CHANGE MANAGEMENT IN THE CONSTRUCTION INDUSTRY :

A CLIENT'S MECHANISM FOR CONTROL

by

ALISTER WILLIAM COUTTS

Submitted in Fulfilment
of the Requirements for the
Degree of Doctor of Philosophy

at the

HERIOT-WATT UNIVERSITY
Department of Building Engineering & Surveying

May 1997

CHANGE MANAGEMENT IN THE CONSTRUCTION INDUSTRY :

A CLIENT'S MECHANISM FOR CONTROL

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

LIST OF FIGURES

ACKNOWLEDGEMENTS

A considerable number of people have contributed their time and I would like to acknowledge the help of the following :

> My wife Sheelagh for encouraging me to continue with my research despite pressure of work and other distractions;
>
> My children, Callum, Fionagh and Moyra for allowing me to hide from them in order to undertake the research project;
>
> My friend and colleague, Linda Gibson, for providing the element of competition and for commenting on the ideas expressed;
>
> Elaine Gilmour, Morag Bryson and Sheelagh for painstakingly deciphering my writing and typing this document.

I thank you all.

ABSTRACT

This research project constitutes an attempt to improve the construction industry's change management process by introducing the Form 'X' Control Mechanism as the means of establishing an effective method of project control.

The traditional practice in the construction industry of appointing the principal designer as team leader has been challenged with the main criticisms on the traditional practice being his, or her, lack of managerial ability and his, or her, failure to control the financial aspects of the project.

The traditional approach has remained essentially unchanged for more than a century but it has become increasingly questioned as the primary means of design management.

One aim of the research, therefore, was to ascertain whether the traditional practices currently is use in the United Kingdom and Hong Kong could be improved upon.

The research began by examining basic systems and project management concepts and noted the development of project management systems and structures for the construction industry.

This was illustrated by reference to a number of articles and it was possible to argue that the industry lacked a comprehensive change control methodology.

The research also provided evidence that the mechanisms used to exercise control in manufacturing industries could not be used to exercise control over construction projects.

This is due, in the main, to the relatively short duration of construction projects and the transient nature of project personnel.

Having examined the difficulties, it has been possible to devise a control methodology which couples communication and control and this mechanism has been adapted to fit existing industry practices.

Using this criterion it was possible to formulate a control procedure which obviates the difficulties which can arise using the traditional approach to change management.

The Form 'X' mechanism requires the design team to quantify, in financial and programme terms, the effect of design or construction changes, and to obtain the client's specific authority prior to revising the works. In doing so the Project Manager is able to determine the magnitude of all changes in terms of time, money and quality.

The system is sufficiently flexible to enable it to be used world-wide, on projects of varying contract values and duration, and it requires only minor modifications to meet the provisions of the standard building and civil engineering conditions of contract.

A variant of the proposed methodology was introduced by Hong Kong's Mass Transit Railway Corporation and utilised on a number of projects. These contracts were examined in detail, as were a number of Mass Transit Railway Corporation contracts which utilised the traditional approach to project control.

The analysis showed that all of the projects on which the Form 'X' system had been used had been completed close to their original contract value whilst a number of the projects which did not use the control methodology suffered from significant cost over-runs.

It was concluded that the Form 'X' methodology successfully eradicates many of the control problems which permeate the traditional approach to change management embodied in the standard conditions of contract for building and civil engineering works.

The Form 'X' control approach was also shown to be popular with the Hong Kong Mass Transit Railway Corporation's senior management team, as well as with the consultants employed in the construction of the railway.

The conclusion of the research project is that the Form 'X' procedure is a highly successful change control methodology which could be used throughout the world on a wide variety of building and civil engineering projects.

HYPOTHESIS

HYPOTHESIS

Project management theory emphasises the need to control three key elements namely, **Time, Money** and **Quality**. In practice this is difficult to achieve as the standard conditions of contract used in the construction industry throughout the world make no provision for the imposition of control mechanisms.

Client organisations often suffer financial problems due to their consultants' difficulty in controlling costs. This difficulty arises, in many cases, from the absence of an adequate change management methodology.

It is argued, therefore, that the introduction of a Change Management Control Mechanism will alleviate the financial problems associated with this failure to control and the following hypothesis is postulated:

> **"The imposition of a Change Management Control Mechanism will ensure that construction projects are completed within budget."**

The validity of this hypothesis will be tested in the chapters which follow.

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.0 Background

The financial management of major projects has been of significant interest both in the United Kingdom and overseas and it can be argued that the present arrangements are only partly successful in preventing cost over-runs.

The investigations conducted in the field of construction cost control have encompassed project case studies, assessments of critical success factors, academic studies of communication interfaces within the project process and direct interviews with construction personnel.

The conclusions drawn from these studies have been numerous but each contains the message that change is required in order to ensure that projects are completed within budget. Client organisations have taken upon themselves the task of seeking and activating improvements in the cost control process and this research into project cost control focuses on such an initiative.

The subject of the study, the Hong Kong Mass Transit Railway Corporation, is one of the most modern and successful transport undertakings in the world. The Corporation was formed in 1974 and built 38.6 km of urban rail network, in phases, during the period 1976-1983. The Corporation, however, experienced cost control problems on a number of contracts and this led to the formulation of a change management methodology.

1.1 Contribution of the PhD Thesis

Change management is a research field which has been neglected and current models for the financial management of construction activity highlight the need for the early planning of individual projects, rather than setting out the specific cost control actions necessary to successfully manage a series of projects.

This thesis develops a model for the financial control of individual projects from the client's perspective with the aim of preventing cost over-runs by controlling the change management process.

The model which has been developed is not merely a theoretical construct, as the Hong Kong Mass Transit Railway Corporation asked the researcher, an employee of the client organisation, to formulate a control methodology which would be used to regulate the change control process. The thesis, therefore, represents an important study in the field of project control.

The researcher devised a methodology which was submitted to senior personnel within the Corporation for comment. As a result of the comments received, the control procedure was modified to take cognisance of the Corporation's organisational structures and systems, and then implemented on a number of contracts.

Due to the nature of the client organisation, and the researcher's position within that organisation, a combination of research methods have been used to determine whether the cost control methodology has been effective in improving the change management process.

It was acknowledged, at the outset, that the nature of the Corporation's construction projects, being large in scale but few in number, would present difficulties from a statistical perspective. The resultant statistical analysis would be capable of challenge owing to the small sample size and action research techniques have been utilised to supplement the quantitative data.

1.2 Format of the Thesis

Chapter One entitled **Introduction** sets the context for the thesis, which is inherently concerned with the financial control of major construction projects. The chapter stresses the importance of change management to client organisations and indicates that the researcher was an employee of the organisation being studied. As part of the Hong Kong Mass Transit Railway Corporation's Estates Construction Department, the researcher was well placed, both to influence corporate thinking on control methodologies and to monitor the performance of all of the Corporation's construction contracts.

Chapter One also makes it clear that the research project is of major significance to the construction industry as the methodology which has been devised can be used on building and civil engineering contracts, irrespective of location, value and contract conditions.

Chapter Two entitled **The Concept of Project Management Control** starts by explaining systems concepts before going on to describe the various Project Management systems and structures in common use.

Interpersonal factors are then discussed together with Information Management as it is argued that these factors play a crucial role in the management of construction projects.

The chapter ends by examining various project control and financial control devices which are used to manage the design and construction process.

Chapter Three entitled **A New Approach to Change Management** outlines the control methodology as it was originally envisaged and then goes on to describe how the procedure was modified for use by the Hong Kong Mass Transit Railway Corporation. The chapter argues that the cost control procedure detailed therein can be used to minimise the level of cost increases which occur due to variations to the contract works.

Chapter Four entitled **Research Methods** discusses the options for collecting and analysing the data to test the hypothesis and advises that a variety of data collection methods are available. Due to the nature of the study the action research methodology is used to supplement the statistical analysis .

Chapter Five entitled **The Approach in Action** reports the results from an analysis of the contract information which has been obtained following a review of all of the contract documentation associated with the projects under scrutiny. An abstract of the information is included as an Appendix and the data has been subjected to statistical analysis in order to determine whether the methodology has been effective.

The statistical analysis provides evidence that the methodology has been successful but, as mentioned above, the relatively small sample size has resulted in the use of action research principles in order to provide additional evidence as to the effectiveness of the cost control procedure.

Chapter Six entitled **Conclusion** draws together the various strands of the research project and suggests how the methodology could be further developed.

The thesis, as presented, comprises a series of interacting issues which come together, in practical form, as the Form 'X' control methodology. The thesis represents a major contribution to the field and is a work of considerable significance to the construction industry.

The fact that the methodology can be used on a variety of projects, irrespective of nature and location, means that there is ample scope for further research.

CHAPTER 2

THE CONCEPT OF PROJECT MANAGEMENT CONTROL

CHAPTER 2

THE CONCEPT OF PROJECT MANAGEMENT CONTROL

2.0 Introduction

The definition of Project Management varies from industry to industry and three definitions of project management in the construction industry are included here.

Weinberg (1) states that:

> **"Project Management is the group of management activities over and above the normal architectural and engineering services related to a construction programme, carried out during the pre-design and construction phases, that provide control over time and cost in the construction of the new facility."**

Walker (2) states that:

> **"Project Management is the planning, control and co-ordination of a project from conception to completion on behalf of a client. It is concerned with the identification of the client's objectives in terms of utility, function, quality, time and cost and the establishment of relationships between resources. The integration, monitoring and control of the contributors to the project and their output, and the evaluation and selection of alternatives in pursuit of the client's satisfaction with the project outcome are fundamental aspects of construction project management"**

Harrison (3) states that:

"Project Management is the achievement of a project's objectives through people, and involves the organising, planning and control of the resources assigned to the project, together with the development of constructive human relations with all those involved, both internal and external to the organisation."

All three definitions stress the importance of control but Harrison's definition is particularly relevant as it goes to the heart of this particular research project in that it stresses the importance of people to the success of the venture.

The Project Manager is commissioned by a prospective client and acts in the best interest of his, or her, client for the duration of the construction process. The Project Manager's role involves the integration of the activities of the individuals involved in the project so that each individual contribution is directed towards achieving the client's objectives. Although a range of multi-disciplinary skills are used in completing the project the organisational form places accountability clearly with the Project Manager.

