepare Draft ETQP from Owner_Eng_Manager_Quality
3. Take action "Draft ETQP"
4. Send PrepareDraft to Electrical_Engineer
5. Receive ContributesDraft from Electrical_Engineer
6. Send ReturnsDraft to Owner_Eng_Manager_Quality
7. Receive Develop Details of ETQP from Owner_Eng_Manager_Quality
8. Send ReturnsDetails to Owner_Eng_Manager_Quality
9. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
10. Send Final_Update to Owner_Eng_Manager_Quality

9.5.7: Electrical_Engineer Actions

1. Receive PrepareDraft from Eng_Manager_Electrical
2. Send ContributesDraft to Eng_Manager_Electrical

9.5.8: Eng_Manager_Mechanical Actions

1. Receive Stakeholders invited (Project Description, Venue, Time) from Owner_Eng_Manager_Quality
2. Receive Prepare Draft ETQP from Owner_Eng_Manager_Quality
3. Take action "Draft ETQP"
4. Send PrepareDraft to Mechanical_Engineer
5. Receive ContributesDraft from Mechanical_Engineer
6. Send ReturnsDraft to Owner_Eng_Manager_Quality
7. Receive Develop Details of ETQP from Owner_Eng_Manager_Quality
8. Send ReturnsDetails to Owner_Eng_Manager_Quality
9. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
10. Send Final_Update to Owner_Eng_Manager_Quality

9.5.9: Mechanical_Engineer Actions

1. Receive PrepareDraft from Eng_Manager_Mechanical
2. Send ContributesDraft to Eng_Manager_Mechanical

9.5.10: Eng_Manager_Control Actions

1. Receive Stakeholders invited (Project Description, Venue, Time) from Owner_Eng_Manager_Quality
2. Receive Prepare Draft ETQP from Owner_Eng_Manager_Quality
3. Take action "Draft ETQP"
4. Send PrepareDraft to Control_Engineer
5. Receive ContributesDraft from Control_Engineer
6. Send ReturnsDraft to Owner_Eng_Manager_Quality
7. Receive Develop Details of ETQP from Owner_Eng_Manager_Quality
8. Send ReturnsDetails to Owner_Eng_Manager_Quality
9. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
10. Send Final_Update to Owner_Eng_Manager_Quality

9.5.11: Control_Engineer Actions

1. Receive PrepareDraft from Eng_Manager_Control
2. Send ContributesDraft to Eng_Manager_Control

9.5.12: Eng_Manager_Civil Actions

1. Receive Stakeholders invited (Project Description, Venue, Time) from Owner_Eng_Manager_Quality
2. Receive Prepare Draft ETQP from Owner_Eng_Manager_Quality
3. Take action "Draft ETQP"
4. Send PrepareDraft to Civil_Engineer
5. Receive ContributesDraft from Civil_Engineer
6. Send ReturnsDraft to Owner_Eng_Manager_Quality
7. Receive Develop Details of ETQP from Owner_Eng_Manager_Quality
8. Send ReturnsDetails to Owner_Eng_Manager_Quality
9. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
10. Send Final_Update to Owner_Eng_Manager_Quality

9.5.13: Civil_Engineer Actions

1. Receive PrepareDraft from Eng_Manager_Civil

2. Send ContributesDraft to Eng_Manager_Civil

9.5.14: SHE_Manager Actions

1. Receive Stakeholders invited (Project Description, Venue, Time) from Owner_Eng_Manager_Quality
2. Receive Prepare Draft ETQP from Owner_Eng_Manager_Quality
3. Take action "Draft ETQP"
4. Send PrepareDraft to SHE_Specialist
5. Receive ContributesDraft from SHE_Specialist
6. Send ReturnsDraft to Owner_Eng_Manager_Quality
7. Receive Develop Details of ETQP from Owner_Eng_Manager_Quality
8. Send ReturnsDetails to Owner_Eng_Manager_Quality
9. Receive Per_Discipline_ReviewETQP from Owner_Eng_Manager_Quality
10. Send Final_Update to Owner_Eng_Manager_Quality