The **stages of the design and construction process** over which the Project Manager is accountable, are listed hereunder:

(a) The **Initial Stage**, with the client setting out the terms of engagement of the Project Manager, the degree of client involvement, the extent of the Project Manager's authority and responsibility and the lines of communication;

(b) The **Feasibility Stage**, involving developing the brief, determining project feasibility, selecting or investigating the site and selecting and briefing the consultants;

(c) The **Approvals Stage**, involving obtaining planning permission and building warrant approval from local authorities;

(d) The **Design Management Stage**, involving developing outline proposals, undertaking environmental impact studies, preparing schematic designs, developing the design, instigating cost planning and obtaining client approval;

(e) The **Documentation Management Stage**, involving constructional and contractual documentation;

(f) The **Tendering Stage**, involving selection of one of a number of contractors able to construct the project at an acceptable price;

(g) The **Construction Monitoring Stage**, involving management of the persons responsible for the construction of the project;

(h) The **Post-Contract Stage**, involving training users or occupiers in the operation and maintenance of the facility.

The Project Manager is not normally able to undertake, personally, all of the tasks or organise all of the necessary sub-processes.

In fact a Project Manager who gets too involved in the sub-processes may neglect his overall role. Specialists in each of the sub-processes often bring with them mini-teams responsible for these sub-processes. However, although various individuals are responsible for parts of the process, the strength of the project management approach lies in the integration provided by the Project Manager in reconciling the varied and conflicting contributions to the project and in providing a single point of accountability for the management of the whole process.

The services provided by the Project Manager vary from project to project, according to each client's specific requirements. Some clients want the Project Manager to manage the project from the initial concept stage while others will not engage a Project Manager until the feasibility of the scheme has been clearly established.

Ryder and Mercer (4) state that the Project Manager plays a key role as he is required to take control of the team and to ensure that the project is completed properly. Ryder makes the point that the Project Manager should act as the single channel of communication between the client and the contractor.

Ryder also states that the essence of project management is:

- Good control of the technical content
- Good control of time
- Good control of expenditure
- Good control of human resources

These factors will be examined later in the chapter with a view to determining the relationship between project structure, systems and staffing and financial and technical control.

The Project Manager is responsible for providing the day-to-day review of, and direction to, the project team. In doing so, the Project Manager must lead, plan, organise and control all activities including, through briefing and interaction, those of the design team and contractors to achieve the desired results.

Hammond (5) echoes these sentiments and states that project management is the technical co-ordination of a client's total requirements. In doing so the project manager defines the project in its entirety and determines how it can be achieved in cost and programme terms.

The conventional list of tasks which are the responsibility of the Project Manager is included as **Appendix 'A'** but of equal importance is the Project Manager's duties as a "people manager" and these inter-personal factors will be discussed later in the chapter.

2.1 Systems Concepts

Webb (6) states that Project Management grew out of the need to improve the organisation of complex, one-off, undertakings. The impetus behind modern Project Management came from the concern of the United States of America military establishment to rationalise, and integrate better, its weapons acquisition process. Intellectually, much of the thrust came from the post Second World War interest in systems thinking.

The concepts of systems have slowly emerged in the 20th century to assume a central importance in the thinking and approach of many scientists and technologists. The ideas have had an important impact on the approach of social scientists and economists.

Kast and Rosenzweig (7) state that a system can be defined as:

> **"An organised or complex whole : an assemblage or combination of things or parts forming a complex or unitary whole."**

Kast and Rosenzweig state that the various types of systems can be classified, in a hierarchy of levels, as follows:

Level	Description
Static Structure :	Level of frameworks such as the anatomy of the universe;
Simple Dynamic :	Pre-determined, necessary, motions;
Control Mechanism :	Self-regulating in maintaining equilibrium;
Open :	Self-maintaining structure being the level at which life, or cells, begins to differentiate from none-life;
Genetic-Societal :	Typified by plants;
Animal :	Characterised by increased mobility, teleological behaviour, and self-awareness;
Human :	Individual is considered as a system with self-awareness and the ability to use language and symbolism;
Social :	Consideration of the content and meaning of messages, the nature and dimensions of value systems, the transcription of images into historical record, the use of subtle symbolisation and complexity of human emotion;
Transcendental :	These are the ultimates and absolutes and the inescapable unknowables, and they also exhibit systematic structure and relationship behaviour.

The research activities detailed in the chapters which follow constitute an examination of a system of human organisation and Kast and Rosenzweig state that there are three managerial levels in the hierarchical structure of complex organisations:

(a) The **technical level** is involved with the actual task performance in the organisation. In industry, the technical functions involve the actual production and distribution of products or services. The technical system is not just involved with physical work but includes many types of technical activities utilising knowledge. For example, research and development, production control, market research, operations research, and most accounting functions are part of the technical system;

(b) The **organisational level** co-ordinates and integrates the task performance of the technical system. A primary function of management at this level is to integrate the input of material, energy, and information obtained from the technical level;

(c) The **institutional level** is involved in relating the activities of the organisation to its environmental system. The organisation must continually receive supporting inputs from the society in order to carry out its transformation activities.

The impetus towards systems thinking, and the systems approach, has arisen for two reasons, namely, a recognition of the complexity of behaviour which arises in both natural and man-made systems, and from the need to gain control over the more threatening outcomes of their behaviour.

2.2 Project Management Systems

During the 1950s, it became apparent that all social systems exhibited open-system characteristics such as self-organisation and boundary management. Simultaneously, this systemic view was enriched by the essentially numeric set of disciplines that has their origin in applying the scientific method to industrial and military applications.
Slowly the two streams merged, helped enormously by the catalytic effect of the development of computers. Two immediate results, important in the development of project management, were the emphasis on defining systems as a whole and the consequent identification of key systems integration points.

As mentioned previously, modern project management practices have their origin in the work undertaken by the United States Air Force in the 1950s.

Morris (8) makes the point that a new United States Air Force organisation, **Air Research and Development Command**, was established, in 1951, to create a new research and development entity concentrating on the long-term development of weapons systems. This organisation was the forerunner of the **Weapons System Project Offices** which were created in 1954 with responsibility for planning systems development, overseeing the technical integration of components, ensuring compatibility of inter-dependent sub-systems and ensuring systems reliability.

These responsibilities would not be out of place if listed in a modern project management brief and the Air Force concept was that weapons systems should be planned, scheduled and controlled, from design through to test, as an operating entity.

Basic to the approach were the assumptions that:

- performance requirements could be specified;

- careful detailed pre-planning could eliminate subsequent configuration and engineering changes;

- speed and efficiency of development could be maximised by selecting the contractor whose proposal best met the performance specification.

These concepts are fundamental to all modern Project Management approaches as they emphasise integration and control of all programme, technical and cost aspects.

Over the last 40 years a considerable number of Project Management tools have been developed, as noted hereunder.

2.2.1 Programme Evaluation and Review Technique (PERT)

PERT is the best known of the Project Management tools and was developed by the **United States Navy's Special Projects Office** in co-operation with **Booz, Allen and Hamilton**, a management consulting firm.

It was specifically directed at planning and controlling the Polaris missile programme, a massive project which had 250 prime contractors and over 9,000 subcontractors.

The introduction of PERT into the Polaris project helped management answer questions such as:

- When will the project be completed?
- When is each individual part of the project scheduled to start and finish?
- Of the hundreds of thousands of "parts" of the project, which ones must be finished on time to avoid making the entire project late?
- Is it possible to shift resources to **critical** parts of the project (those that must be finished on time) from other **non-critical** parts of the project (parts which can be delayed without affecting the overall completion time of the project)?
- Among all the hundreds of thousands of parts of the project, where should management concentrate its efforts at any one time?

Morris argues that PERT should not be regarded merely as a sterile process involving only the calculation of times, the drawing of networks and the determination of slack resources. He states that it is a dynamic process involved with change, with readjustment and with the formulation of new networks, when there are changes in schedules, and with the constant revision of plans to achieve better performance in the light of changing conditions. It is for this reason that the process of adjusting and re-planning a PERT network is of importance.

2.2.2 Critical Path Method (CPM)

Next to PERT, the **Critical Path Method** of planning and controlling projects has enjoyed the widest use among all the systems that follow the networking principle. **CPM** was developed by **Morgan R Walker** of **Du Pont and James E Kelly** of **Remington Rand Univac** to help schedule maintenance in chemical plants.

CPM is very similar to PERT as both use the network technique but they were developed to answer different questions. Morris makes the point that Du Pont required information on **activity durations** whilst the Navy required information on the **probability of an event occurring**.

The fundamental departure of CPM from PERT is that CPM brings the concept of **cost** more prominently into the planning and control process. When time and costs can both be accurately estimated then CPM may be superior to PERT. But when there is an extreme degree of uncertainty, and when control over time outweighs control over costs, PERT may well be the better choice. Notwithstanding the above, the networking principles involved in CPM are similar to those in the PERT system.

Under the CPM system, two time and cost estimates are indicated for each activity in the network, namely the **normal** estimate and the **crash** estimate. The normal estimate of time approximates the most likely time estimate in PERT. Normal cost is that associated with finishing the project in the normal time. The crash time estimate is the time that would be required if no costs were spared in reducing the project time. Crash cost is the cost associated with undertaking the activity on a crash basis so as to minimise duration.

Whilst PERT was the principal planning package of the 1950s, CPM was the more popular, or commonly used package in the 1960s. This was due, in the main, to fact that the founders of CPM left Du Pont in 1959 to form their own organisation, Mauchly Associates, to develop and market the CPM approach.

Other systems, however, continued to be developed as noted hereunder.

2.2.3 PERT / COST

Morris states that the **Polaris Special Projects Office** of the United States Navy had been conscious of the shortcomings of PERT, in that it was unable to deal with cost-related matters as satisfactory as it scheduled programme activities.

When they were originally developed, PERT and CPM were both time-oriented. They were designed to allow project planners to produce time schedules for the planning and monitoring of complex projects. In neither case was cost a major consideration, even though CPM did include the concepts of direct cost, indirect cost, and utility cost. Earlier users of PERT and CPM noticed the need for these techniques to deal with project cost control as well as time control.

The US Navy had worked with Lockheed, General Electric, the Mitre Corporation and Stanford University in the late 1950s to develop a version of PERT that included a cost-control dimension. In June 1962 the US government published a manual entitled **DoD and NASA Guide, PERT / COST Systems Design**.