9.5.15: SHE_Specialist Actions

1. Receive PrepareDraft from SHE_Manager
2. Send ContributesDraft to SHE_Manager

9.6 APPENDIX D.6: ETQP FRAMEWORK MODELING CODE

```
module : Project, Owner_Quality_Dept, Disciplines
processor : Project_Team in Project, Owner_Eng_Manager_Quality in Owner_Quality_Dept, Document_Controller in
Owner_Quality_Dept, ETQP_Repository in Owner_Quality_Dept
processor : Electrical_Dept in Disciplines, Mechanical_Dept in Disciplines
processor : Control_Dept in Disciplines, Civil_Dept in Disciplines, SHE_Dept in Disciplines
eternal : Project_Manager in Project_Team, Steering_Committee in Project_Team
eternal : Eng_Manager_Electrical in Electrical_Dept, Eng_Manager_Civil in Civil_Dept
eternal : Eng_Manager_Control in Control_Dept, Eng_Manager_Mechanical in Mechanical_Dept
eternal : SHE_Manager in SHE_Dept, SHE_Specialist in SHE_Dept
eternal : Electrical_Engineer in Electrical_Dept, Mechanical_Engineer in Mechanical_Dept
eternal : Civil_Engineer in Civil_Dept, Control_Engineer in Control_Dept

feature "ETQP Framing Meeting and Draft ETQP Preparation"

    [*This work flow documents the Planning processes used in Owner_Quality_Dept Interactions
    with external as well as internal Engineering Track Quality Stakeholders.

    This is a comprehensive document that has been distributed to all departments
    involved in Engineering Track Quality Plan. This document should be used for specific projects when
    Any deviations from the process defined here should be approved by the department heads.

    *]

    StartQualityProcess : Steering_Committee -> Owner_Eng_Manager_Quality
    Liase : Project_Manager ->  Owner_Eng_Manager_Quality

    Owner_Eng_Manager_Quality multicasts "Stakeholders invited"("Project Description", "Venue", "Time") to
Eng_Manager_Electrical, Eng_Manager_Civil, Eng_Manager_Control, Eng_Manager_Mechanical, SHE_Manager
    "Documents Framing Meeting"("Title", "Participants", "Subject", "Details") : Owner_Eng_Manager_Quality ->
Document_Controller
      Record_Details_on_Invitations: Document_Controller -> ETQP_Repository

    Owner_Eng_Manager_Quality multicasts "Prepare Draft ETQP" to Eng_Manager_Electrical, Eng_Manager_Civil,
Eng_Manager_Control, Eng_Manager_Mechanical
    Eng_Manager_Electrical takes action "Draft ETQP"
      PrepareDraft : Eng_Manager_Electrical -> Electrical_Engineer
      ContributesDraft : Electrical_Engineer -> Eng_Manager_Electrical
      ReturnsDraft : Eng_Manager_Electrical -> Owner_Eng_Manager_Quality
      Draft_Details_on_Electrical_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Draft_Details_on_Electrical_Concerns : Document_Controller -> ETQP_Repository
```

```
    Eng_Manager_Mechanical takes action "Draft ETQP"
      PrepareDraft : Eng_Manager_Mechanical -> Mechanical_Engineer
      ContributesDraft : Mechanical_Engineer -> Eng_Manager_Mechanical
      ReturnsDraft : Eng_Manager_Mechanical -> Owner_Eng_Manager_Quality
      Draft_Details_on_Mechanical_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Draft_Details_on_Mechanical_Concerns : Document_Controller -> ETQP_Repository

    Eng_Manager_Civil takes action "Draft ETQP"
      PrepareDraft : Eng_Manager_Civil -> Civil_Engineer
      ContributesDraft : Civil_Engineer -> Eng_Manager_Civil
      ReturnsDraft : Eng_Manager_Civil -> Owner_Eng_Manager_Quality
      Draft_Details_on_Civil_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Draft_Details_on_Civil_Concerns : Document_Controller -> ETQP_Repository

    Eng_Manager_Control takes action "Draft ETQP"
      PrepareDraft : Eng_Manager_Control -> Control_Engineer
      ContributesDraft : Control_Engineer -> Eng_Manager_Control
      ReturnsDraft : Eng_Manager_Control -> Owner_Eng_Manager_Quality
      Draft_Details_on_Control_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Draft_Details_on_Control_Concerns : Document_Controller -> ETQP_Repository

    /*pagebreak*/

    "Prepare Draft ETQP" : Owner_Eng_Manager_Quality -> SHE_Manager
    SHE_Manager takes action "Draft ETQP"
      PrepareDraft : SHE_Manager -> SHE_Specialist
      ContributesDraft : SHE_Specialist -> SHE_Manager
      ReturnsDraft : SHE_Manager -> Owner_Eng_Manager_Quality
      Draft_Details_on_SHE_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Draft_Details_on_SHE_Concerns : Document_Controller -> ETQP_Repository

    Owner_Eng_Manager_Quality multicasts "Develop Details of ETQP" to Eng_Manager_Electrical, Eng_Manager_Civil,
Eng_Manager_Control, Eng_Manager_Mechanical, SHE_Manager
      ReturnsDetails : Eng_Manager_Electrical -> Owner_Eng_Manager_Quality
      ReturnsDetails : Eng_Manager_Civil -> Owner_Eng_Manager_Quality
      ReturnsDetails : Eng_Manager_Control -> Owner_Eng_Manager_Quality
      ReturnsDetails : Eng_Manager_Mechanical -> Owner_Eng_Manager_Quality
      ReturnsDetails : SHE_Manager -> Owner_Eng_Manager_Quality
      Details_on_Electrical_Concerns : Owner_Eng_Manager_Quality -> Document_Controller
      Details_on_Electrical_Concerns : Document_Controller -> ETQP_Repository
```

```
  pagebreak

  CompileETQP : Owner_Eng_Manager_Quality -> ETQP_Repository

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> Document_Controller
  UpdateETQP : Document_Controller -> ETQP_Repository
  Update_on_ETQP : ETQP_Repository -> Document_Controller
  Update_on_ETQP : Document_Controller -> Owner_Eng_Manager_Quality

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> Eng_Manager_Electrical
  Final_Update : Eng_Manager_Electrical -> Owner_Eng_Manager_Quality

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> Eng_Manager_Mechanical
  Final_Update : Eng_Manager_Mechanical -> Owner_Eng_Manager_Quality

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> Eng_Manager_Civil
  Final_Update : Eng_Manager_Civil -> Owner_Eng_Manager_Quality

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> Eng_Manager_Control
  Final_Update : Eng_Manager_Control -> Owner_Eng_Manager_Quality

  Per_Discipline_ReviewETQP : Owner_Eng_Manager_Quality -> SHE_Manager
  Final_Update : SHE_Manager -> Owner_Eng_Manager_Quality

  FinalETQP_Compiled : Owner_Eng_Manager_Quality -> ETQP_Repository
  Liase :  Owner_Eng_Manager_Quality -> Project_Manager

  ETQP_Update : Owner_Eng_Manager_Quality -> Steering_Committee

  /* End of Compilation Phase */

endfeature
```