This manual was of considerable significance in that it introduced the concept of the **Work Breakdown Structure** for the first time. The foundation of the PERT / COST system is the measurement and control of costs by **"work packages"**. These activities generally represent parts of a project for which responsibility is easily determined. In the original DoD and NASA Guide, the lowest-level work package was limited to US$100,000 in cost terms and 3 months duration.

Subsequent variations of the PERT / COST technique have been considerably more flexible in defining such limits. Today there are many different versions of this early project cost accounting technique.

The use of PERT / COST in project management allows one to go beyond the traditional comparison of actual with budgeted costs. Since this technique deals with time and cost, one can compare, in addition, **scheduled** work with **completed** work. Generally costs are coded according to activity. At the time costs are gathered, estimates are made of the proportion of that activity that has been completed. If the original assumption that cost and time are directly proportional is true, then comparison between cost incurred and work completed yields information vital to project control. Specifically, if an activity has incurred 75 percent of its budgeted cost but is only 55 percent completed, then one has what is normally described as a budget over-run.

It is quite usual for project managers to receive reports which answer pertinent questions such as:

- What is the expected completion time?
- Is the activity now on schedule?
- What are the budget over-runs on each activity?
- Is the situation getting better or worse?

2.2.4 CPM / COST

Sears (9) states that an original cost estimate has a great deal in common with an original critical path or CPM network as the estimate is a model of the structure in cost terms.

A CPM network is a model of time based on other completed projects. Cost control and CPM schedule control can be visualised as parallel functions.

The first step in integrating a cost control system with a CPM network is the examination of the degree of detail required for the systems as they are currently used. The basic building blocks of a network are activities, with an activity being defined as a unit of work which takes place in a specific location and has a finite time duration.

The simplest form of CPM / COST integration is that of an activity which involves only one cost account and where the cost account is unique to that activity. A more beneficial approach is to allow a cost account to consist of numerous activities. The actual cost of each activity is lost using this method but, since the activities vary in size, in complexity and cost, from project to project, this loss of detail is of little significance.

The information required for CPM / COST is the same as that required for any conventional cost system. The combination of costs and the CPM schedule also facilitates accurate cash flow forecasting. Cash forecasting falls more into the realm of financial management than project management but the efficient use of cash on a project can have a major impact on the total project cost.

2.2.5 Graphical Evaluation and Review Technique (GERT)

Morris (10) states that the estimation of a proposed project's construction cost and duration by network analysis has been the subject of considerable research since the introduction of CPM and PERT.

The original distinctions between the deterministic CPM, with its emphasis on cost, and the probabilistic PERT, with its time concerns, have tended to fade with the synthesis of commonly applicable network formats and the development of computer facilities capable of handling the combined data requirements.

It can be argued that what was lacking in the initial planning, or pre-contract review, stage of project development was a means of exploring the likelihood of project delay, the financial implications of delay and the eventual necessity of 'crashing' in order to keep the project on schedule.

This can be overcome by the use of pre-construction analysis of proposed schedules which will result in the identification of several key dates, or milestones, within the construction period. The attainment of a number of intermediate milestones may also be necessary to delineate phases and keep the work on schedule.

The proposed milestone method of dealing with activity duration-cost functions that are conditionally dependent on start date or other future outcomes is based on the **Graphical Evaluation and Review Technique (GERT)** whereby activities are structured in a discrete decision-tree fashion, within a conventional PERT / CPM network of sequential operations.

The study reviews deterministic and probabilistic programming methods together with the commonly assumed time versus cost relationships. These aspects are then classified according to the treatment of uncertainty in structuring individual activity data for network analysis.

GERT is a planning rather than a project control tool and **Pultar (11)** has developed this argument by stating that the main aim of the technique was to overcome the problem of multiple activities during the application of the conventional critical path and precedence diagramming methods to construction scheduling.

There are several factors which have contributed to the ineffectiveness of CPM / PDM techniques. Pultar was concerned that CPM considered only time which is not the principal consideration in the world of construction. In construction, progress is considered in terms of the amount of work to be completed rather than the time in which this may be done as is the case in CPM / PDM techniques.

The timing or scheduling of activities in construction is much more likely to be governed by the progress level achieved on other activities than by simple time constraints. Such interdependence between activities is formalised by timing relationships.

Project scheduling is concerned with the problem of determining the early and late starts, along with the respective progress curves, of the activities contained in the project.

In each activity, the events for which early project time values are to be computed are identified by finding:

- The events on which constraints are imposed;

- The events that are predecessor events in timing relationships.

The procedure of revising the early and late starts of the project activities according to the actual progress is known as schedule updating and allows managers to revise schedules on the basis of known information.

Dawson and Dawson (12) confirm this view and state that activity networks such as PERT have been used to plan and manage all kinds of projects within both academia and industry. They are, however, limited by their inflexible structure, and, therefore, cannot explicitly identify and control potential risk points and uncertainties within projects.

Current thinking within the field of project management identifies the need to manage five objectives successfully within any project - **scope, quality, time, cost** and **organisation**.

Generalised activity networks, therefore, provide a more realistic means of controlling projects by identifying and analysing scope possibilities within project plans. However, only two implementations of generalised activity networks have been created over the years - Graphical Evaluation and Review Technique (GERT), which has been described above, and a similar technique entitled the **Vertical Evaluation and Review Technique (VERT)**.

2.2.6 Planning Orientated Evaluation Method (POEM)

Howes, Little and Fong (13) have, therefore, developed a new system for dynamic project management and control known as **Planning Orientated Evaluation Method (POEM)**. This methodology has been considered as a core project management evaluation system incorporating cost and time analysis.

The performance control method gives the Project Manager a direct influence over the project completion date and rate of spend. The prime objective of the system is to permit project programmes to be prepared, on screen, by the Project Manager utilising modules of standard data relating to the activity breakdown of the project. Modules relate to programme, labour, materials, plant, site supervision, sub-contractors, asset realisation, variation schedules and cash flow forecasting.

Morris (14), however, states that there are a number of factors which affect the management of a specific project, namely:

(a) The complexity and volatility of the project and its environment;

(b) The extent which the technology is state of the art;

(c) The presence of external factors, such as government regulations and the physical environment, which serve to constrain management;

(d) The extent to which project size exceeds a previously established threshold for the industry, technology or enterprise.

Morris believes that the size and sophistication of project planning and control systems are determined by the degree of project complexity and that the requirements of a successful systems installation include:

(a) The system requirements must be specified at an early stage;

(b) The user level must be clearly specified;

(c) The design installation process must be planned;

(d) Adequate time and money must be allocated for system installation;

(e) The system installation must have an organisation to support it;

(f) Adequate time must be allowed for training the users of the system;

(g) Procedures for obtaining and preparing data must be developed;

(h) Procedures must be installed, tested, and loaded with live data .

Morris concludes by stating that the time-honoured characteristics of a good system are:

(a) It provides timely data;

(b) The data is appropriate to the users' needs;

(c) The data is of good quality;

(d) The data is compatible with other data with which it must be integrated;

(e) The cost of obtaining the data is reasonable.

Morris views the systems approach as a mechanical application of rules on procedures and it is argued that the Form 'X' system described in Chapter Three is in line with his way of thinking.

Walker and Hughes (15) have a similar viewpoint to Morris and they argue that, in order to analyse operating and managing systems, in terms of their effect on the project outcome, it is necessary to identify relationships and distinguish between various levels of decision-making.

Key decisions are determined by the client as a result of the client's internal procedures for expenditure. They range from approval of design and budget proposals, and decisions to delay the project, to decisions to change the nature of the project. The systems created by primary decisions consist of a number of sub-systems created by key decisions.

Morris (16) has undertaken considerable research into the operation of project management organisations and he states that project management has encouraged innovation in three areas namely:

- The development of project management tools and techniques;
- The use of the Project Manager as an activator or integrator;
- An increased knowledge of project organisations.

The systems framework pervades project organisation thinking and project management is a coherent management activity in a dynamic situation which distinguishes it from the management arrangements which apply to manufacturing industry. As noted above, projects are transient phenomena and project management is the dynamic management process for accomplishing defined change.

Morris emphasises that projects have a defined end objective, namely completion of the project, and they follow a series of processes as detailed hereunder:

(a) Planning and implementing work in certain pre-defined sub-systems;

(b) Creating an organisation based on the principles of project organisation;

(c) Moving through an immutable life cycle which is common to all projects;

(d) Implementing project control systems that report against pre-determined data.

Control needs vary by level of management and this determines the quality and quantity of data which is required. Morris makes the point that, in order to provide data that is reliable, project control should be undertaken by an organisationally discrete staff group which is remote from the functional group working on their project.

As will be seen from the sections which follow, it can be argued that project management systems are merely tools in the planning of construction activities and other factors are of equal importance.

2.3 Project Management Structures

As stated above, the main technical functions which the Project Manager needs to perform are those of planning, cost control and the administration of contracts. None of the other people involved in a project regard these matters as their principal activities. For this reason, developments in technique for these three functions have been rapid since project management, as a separate discipline, has emerged. Managers now use well tested systems and organisational forms to suit the needs of their project.

Thompson (17) argues that clients must provide the resources and support which the project requires. The owner of the project must also provide clear direction and timely decisions and must assist the project management team in driving the project to a successful conclusion.

A strong, temporary, corporate project team should be established, within the parent organisation, to support project management.

Shirazi, Langford and Rowlinson (18) have also researched this topic and state that the process of developing an appropriate organisational structure has its roots in organisational theory dating back to the 1940s. More recent developments in organisational design have focused upon the process of achieving a co-ordinated effort through the structuring of tasks, authority and workflow. Their findings suggest that complex environments lead to greater decentralisation of authority, mainly by delegation.

Tatum and Teague (19) support this contention and state that the increased scope and complexity of civil engineering and building construction projects has increased the size of the design and construction organisations. It is evident that large and complex structures will be required for the "super-projects" of the future. Energy generation and distribution and transport infrastructures are examples of the type of project which will demand larger organisations for adequate project performance. Tatum and Teague also describe the necessary systems and information flows which are required in civil engineering and building construction and make specific reference to the type and timing of critical information.