10.0 APPENDIX E: ENGINEERING TRACK QUALITY SYSTEM STRATEGY

10.1 BACKGROUND

Sections 4.3, 4.4, and 4.5 cover the development of a comprehensive systemized ETQP. The catalogue of practices for quality operating environment consists of two sections reflecting the strategic and operational best practices for Sasol (Ref: 39). This catalogue is constructed from references from well known standards:

- British Standards
- ISO Standards
- ASME Standards

To update the catalogue for systemized ETQP operating environment, the following references may be consulted:

- Sasol operating procedures
- South African government regulations

For the purpose of this sample strategy, the table below indicates some quality tools specified by the researcher. This is subject to review and adjustment when necessary.

Quality Tools to be used	Description of use
Inspection	Visual measurements and comparison should be made and recorded for control and documentation purpose.
Testing	Operating conditions of equipment and tools should be checked and recorded. E.g. Piping and Instruments
Project Quality policy	All operations should be carried out as set out in the drafted policy so as to achieve intent of the quality team.
Training	Members will be trained in areas where special knowledge is required.
Quality records	Proper documentation of all observations and outcomes should be made using appropriate data books.

10.2 STRATEGIC PRACTICES

ENGINEERING TRACK QUALITY SYSTEM AWARENESS AND TRAINING
All ETQ system users fully comprehend their respective quality roles and responsibilities
There is adequate in-house expertise for all supported services, mechanisms, methodologies, tools, technologies including their secure operation
Ensure that ETQ system users are fully trained in quality procedures and the risks associated with non-conformance. Periodic reminders must be provided to all
Everyone's understanding of engineering quality information is documented and conformance is periodically verified

Table 10.1 Engineering Track Quality System awareness and Training

ENGINEERING TRACK QUALITY SYSTEM QUALITY STRATEGY
The company's strategies routinely incorporates engineering quality considerations
Engineering quality strategies and policies take to consideration the company's mission, strategies, and goals
Engineering quality strategies, goals and objectives are documented and routinely reviewed, updated and communicated to all users.

Table 10.2 Engineering Track Quality System Quality Strategy

ENGINEERING TRACK QUALITY SYSTEM MANAGEMENT
Management allocates sufficient funds and resources to Engineering Track Quality System activities
Quality roles and responsibilities are defined for all participating professionals
Develop a quality policy that addresses the use of modeling tools
The company's hiring and firing practices for personnel take Engineering Track Quality System issues into account
The required level of information regarding quality and how they are applied to individuals and groups are documented and enacted
The company manages Engineering Track Quality risks, including: • Assessing risk to quality activities to comprehend the value of the

ENGINEERING TRACK QUALITY SYSTEM POLICIES AND REGULATIONS
The company has a comprehensive set of documented, current quality policies that are periodically reviewed and updated. These Policies addresses key operations including: • ETQP procedures • Quality management system • Punching procedures •
There is a documented process for management of quality policies including: • Creation • Administration (including periodic reviews and updates) • Communication
The company has a documented process for evaluating and ensuring compliance with quality policies for Engineering Track Quality system, applicable laws and regulations, and insurance requirements
The company uniformly enforces its quality policies
Revision of quality policies and procedures are restricted to authorized personnel

Table 10.4 Engineering Track Quality System Policies and Regulations

COLLABORATIVE QUALITY MANAGEMENT
The company has policies and procedures for ensuring quality when working with external parties
The company has verified that outsourced quality services meet with its quality needs and requirements
The company documents, monitors and enforces compliance on external parties
The company provides and verifies awareness and training on applicable external parties policies and procedures for personnel who are involved with those companies
There are documented procedures for third party companies whose services have been terminated. Those procedures are communicated and coordinated with the company

Table 10.5 Collaborative Quality Management

CONTINGENCY PLANNING
An analysis of operations, applications, and information criticality has been performed
The company has documented: • Quality continuity or emergency operations plans • Contingency recovery plans • Contingency plans for responding to emergencies
The contingency and quality continuity plans consider physical requirements and control
The contingency and quality continuity plans are periodically reviewed, tested and revised
All personnel needed to participate are: • Aware of the contingency and quality continuity plans • Understand and are able to carry out their responsibilities during these periods

Table 10.6Contingency Planning

ENGINEERING TRACK QUALITY ADMINISTRATION AND TOOLS
New quality tools, procedures and mechanisms are routinely reviewed for applicability in meeting the company's quality strategies
Tools and mechanisms for quality system management and administration are used, reviewed and updated or replaced. Examples include: • A dedicated Computer System used as an ETQ Repository server • System Architect CASE tool • Visual Analyst CASE tool • Oracle or SQL Database servers