The specific objectives of a construction programme were also identified and such programmes were considered to be essential in order to ensure that both the conceptual design and construction details would support the most efficient construction sequence and method of construction.

Harding (20), (21) and (22) has produced a number of papers dealing with the pattern of organisation and he argued that the pattern should mirror the function performed, not the authority inherited. The effectiveness of this pattern will depend upon whether the operational manager accepts the functional authority of the specialist.

Harding also touches on the importance of interpersonal relationships and he focuses on the fact that it is the people within organisations who carry out its functions and who exert authority, discretion and responsibility. Harding argues that control stems from the planning process and objective setting carried out by the employees of the firm. He also states that having an objective is fundamental to control and that without determining objectives, control is not possible. In organisational structuring it is usual to find both objective setting and control in the hands the personnel who occupy key posts.

The work of **Bissett (23)** is particularly relevant in this area and he advocates a structured approach to project planning and control which, he states, involves four stages:

(a) Ensuring appropriate involvement of the project management team;

(b) Top down development of the project plan;

(c) Definition of updating procedures, including data collection and progress reporting;

(d) Preparation of a procedures manual and training of project control staff.

The process of management control can be viewed as a four stage iterative cycle:

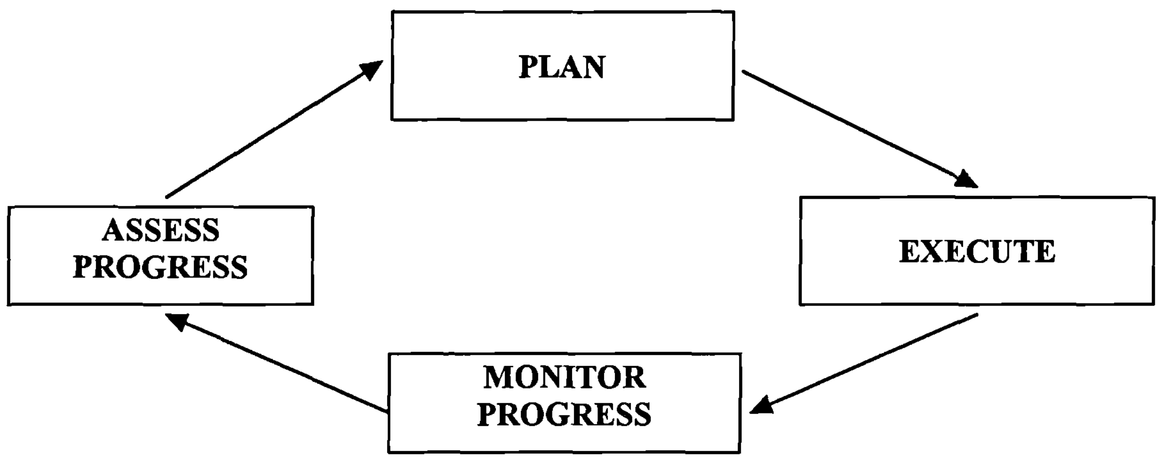


Figure 2.1 <u>**The Cycle of Management Control**</u>

Source: **A Structured Approach to Project Planning and Progress Control** by Bissett in Project Manager, July 1982, page 5.

For management of the project, the 'Assess Progress' stage requires updating of the project network. Emphasis is placed on documenting any changes in the assumptions underlying duration estimates or activity relationships.

Bissett stresses the need to communicate the results of the update and recommends the use of a system which mandates the submission of updated progress reports to senior management at regular intervals. He also states that a procedures manual should be compiled for the following purposes:

(a) To act as a reference to the overall planning approach;

(b) To act as a guide to project documentation;

(c) To act as a training aid to the Project Manager.

Hayward (24) makes the point that procedural systems will only be effective if a strong and highly skilled project management group is in place. He argues that the team must have the power to direct, co-ordinate, programme, monitor and determine priorities for various contracts and design groups. The team must manage every aspect within a cost budget and a prescribed time schedule.

Major projects involve many construction disciplines and it is necessary to select staff carefully to ensure that they are of sufficient calibre and experience to execute the project.

The successful completion of large projects relies heavily on appropriate systems being set up at the start and depends on the use of experienced management with a real understanding of their duties. Managers must also be adept at controlling spending of money against the realistic forecasting and programming of the contract work.

Weinberg (25) placed considerable emphasis on the control of time and cost and he argued that the greatest potential savings, in time and cost, in a construction programme, can be achieved during the design phase. This view has general support as it is during the design phase that the building criteria are established, systems and components affecting construction schedules are selected and the start date for construction decided.

These activities almost always influence time and cost more than the management activities which are not usually initiated until construction begins. In order to be most effective, therefore, the Project Manager should be employed before the designer and work with the client in determining the organisation during the initial planning and budgeting stages of the project.

The Project Manager's objectives are to provide the owner builder or developer, with the widest range of construction services required to complete a project within the established programme, budget and time in the most economical, expedient and professional manner.

Weinberg states that evidence exists, both in the United States of America and Europe, to indicate that the use of time/cost control systems effectively allows projects to be designed and constructed in less time, and at less cost, than directly comparable projects using more traditional methods.

It should be recognised, however, that a system is simply a series of inter-related procedures which have evolved, been tested and been proven to be practical and productive when staff and the structure are in place.

Weinberg's time/cost control system consisted of ten basic components:

(a) Effective pre-design programming and budgeting;

(b) Proper selection of consultants and preparation of contract documentation;

(c) Use of pre-design project analysis;

(d) Use of costs and methods analysis;

(e) Use of integrated cost control procedures;

(f) Use of design review and approval procedures;

(g) Use of time control procedures;

(h) Use of computer assisted scheduling;

(i) Effective management of contract award;

(j) Effective management during construction phase.

Partington (26), however, counsels caution and states that it is necessary to abandon more bureaucratic forms of organisation in favour of flexible, project-based, structures. He states that organisations are merely reflecting demands for change in a number of ways:

- Downsizing
- Co-operation
- Delayering
- Learning
- Innovation
- Empowering

Partington argues that systems need to be tailored to specific organisations and he presents evidence that it is difficult to achieve a balance between excessive control and insufficient control in a multi-project environment. However, bureaucratic forms of organisation may provide an environment of security and continuity for the individual.

Ryder and Mercer (27) have researched the topic and state that the Project Management structure for large projects should take the following form:

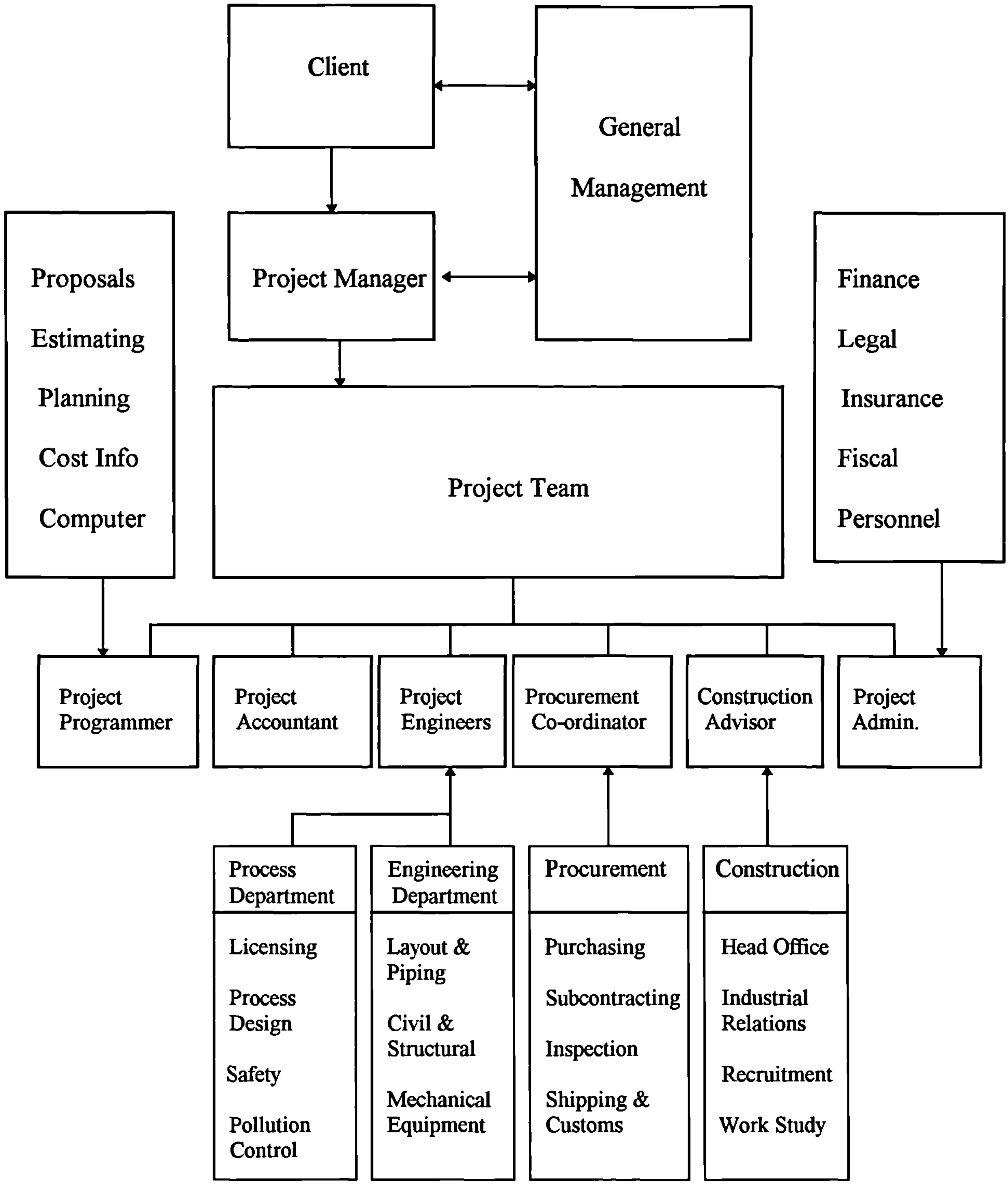


Figure 2.2 <u>**Project Organisation**</u>

Source: **Project Management** by Ryder and Mercer in Management of Large Capital Projects, published by ICE, London, 1978, page 82.