Table 10.7 Engineering Track Quality Plan Administration Tools

OPERATIONAL PRACTICES
There are documented quality plan(s) for the systemized Engineering Track Quality Plan
Quality plan(s) are periodically reviewed, and updated
The integrity of required software is regularly verified
All procedures are up to date with respect to revisions and recommendations
There is a documented data backup that: • Is routinely updated • Is periodically updated • Calls for regularly scheduled backups of both software and data • Requires periodic testing and verification of ability to restore from backups
A quality personnel understand and are able to carry out their responsibilities under the backup plans
Changes to quality documents, information structure, hardware and software, are planned, controlled and documented

Table 10.8 Operational Practices

ENGINEERING TRACK QUALITY SYSTEM MONITORING AND AUDIT
Activity is monitored by qualified discipline specific staff
Quality activity is logged or recorded
Records or logs are reviewed on a regular basis
Unusual activity is dealt with according to the appropriate policy and procedure
Tools are periodically reviewed and updated

Table 10.9 Engineering Track Quality System Monitoring and Audit

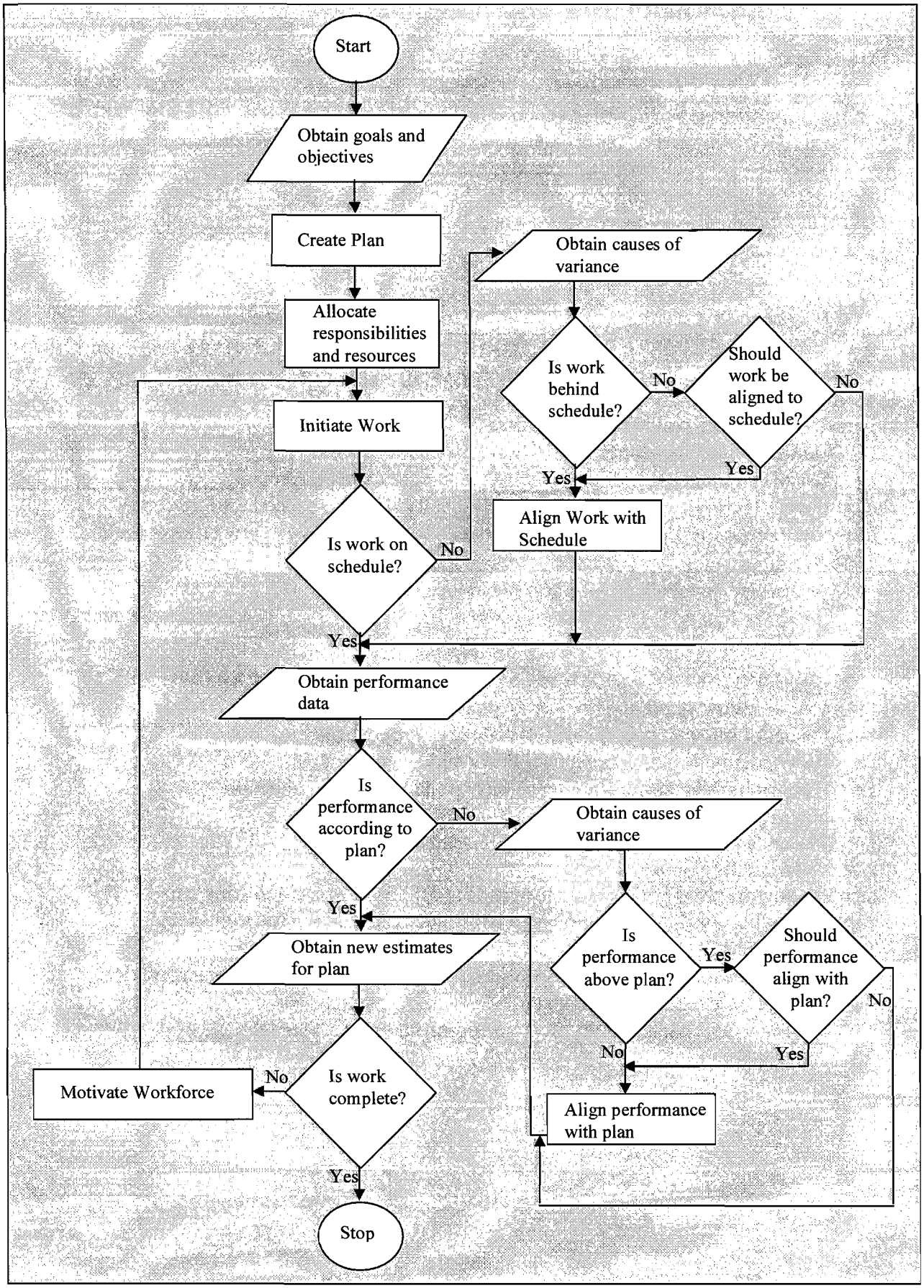
ENGINEERING TRACK QUALITY SYSTEM INCIDENT MANAGEMENT
Documented procedures exist for identifying, reporting and responding to separate quality and violations including: • Quality based incidents • Social engineering incidents
Incident management procedures are periodically tested, verified and updated
There are documented policies and procedures for working with law enforcement agencies