Under this set up the Project Manager is required to oversee all aspects of the project and, in relation to cost control, must decide whether the estimate prepared in the tender stage is in sufficient detail to become the **Cost Control Document** at contract stage. If the estimate has been prepared in sufficient detail it may well be suitable. However, if the estimate has been prepared in a short space of time it may be necessary to prepare a more detailed estimate to be used as the Cost Control Document. The control point is generally the **Cost Controller** who forms part of the project team. The Project Manager may stipulate that he requires to personally authorise:

(a) all purchase requisitions over a given value;

(b) purchase requisitions for certain key items, which either have a significant effect of the operation of the facility or the execution of the programme.

More senior management approval is also desirable where orders in excess of a prescribed sum are to be placed or sizeable over-spends are anticipated.

The Project Manager must hold, at regular intervals, a detailed review of the costs incurred to date, and the trends which are appearing, both within the job and nationally, or internationally, as far as escalation and hardening of markets are concerned, so that a view can be taken in predicting the anticipated final cost.

In relation to the programme the Project Manager must develop an overall network with a limited number of activities to ensure that the logic of the proposed method of carrying out the work is basically sound. The inter-dependencies resulting from this should then be clearly shown in critical path form and the immediate sub-critical paths identified.

Hollands and Wilson (28) are concerned with the tendency to be prescriptive over the structure of organisations and they argue that each building project is unique and the project organisation must be designed around its unique features such as its people, its location or its distinctive competence. Therefore, a one-off management design system is created for a specific project to be completed at a specific cost, in a specific time and in a specific place.

The organisation should take into account the history of previous projects, learn from them and use the information for the benefit of future projects.

Holland states that the basic philosophy, spirit and drive of an organisation have far more to do with its relative achievements than do technological or economic resources, organisation structure, innovation or timing. All of these things weigh heavily on success, but they are, it is argued, transcended by how strongly the people in the organisation believe in its basic precepts and how faithfully they can carry them out.

Holland argues that decentralised decision making distributes the responsibility as autonomy is provided together with discretion. This decentralisation brings with it a financial discipline and responsibility while not disturbing the flexibility needed to carry out construction activities. The basis for project organisation includes a combination of 'loose' decentralised functions and 'tight' centralised functions so that there is a balanced reconciliation of all stages of the project.

The impact of these concepts, and the others which have been included in the earlier sections, have a impact on the personnel working within the organisation and this forms the basis of the next section.

2.4 Interpersonal Factors

Webb (29) states that project management was born from two separate events, firstly the appointment of people responsible for the completion of 'projects' and secondly, the use of techniques, known only to the initiated, to give the managers a new and precise level of control.

Webb argues that, rather than rely on control devices, a better approach lies with the people that do the work and he claims that the original scientific management approach, with its strong emphasis on order, structure and a deterministic view, completely excludes the human element. This action may lead to difficulties especially where firms have large numbers of contract staff. These staff may fail to appreciate and abide by the values of the organisation with a consequent failure to control.

Craig (30) also indicates that project financial controls, particularly on a one-off, mega-project of significant complexity, depend heavily on having the right managers in the right place. Again the importance of having the appropriate people in post is emphasised and Craig states that effective controls stems from having:

(a) An effective leader in charge of the project;

(b) A management team that actually works as a team;

(c) An effective management system to monitor progress and control costs.

It is argued, therefore, that the human resources element is of crucial importance to the functioning of the system.

Barnes (31) has published a number of papers on the importance of human resource management and he states that effective project management has much to do with people and their motivation. He argues that getting the motivation right can have more impact upon project success than choosing the correct system. Whilst this can be debated, there is little doubt that motivational factors can have an important impact upon the project management arrangements.

It follows, therefore, that the systems of planning and cost control should be examined to see whether they are appropriate to the style of control exerted by senior management.

The key to effective control lies in the level of responsibility, or empowerment, given to managers and **Edmonstone and Havergal (32)** define empowerment as:

> **"enabling those who work within the organisation to achieve its purpose, to share its values and to feel valued themselves"**

Edmonstone states that empowerment should not be seen as an end in itself as the aim is to create the conditions to enable decisions to be taken.

Newcombe (33) has also been active in this field and he has attempted to link construction project management with the theory of organisational power. He argues that construction management is based on the modern management principle of empowerment and that good people management skills and communication skills are necessary in order for the project manager to develop new sources of power such as information access and credible relationships.

These concepts are echoed by **Naoum and Pryce (34)** who state that firms which anticipate and react accordingly to their internal and external environments are far more successful than static, reactive, organisations. They also argue that successful firms have a people focus and try to develop a strong culture directly associated with success.

Success in project management terms means matching structure to strategy, structure to culture and culture to strategy. The difficulty lies, however, in the transient nature of construction professions who tend to move from project to project rather than remain with the parent or commissioning organisation.

This fact was recognised by **Handa and McLaughlin (35)** who state that construction projects, particularly large projects, involve inter-personal relationships at various levels. Understanding and controlling these relationships is as essential as controlling the physical aspects of a project.

The minimum requirements for inter-group effectiveness have been postulated as:

- Internal social stability
- External value sharing
- Legitimate authority hierarchy

The social interaction of the various on-site personnel very often affects the mood of the whole project and systems may need to be devised to ensure that the organisation's aims are not subverted by the aspirations of the staff. Staff on large projects may not be aware of the aims of the organisation and contract staff may experience difficulties in working to unfamiliar rules and procedures.

Barnes (36) has considered the aforementioned arguments and he stresses human factors as being the key to achieving good project cost control. Barnes argues that success in controlling the cost of a project has much to do with interpersonal relationships, with attitudes to control and with the way authority for making decisions is divided amongst a group of managers.

He believes that the analysis of completed projects reveals little connection between the technique of cost control used and whether the cost target was met. Instead it appears that if a project was firmly expected to be completed within budget, and the people running it firmly believed that it could be, it usually was. By comparing evidence from various sectors of the construction industry, he identifies the attitudes, organisation and information which people need in order to control project costs effectively.

Barnes believes that successful cost control depends upon the attitude of Project Managers and indicates that it is human factors which determine whether attitudes towards cost control are either favourable or unfavourable. He illustrates the attitude of Project Managers to control by reference to **Figure 2.3** hereunder.

This figure, however, simplifies the range of project attitudes encountered in real life. An individual concerned with project management decisions will be positioned somewhere in the triangle of control attitudes according to the relative importance he attaches to control of performance, cost and time.

It can be said that a Project Manager with a balanced attitude to control should place himself equidistant from the three points of the triangle so that he can take all three factors into account each time a significant decision needs to be taken.

This may not, in fact, be appropriate and it can be argued that the Project Manager should adopt the same attitude as the project sponsor, or client.

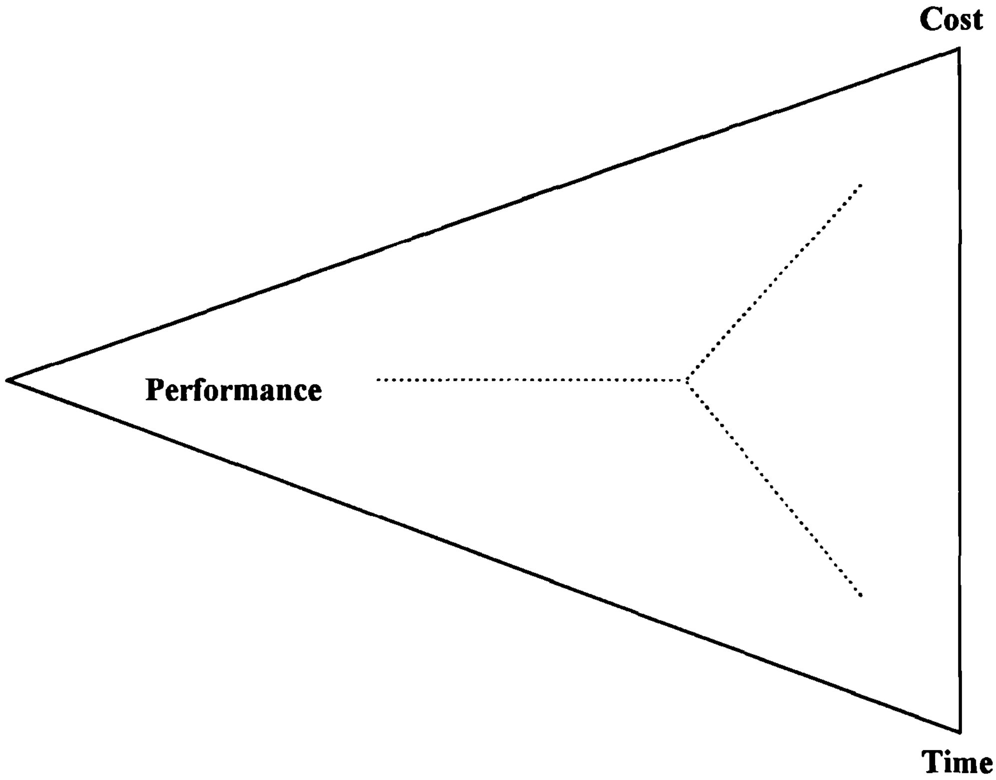


Figure 2.3 **The Project Manager's Attitude To Control**

Source: **Human Factors In Project Control** by Barnes in paper to 5th International Cost Engineering Congress, Utrecht, 1978, page 245.

It can be argued that the only way to ensure that project cost is controlled is to put a cost controller in charge and then authorising him, or her, to take all of the decisions affecting project cost. This, in turn, means backing the Project Manager when conflicts with other, differently-motivated, personnel arise. As long as the cost controller is the person in charge, the selection of a particular control technique is of less importance.

The problem in organising to achieve cost control is that of determining the spending authority amongst a group of managers. Each manager should make his decision in the same way that the top manager would if he knew the detail and had time to make the decision.

On the smallest project, the senior manager knows all of the detail and has time to make all the decision so that no organisation for control, as such, is required. Few projects are really that small, but it can be argued that organisation for cost control is only a problem of scale and communication.

As noted above, an organisation structure which makes all managers react in the same way is conducive to control whereas one which requires senior managers to act differently from junior staff is likely to fail. The best way a senior manager can achieve control on behalf of the client is to make sure that all managers are aware of the major decisions which have been made and aware of the attitudes which they should adopt when making decisions at their level. This is at the heart of the argument that the development of a corporate culture will assist an organisation's decision making processes.