Table 10.10 Engineering Track Quality System Incident Management

ENGINEERING TRACK QUALITY GENERAL STAFF PRACTICES
All personnel follow good quality practice such as: • Securing information for which they are responsible • Recognizing and reporting incidents and deviations • Understanding and following quality policies and regulations • Having adequate ability to use information
All staff at all levels implement their assigned roles and responsibilities for quality monitoring
There are documented procedures for guiding all personnel (including third party companies) who build quality and work in project locations. This includes: • Employees • Contractors, Partners, collaborators, and personnel from service providers • Facility maintenance personnel • Engineering Track Quality System maintenance personnel

Table 10.11 Engineering Track Quality General Staff Practices

11.0 APPENDIX F: Execution Flow for individual Activities



12.0 APPENDIX G: Sample Work Authorisation Form for Petrochemical Companies (IGBE .V, 2006:20)

Ref Code:	Date Issued:	Work Title:
Description (Scope):		

Input to work:	1.	2.	3.	Expected output:	Scheduled Time:	
4.	5.	6.	7.		Duration	
8.	9.	10.	11.		Start date	
12.	13.	14.	15.		End date	

Risks Involved:	1.	2.	3.	Foreseeable precautions:
4.	5.	6.	7.	
8.	9.	10.	11.	

Account code:				Cost Accounting					
WBS code	Cost code	Task Description	Start date/time	End date/time	Total month/day/hours	Total in hours	Cost per hour	Total cost	

Resources Required							Cost Aggregation (by period breakdown)		
Code	Responsibility	Period Available							
		From	To	Hours	Cost/hour	Total	Period (Phase)	Aggregated Cost	

Signatories

Responsible Person:
Name.....
Rank.....
Sign.....
Date.....

Work Acceptance:
Client Name.....
Rank.....
Sign.....
Date.....

Work Cancellation:
Name.....
Rank.....
Sign.....
Date.....

Work Completion:
Client Name.....
Rank.....
Sign.....
Date.....

Completion Acknowledgment:
Name.....
Rank.....
Sign.....
Date.....