In addition to the above, the question of ability, or lack of it must also be addressed.

Barrett (37) has conducted research in this field and he stated that an ability gap exists within construction firms whereby the level of knowledge demanded by the task faced, and the abilities of those doing the work, are unequal.

The concept of the firm's ability gap enables technology, systems and structure to be seen as alternative means of reducing the volume of exceptions referred up the hierarchy of the firm. The magnitude of the gap will depend on the abilities of the staff and the extent to which technology, specialisation and team working are employed.

The skill of the individuals within the firm, together with the organisation's culture, will dictate the nature of the system which will be used to exercise project cost control.

Skitmore, Stradling and Tuohy (38) are in agreement with this point and they state that it has been established that human judgements are subject to systematic error, or bias, as well as unsystematic error or variance.

They make the point that a considerable psychological literature has developed from the study of judgmental error and the process of decision-making under uncertainty. Their conclusion was that the organisational structure and systems of the organisation must be carefully designed to be appropriate to the project, with full consideration of the participants contribution to the decision making process.

This is particularly true with respect to the development of systems and structures relating to financial control. Any cost control methodology which is devised will be required to deal with reality and **Cormican (39)** makes the point that Project Managers operate in an industry which exists in a state of uncertainty and which faces problems not encountered in other industries. Cormican states that managers in the construction industry operate in a completely different environment from a manager in a manufacturing company.

Cormican states that a thorough understanding of organisational theory is essential as managers need to appreciate the generalisations applicable to all organisations which may assist management when designing new organisations or managing existing ones.

Cormican also makes the point that the construction industry is in a unique situation because of the nature of its production base. He argues that the construction industry cannot adopt a number of the techniques which have been developed with the aim of improving the performance of firms, including the use of corporate culture, due to the short duration of production activities.

Some of the unique problems facing managers in the construction industry are as follows:

(a) They are expected to set up a factory (site), produce and erect components (construct), make a profit and close down in a specified period;

(b) They will have to supervise technical staff in each new factory (site) who are unlikely to have worked together;

(c) They must obtain and control a labour force which fluctuates significantly during the course of a contract and which is, traditionally, itinerant in nature;

(d) They must obtain and control plant and equipment, the requirements of which fluctuates significantly from month to month;

(e) Their future work load is often at the mercy of Government policies;

(f) They are usually unable to communicate with the design team or client before tendering;

(g) They often lack the time for detailed planning after the award of the contract;

(h) With the exception of speculative house-builders and contractor-developers, they cannot mould their own market as both product and time scale is decided by external parties;

(i) They must control both domestic and nominated sub-contractors;

(j) They usually operate in a fiercely competitive market place;

(k) Government policies create uncertainty within the industry making finance for projects difficult to obtain and accurate long range planning difficult;

(l) The designers and their clients are often vague about short term objectives;

(m) Project designs are subject to change at short notice and contractors are, on occasion, required to tender and/or commence construction before designs for components or sections are complete.

The difficulty in using established techniques has been recognised by **Taylor, Benton and Kellogg (40)** who have stated that building an interdisciplinary team, and related understandings, can take from six months to two years. This makes the use of a team-work approach to cost control problematic as the participants are unlikely to have bonded during the initial stages of the contract. This is particularly true when 'fast-tracking' or other expedient decision making techniques are employed.

Dodd and McDermott (41) make the point that most cost control difficulties are caused by variations to the contract. They also indicate that variations do not appear to be strongly related to time and cost but have much to do with the personalities involved. They make the point that human relations clearly impact both on project conflict and project performance and a cost control system may be used to clarify relationships and minimise the risk of dispute.

2.5 Information Management

Buckley (42) makes the point that organic and socio-cultural systems are examples of **'organised complexity'**. Whereas the relations among components of mechanical systems are a function primarily of spatial and temporal considerations, and the transmission of energy from one component to another, the interrelations characterising higher levels have come to depend more and more on the transmission of **information** - a principle fundamental to modern complex system analysis. Information exchange, or the process of **communication**, cannot be over emphasised.

Communication is, therefore, an essential and a most important part of the management process. The process of communication involves an interchange of thoughts, information, knowledge and opinions. To transmit information to an individual is only part of the total process. Communication has not taken place until the person receiving the information is in a position to understand what the information means and is able to respond to it. This response is known as **feedback** and it is an essential part of the communication process.

When communication is regarded as a process, therefore, it is not complete unless it engenders a response from the person to whom it is directed. Information has to be identified by its receiver as being meaningful and to which, if the communication process is to be completed, a response has to be made.

The design, construction and commissioning of a project can only be successful if good communication exists between all the parties that are involved, and high quality information is passed throughout the whole of the project management system.

Nevertheless Buckley states that few, if any, project management information systems are free from serious defects. A management information system, in this context, is a system through which specified data is collected, processed and then communicated in order to support decision-making by those who are responsible for the management of resources, by providing accurate and relevant information concerning those resources at the appropriate time.

Because of the vastly improved data processing functions as a result of the use of computers, management information systems are frequently assumed to be synonymous with computer-based information systems. This is not necessarily the case, though clearly, with the undeniable advantages of the rapid and extensive processing facilities that are available by using computers, it is desirable that a management information system of significant size and complexity should, more conveniently, operate in this way. The use of a computer for this purpose, in itself, demands a readjustment of many management philosophies in order to adapt to the facility to process ever-increasing volumes of data and information for the purposes of construction project control.

In order for a manager to be able to request information, have the data collected and processed, and then to have the information transmitted back to him, a communication system needs to exist. Within this communications system will be the individuals who will undertake all the processes that are involved, both in relation to the internal organisation of that system and its environment.

The system that enables an organisation to operate as a whole, and to co-ordinate the various skills and the efforts of all of those individuals involved towards achieving the company's objectives, is its communication system.

These communication systems will be at various levels of operation, namely between individuals, between divisions or departments of the company, between different projects and between different companies within a group of companies.

Without appropriate communication systems an organisation can neither be led by its senior management nor can subordinate managers be expected to participate in the decision making appropriate to their particular level within the organisation.

Carter, Cheetham and Lewis (43) make the point that, in many organisations, communications have been designed to satisfy organisational needs based upon the real or perceived hierarchy of the members of the management structure and their 'need to know', or have access to particular items of information. It can be argued that information flow should be related to decision making and the resulting communication system should indicate the way an organisation actually functions.

Efficient information systems are an essential tool in organisations and a systems management approach can be used for the benefit of all parties.

Galbraith (44) emphasises this fact and states that the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance. The basic effect of uncertainty is to limit the ability of organisations to pre-plan or to make decisions.

As the amount of uncertainty increases, and therefore information increases, the organisation must adopt integrating mechanisms which increase its information processing capabilities.

Galbraith makes the point that this increased capability can be accomplished by:

- Hierarchy
- Co-ordination by rules or programs
- Co-ordination by targets or goals

To avoid information overload an organisation can:

- Create slack resources by raising the level of budget authority;
- Create self contained tasks by empowerment;
- Invest in vertical information systems, including systems of communication;
- Create lateral relations, including establishment of task forces.

The organisation would be able to follow one or more of the abovementioned strategies and it is argued that failure to do so will result in reduced performance standards.

As mentioned above, the systems concept is of fundamental importance to modern management science thinking. It has made a far-reaching impact on the ways in which the functions of management are being both planned and implemented.

Its application over a wide and diverse range of activities has provided the modern manager with an analytical framework that can be used to cope with problems and situations which are increasingly complex and difficult to understand.

A management system will consist of all those parts of the system which come under the control, and can be influenced by, a particular manager or management. Everything outside the boundary will become the environment of the system. If the environment is changed the system will be affected and, as a result, the system may change some or all of the activities of the environment.

The environment of a management system consists of those aspects which influence the system contained within the boundary but which are not directly under the control of the system manager. For example, if the management of a construction site is considered, then part of the environment will usually consist of the requirements of the relevant local authority, the activities of trade unions, health and safety legislation etc.

All of these factors, and others, influence the system under the Project Manager's control but they are not directly controlled by the manager. As a result, it is often difficult to draw a precise and exact boundary round a particular management system since there will be grey areas of interaction between the two. In spite of this, an attempt to define the boundary is essential for an adequate understanding of not only how the system will interact within itself but also with its environment. It will enable the manager to define more clearly the objectives of the system and, if necessary, each part of the system.

If a management system is to be controlled, data must be provided as a feedback in order to form the basis for decision-making. This in turn implies that a system must incorporate the means for collecting, receiving, storing, classifying, analysing and transmitting data as part of a management process.

This concept is at the heart of the research project detailed in the chapters which follow.

Another human factor to be considered concerns the operation of information systems as information must be as accurate as possible if control is to be more than an arbitrary selection between alternative courses of action. The best way to achieve this is to ensure that all managers responsible for contributing information to the system also receive information to help them do their job. In this way the Project Manager has an interest in providing accurate data.

O'Brien, Fischer and Jucker (45) state that a co-ordination system can achieve an efficient allocation of resources with differing amounts of information. They note, however, that a centralised system is much better at reacting quickly to crisis and with less duplication in effort. In principle, this mode of co-ordination minimises the amount of information that can be shared for selection of an optimal response to a changed condition.

For centralisation to become practical, internal organisational units must be willing and able to share information. Modern information technology now makes sharing possible and it facilitates the free flow of information.

Alexander (46) makes the point that participants are seen as part of a system charged with achieving specific objectives set by the sponsoring organisation and it is argued that communication is the key to achieving the cohesion of the team.

Spridharan (47) agrees on this point but states that many project and scheduling systems produce a large number of redundant and useless reports that do not contain specific directions as to how they can be used to assist managers in fulfilling the project objectives.

Current reporting systems do not meet the requirements of the personnel who work in the building and civil engineering industries as they require precise information relating to future cost trends based upon known information.

Wright (48) states that information flow models can demonstrate that the control of costs on construction projects can be approached in the same way as the control of company costs, namely by some form of budgetary control.

Wright argues that the basic objectives are to provide information at frequent intervals on the following topics:

(a) what the final cost will be;

(b) the reasons for the changes;

(c) the cash outlays which have been committed but are not yet paid.

Wright goes on to state that he believes that not only is there a need for the above information but it must be provided at the correct time to enable adverse factors to be reversed or compensated for.