13.0 APPENDIX H: INTERVIEW TOOLS

Name	Role	Organisation	Subject Covered	Contact Phone
Kobus Straus	Owner Engineering Manager: Quality	Sasol Technology	General ETQP operations	016-960-3574 082-788-3191
Kobus Keyser	Process Specialist	Sasol Infrachem	Punching Activities, Construction Quality Assurance	
Andreas Ulbrich	Process Engineering Management	Sasol Technology	Engineering Management	083-302-1938
Pieter Fick	Engineering Manager: Project	Sasol Technology	ETQP as a Project tool	016-940-2339
Chris van den Berg	Manager: Governance and Systems	Sasol Technology	ETQP structure and interfaces in BD&I Context	016-960-2366 083-635-7678
Francois Lombard	Manager: Engineering Integration and Quality	Sasol Technology	Quality Management Structure in ETQP Project	016-960-4664 082-854-3527
Gerrie de Jong	Engineering Manager: Systems	Sasol Technology	Components of ETQP systems	016-960-2071
Jacques Steyn	Document Management Systems	Sasol Technology	Repository Management in High Technology Projects	016-960-5310
Martin Smith	Contractor	Graniker LTA	Role of ETQP on Contracting Activities compared with other Implementations	082-570-2842

Table 13-1: Interviewee Configuration

Research Validation Response

Inbox

Victor I | show details 10/3/07 Reply

Sir,

I got a verbal response from one of the interviewees for my research and the following is the brief of the conversation.

Name: Kobus Keyser
Role: Senior Technical Officer, Sasol Infragas, ATR (Plant Optimization and Upgrade)

Discussion held on 3rd October 2007
Place: ATR Control room
Time: 09:45am
Subject: ETQP systemization process
Present use: plant activities

Response:
Quote: " I have been using your framework recently. I printed a copy of the diagaram from your thesis and placed it on my Notice board as I speak. So far, its working very fine. Am so busy with woirk now but I'll email you ones am able to regarding other findings."

For further enquiry K. Keyser can be reached on: 016-960-3962 (Office), 083-627-9636 (Mobile)

K. Keyser was one of the interviewees I selected in the course of research. He is also listed among the "interviewee configuration in Chapter 5 of thesis.

Regards

IGBE Victor
Research topic: Systemization of engineering track qualty plan for business development and integration, Sasol case study

Reply Forward

Harry to show details 10/9/07 Reply

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For Change Management Initiatives
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SAMPLE INTERVIEW COMMUNICATION TO INTERVIEWEES

Dear Sir,

My name is IGBE Victor. I am a Master Degree Student of North-West University, currently working with Infrachem ATR, Sasol.

I want to first apologize for taking some of your time to attend to this request of mine. Thank you very much for granting me audience, considering your tight schedule.

I am presently carrying out a research study on the systemization of ETQP, a track in the BD&I model of Sasol. The whole idea is to analyze the current system and come up with a process that could ensure a higher level of interoperability between ETQP functions.

Through your response I want to validate the credibility of the work done in this research process. I attached a summarized copy of the dissertation of just 18 pages so you can easily read through. I also attached a draft copy of the dissertation for your reference.

There is a table containing the structured question areas in page 2, which will guide your response. The scoring for responses is calibrated as indicated in the next page. Please feel free to type in additional comments under the Score column. I will rearrange them for reporting.

Ten (10) areas have been drafted for you to respond on. You could skip any that you feel has less relevance to you expertise. For description of how each AREA was covered in the context of this research please see the table on page 4. References made in the table can be found in the original dissertation.

Thank you very much for you cooperation in this important process in my academic development.

The tool used to obtain information from the interviewees is showed below. The scoring for responses is calibrated as indicated.