Wright's basic **information flow** system is shown hereunder and demonstrates the relationship between the original information used for estimation/tender purposes and the actual cost of undertaking the project:

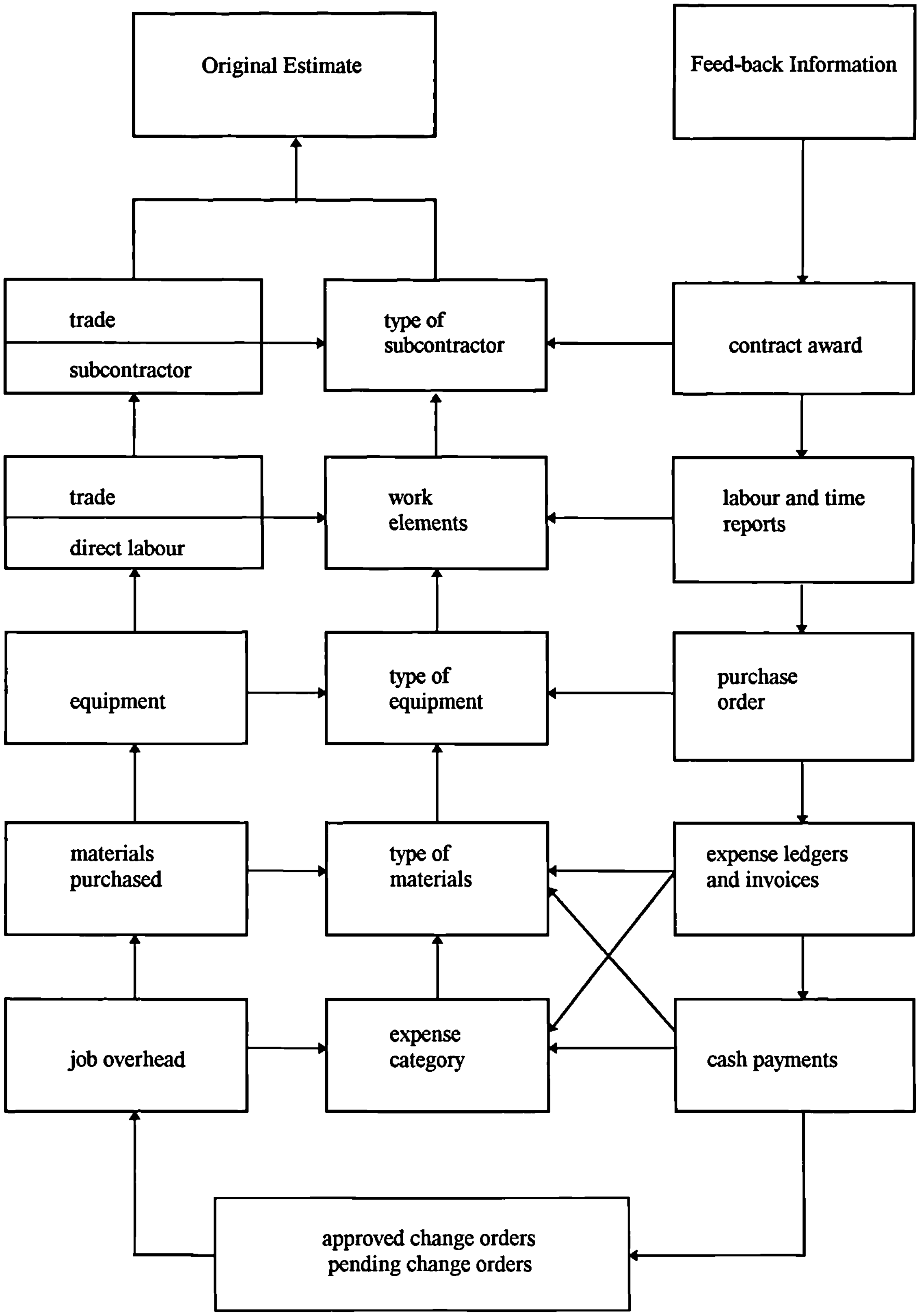


Figure 2.4 <u>**Information Flow System**</u>

Source: **Controlling Costs** by Wright in Building, 12 March 1971, page 143.

Information flow is vital but there are other factors to consider when debating the reason for inadequate cost control.

Beaton (49) also stresses the importance of information and he states that the Project Manager can receive significant support from the computer in exercising control over progress and costs.

He states that the Project Manager must to be able to prepare a project schedule, and then make a judgement as to its quality and reliability. There are various ways to analyse the quality of the schedule with the best way being to try alternative strategies, as is implicit in critical path theory. It is important to reconcile the theory with what has been done in the past, with the ultimate objective of preparing a reasonable, but tight, programme which is well understood and agreed to ahead of time. This is the initial, and most important step in project control.

The second step is to ensure that progress matches the programme. A good form of status reporting, involving a logical percentage complete tabulation, and a method for projecting the efforts of delays, are the pre-requisites.

Many of Beaton's examples are drawn from large projects. This is partly a reflection on the author's experience, which has tended to be on large, international projects, and partly because organisational issues are inescapably more important on large projects then they are on smaller projects. The attention to large projects also reflects their substantial growth in number over the past 20 years.

In this context information is of fundamental importance and this point has been taken up by **Nordqvist (50)** who states that the construction of a large and complex installation such as a hospital or steelworks is a process which extends over a considerable number of years and consumes large resources.

It is, therefore, extremely important that functional planning, in particular, should provide scope for the correct decisions to be reached quickly and enable the flexibility necessary to cope with unexpected changes in conditions to be retained to the greatest possible extent.

As a result he has formulated a functional programme to provide data for :

(a) the design of construction and equipment in the form required;

(b) the planning of the operation;

(c) the employment of staff.

The importance of information was also recognised by **Harper (51)** who placed great emphasis on the importance of communication and he states that increasingly, with modern construction techniques, the required performance of a completed building depends as much upon the person who manages the process as the man or woman who designs it.

This involves the early development of teams initiating proposals through feasibility and model studies to which both designers and construction companies contribute.

Barnes (52) takes this a step further and states that **Management Information Systems** which concentrate upon recording project costs and progress seldom have much impact upon management decisions.

Barnes states that projects are well managed by people with strong personalities and an aura of experience and badly managed by people who rely upon paperwork and management information systems. He argues that the main value of an information system is to distribute information about what has happened and it has little to do with control of what has yet to happen.

This suggestion is open to debate and **Branton and Butler (53),** in a more modern study, state that an appropriate control system will overcome human deficiencies. To Branton and Butler, the central theme is the expanding use of computers in project management. They argue that the project management system must allow for the creation of a data file, outside of the standard network structure, to capture and process this information.

Individual changes are rarely considered in isolation and the Project Manager is usually concerned to assess the cumulative effect of a number of proposed changes. Systems can be developed to detail changes and to estimate their effect on project finances and project duration.

Berney and Howes (54) state that the ability to accurately plan, monitor and forecast expenditure and resources, is critical to the management and corporate control of an organisation's economic health.

Predicting corporate profitability and its probable variation, based on the value of completed work to date, is not only essential to the health of a project but provides a powerful diagnostic tool for the decision maker. The activity of an organisation engaged in major construction activities is represented by an amalgam of projects and their control is vital to the overall success of the organisation.

Corporate control is, therefore, achieved by focusing on existing and future projects.

Existing project control systems have been observed to suffer from inadequate feedback due to the lack of sufficiently accurate information to facilitate adequate corrective measures. For this reason, management aids have been introduced, including software packages. However, a need exists for more reliable and flexible aids which go beyond currently available project and financial modelling software. In particular, current software does not address the need for reliable forecasting and contingency planning models of the overall financial and monitoring facets of the organisation.

The basic objective of Berney and Howes was to describe a variable and flexible means of planning, monitoring and forecasting project and corporate strategies and many predictive aspects of project management have been researched by them. However, as the term 'predictive' is open to wide interpretation, the specific concern of Berney and Howes' paper is primarily related to the application of quantitative methods.

The key issues addressed in Berney and Howes research work was the need to establish models to make improvements to the accuracy with which they represent actual projects.

Only on this basis did they consider the ability to forecast likely outcomes given statistically derived levels of confidence. Their secondary issue of concern was the need to determine a viable means of planning and monitoring.

The current methods of quantitatively analysing a project have generally relied on either the network planning approach or the bar chart approach.

The view taken by Berney and Howes was that network procedures were best used to analyse specific activities which involve a strict procedure and have a complex structure with the resulting "cost" break-down being incorporated in a bar chart. The term "cost" was used loosely in the sense that it was used to measure, for instance, man-hours or material quantities, as well as monetary outlays or returns.

Utilising information from specific activities, which are deducted using network analysis and the description of other activities to be specified within the structure of a bar chart it is possible to construct the profile of a project.

Monitoring, however, is not only concerned with the means of establishing performance which leads to re-planning, but also concerns the process of management in the light of determined targets or objectives. It is equally important for the client and management team to estimate the actual outcome of a large project, i.e. estimate total cost, duration profits and other "costs" associated with the current status of work.

The issues which Berney and Howes have tried to address are:

(a) To find the models which exhibited "cost" profiles that realistically replicate projects;

(b) To derive methods of generating budgets which are appropriate to a practical method of project planning;

(c) To derive a means by which current and future activities may be “re-programmed";

(d) To enable project trends to be soundly established.

It can be argued that, if a model can represent the activity or project accurately, it could be used as the basis of probabilistic investigation, thereby considerably reducing the need for time-consuming in-depth studies which the present system requires.

Whereas Berney and Howes have argued that there was some doubt about whether cash flow could be accurately forecast using the programmes available in the 1970s they now state that a large suite of computer programs has been developed to cover the forecasting of trends. This program, called **Visual Interpretation and Evaluation of Risks (VISIER)**, provides a corporate and project planning aid with a comprehensive quantitative and analytical basis.

The work of **Edwards, Shaw and Holt (55)** is also relevant and they have examined the trend towards computer-based records management with specific reference to **Electronic Document Management Systems (EDMS)**. Traditionally, information has been created and archived on paper but these system are being replaced by modern computer systems to allow documents to be manipulated throughout their entire life cycle. EDMS can allow easy document transfer between the parties in an instantaneous fashion.