Response Table

1 = No	2 = Poor	3 = Fair	4 = Good	5 = Excellent

AREA	INTERVIEW QUESTION	SCORE
Strategy	• ETQP* defines a quality management strategy	
	• ETQP supports the goal to implement projects quicker, which results in generating income earlier at a lower cost	
Process	• The configuration of the systemized ETQP process have procedures to systematically identify and close quality gaps	
	• In the process outlined in this work ETQP provide team members the opportunity to contribute ideas	
	• ETQP provide ways of identifying best practices	
	• ETQP contain a provision to transfer best practices lessons learned	
	• ETQP has a process for capturing tacit knowledge	
Structure	• ETQP depicts the functional demands of quality process management	
	• ETQP supports resources required to carry out quality process management	
	• ETQP recognizes the role of top management in quality process management	
Knowledge	• ETQP involves new knowledge that links all members to one another and to all relevant external parties	
	• ETQP creates a centralized process that is accessible to the entire team	
	• Knowledge of proposed technical framework brings the various units closer to central management	
	• Knowledge of the use of information systems enhances integration among units	
Gap Management	• ETQP provides measures to review current activities for possible improvement	
	• ETQP handles change with necessary resources in the chain process	
	• ETQP contains indicators to manage knowledge	
Document Management	• Managing information documentation is central to ETQP	

**ETQP here refers to the systemized ETQP as proposed in chapter 4*

	• ETQP contains procedures to manage Document change	
	• ETQP defines a repository that contains relative set of standard documentation at any instance	
Systemized Framework	• ETQP contains the characteristics of a systemized process	
	• ETQP provides a network that reacts quickly when needed	
	• ETQP contains a continuous culture of knowledge sharing	
	• ETQP has a positive impact on human resources	
Integration	• ETQP plugs into BD&I framework adequately	
	• ETQP supports the overall goal of the BD&I initiative	
	• ETQP phases satisfy the activity level demands (specific details for each activity depends on contract type)	
Culture	• ETQP encourages and facilitates knowledge sharing	
	• ETQP defines an open and trusted process as part of the culture	
	• Flexibility is inherent and this could drive the process	
Interface	• ETQP depends on other tracks in the BD&I	
	• Other tracks depend on ETQP to achieve set goal	
	• ETQP contains provisions to relate with other project units	

Table 13-2: Interview Question Areas

End of Interview Section.....

Thank you for responding.

The next table contains the definitions of the concepts of each interview area.

DEFINING INTERVIEW AREA CONCEPTS IN CONTEXT	
Strategy	In this dissertation it was established that a plan is vital to manage the ETQP process and its configuration (Chapter 4). This contributed to the structure proposed (figure 4-5), and a plan to achieve the proposed aim (Appendix 10).
Process	This is the series of actions defined towards achieving the aim of engineering quality process management. Appendix F shows a summary of every activity while figure 4-4 defines the process.
Structure	This is a logical relation within ETQP, defining the hierarchy of execution flow. This is designed to support the decision cycles and work flows. It should also support continuous improvement and change management. (Figure 4-5)
Knowledge	This is the contribution made by this study to the knowledge body of ETQP current operations. The proposed process in figures 4-4 and 4-5, and the documentation structure indicated in figures 4-5 and 4-7 outlines a way of carrying out activities which every participating team members will have to learn.
Gap Management	This is the coordination around the continuous improvement features of the system. In figures 3-6, 4-4 and Appendix F, this feature is represented in the decision cycles defined around review activities, change control activities, and conformance to quality standards respectively. For any deviations observed appropriate documentation is made for reworks, upgrades, and optimizations as necessary (figures 4-3 and 4-4).
Document Management	The management of documents used in controlling ETQP activities. Figures 4-5 and 4-7 shows the documentation structure. Sections 4.6.1 and 4.6.2 contain the algorithm for the management process.
Systemized Framework	A framework that outlines the different components of the ETQP process and linking them in a logical fashion that connects to the aim of ETQP. Appendix D and figures 4-4, 4-5 depicts the framework drawn up in the course of this study.
Integration	The BD&I model is a comprehensive business development model within which ETQP operates. The unification of the ETQP phases with BD&I is referred to as the integration. This is achieved in Section 4.12.
Culture	The customary way of carrying out ETQP activities. The culture defined in this study is represented in section table 4-1 and refined in table 4-3 for the systemized solution.
Interface	This is the borderline of responsibilities and accountabilities in the project scope of execution. How ETQP interfaces with the business and project tracks is shown in figure 4-10

Table 13-3: Interview Area Concept Definition

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