This method would speed communication and reduce the level of paper required to convey or authorise decisions. A variant of this system will be suggested, in Chapter Five, as being a suitable communication mechanism for conveying Form 'X' decisions to the parties involved in the decision-making process.

Hastak, Halpin and Vanegas (56) have also developed a computerised decision support system which they call **Cost Management Planning Support System (COMPASS)**.

This system was developed because existing methods of cost control focus on identifying and controlling cost components that have already experienced a cost escalation and Hastak argues that existing methods focus on the symptoms rather than the cause.

COMPASS is a suite of programs which includes a data processing model, a group decision model, a probable weighted percentage cost escalation model and a decision analysis model. The four models use Microsoft Excel spreadsheets and workbook settings for data processing, information transfer and analysis.

The accuracy of the system depends to a large extent on the validity of the input data provided and it is important to analyse past performance data before the data is used in identifying potential risk attributes and in developing a cost control strategy for a new project.

Kirby, Furry and Hicks (57) has also been active in this area and he states that the establishment of a formal design review program conducted by qualified professionals is the most effective means of identifying deficiencies and incorporating improvements. Recognition of this has led the **American Corps of Engineers** to introduce a programme for conducting technical reviews of all significant projects. They have developed a computer aided management support which they call the **Automated Review Management System (ARMS)**. This provides a structured framework for conducting design reviews by linking all review participants into a common management network and database. ARMS fosters increased communication and interaction amongst all participants and provides a mechanism for data collection, collation and distribution of information and the analysis of claims.

2.6 Project Control

Munns and Bjeirmi (58) state that the role of different project management techniques to implement projects successfully has been widely established in areas such as planning and control of time, cost and quality.

The key to successful project management is the achievement of project objectives by utilising the existing organisational structures and resources. This is achieved by applying a collection of tools and techniques without adversely disturbing the routine operations of the organisation.

Project management is orientated towards planning and control and is essentially concerned with delivery on time, within budget and to appropriate performance standards.

The factors which cause project management to fail are:

- Inadequate basis for project
- Wrong person as project manager
- Senior management un-supportive
- Tasks inadequately defined
- Lack of project management techniques
- Management techniques mis-applied
- Project completion not planned
- Lack of commitment to project

The majority of the literature on project management stresses the importance of techniques in achieving project objectives. There has been a concentration on the 'hard' issues in project management, such as tools or techniques, rather than on the 'soft' issues, such as people management skills. This research project is an attempt to show that the two are inseparably inter-linked and each has a bearing on the other.

Harding (59) tends to focus on the 'hard' issues and he argues that objective setting is the key to successful project control. He puts forward two diagrams to illustrate his point of view:

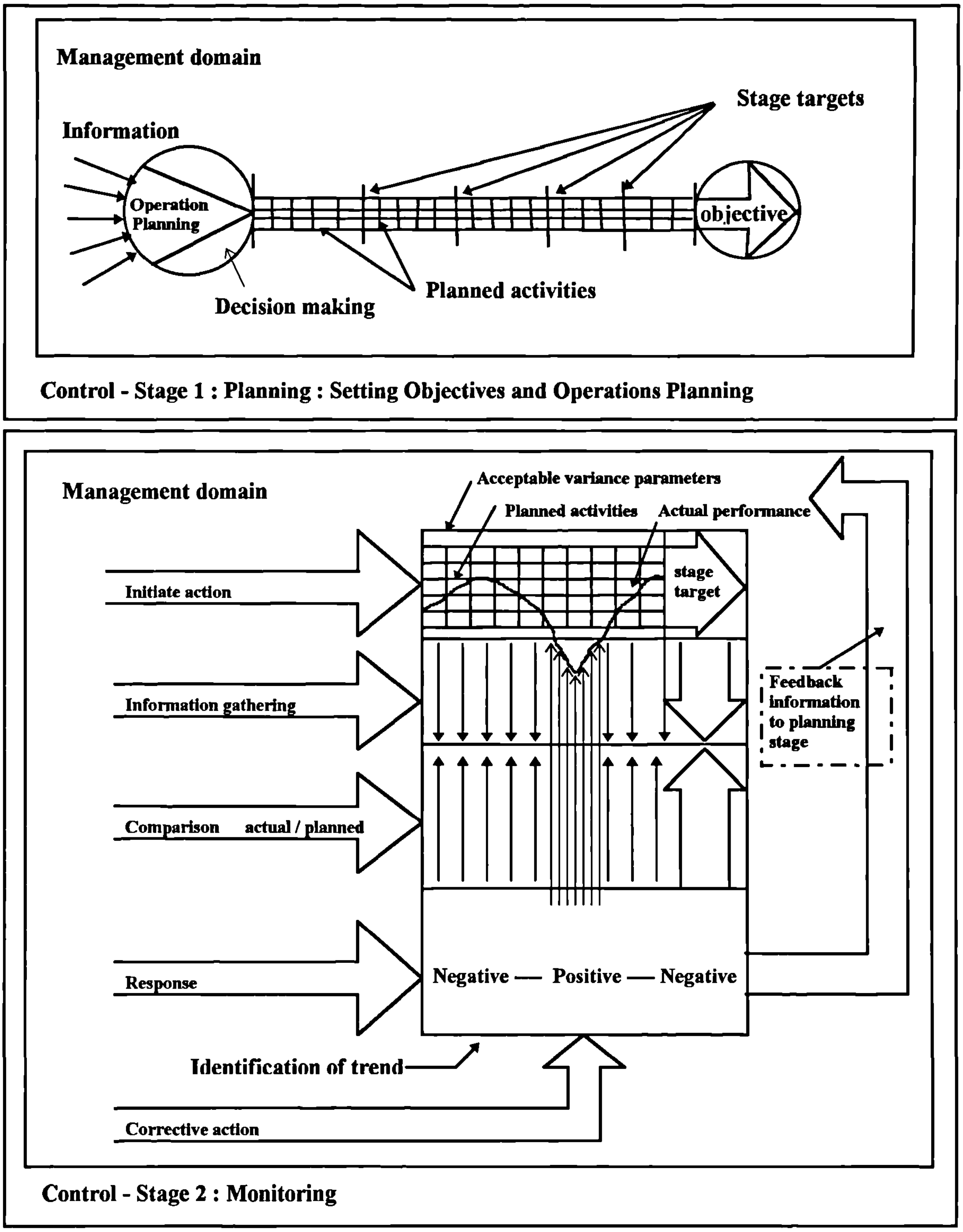


Figure 2.5 <u>Planning and Monitoring Model</u>

Source: **Management Should Ensure That Objectives Are Met** by Harding in Building Trades Journal, 31 October 1980, page 16.

These diagrams show that control stems from the overall process of planning and objectives setting and that regulation is the on-going process of monitoring. Regulation has been likened by Harding to the operation of turning on or off a tap. The tap is provided by the objective-setter, but the operation of the tap is given to others. This allows them to regulate the flow of water, but not to decide whether water should or should not be provided. In organisational structuring it is usual to find control invested in the key posts which direct the whole enterprise and set its objectives together with those which direct its major sub-systems.

Regulation may occur in two ways in an enterprise:

(a) **As a part of all posts to some degree**.

Each post in the enterprise depends upon others for its performance and if one member restricts his own performance then it acts as a regulator on other dependent posts. This may be deliberate, i.e. used consciously to influence another course of action, or accidental, i.e. arising out of inefficiency, incompetence or inability to resist more powerful external influences.

(b) **As part of the managing system**.

It is assigned to certain posts as a specialist function. Also, all posts have regulation assigned to them so that local regulation, at the level of each post, can be ensured. In practice it is usual to ignore the distinction between control and regulation and to refer only to control, but the distinction is important for a full understanding of organisation structuring.

Bissett (60) on the other hand believes that planned networks are the essential pre-requisite to project success and he advocates that the following courses of action should be adopted at the start of a contract.

(a) Develop a formal project network, both for planning purposes and as a basis for future progress control;

(b) Implement an effective progress control procedure, which requires not only the development of a network, but also requires reports on specification changes and assistance with the initial updating and development of a **Manual of Procedures**.

Hayward (61), however, believes that due to the varied and complex nature of modern projects, a strong, highly-skilled, **Project Management Group**, having the power to direct, co-ordinate, programme, monitor and determine priorities for various contracts and design groups, should be established as part of the primary control mechanism. He argues that the team must manage every aspect within a cost budget and a prescribed time schedule and must ensure that all interface and compatibility problems are resolved.

Hayward states that the Project Management Group should be set up at the start of the project, in order that the correct priorities, and overall planning, are efficiently channelled towards both the short term and overall goals.

In addition, at this early stage, the necessary techniques would be applied to enable adequate control of manpower, time and expenditure. By doing so, the client is relieved of the liability to adapt his own organisation to control the design and construction of the new facility.

The responsibility and extent of the authority of the Project Management Group would be clearly defined and should be incorporated in a detailed contractual agreement, whilst permitting the client the degree of control necessary to determine and particular preference. Hayward believes that it is important for the Project Manager to have authority to enter into contracts and make commitments on behalf to the client.

Morris (62) makes the point that it is not enough merely to establish project management groups and modern project control systems are required. In particular he argues that a number of significant changes have occurred in the nature of projects since the introduction of CPM and PERT namely:

(a) Projects have become larger and more complex in technical and organisational terms;

(b) Computing capabilities have increased dramatically;

(c) Complex, innovative, project organisational forms, such as matrices, have emerged, while behavioural techniques, such as group theory and conflict management, have become widespread.

Sophisticated project control systems are difficult to install, partly because they are usually technically complex, and partly because their implementation must be phased to suit the needs of the project as a whole.

Bennett (63) states that there are many techniques available for modelling construction projects in terms of separate roles, ranging from simple static models, of which bar charts are the prime example, to complex computer models.

He identifies eight means of co-ordinating construction projects:

- Rules, Programmes and Procedures
- Hierarchical Referral
- Goal Setting and Targets
- Professionalism
- Slack Resources
- Subdivision of Projects
- Vertical Informal Flow
- Lateral Relations

The use of these devices enables better technical and financial control.

Rowings (64) is in agreement with these points and states that the computerisation of project-control functions is now commonplace with sophisticated scheduling software widely available. Financial control software is, however, relatively rare with the emphasis on accounting-style packages.

Current software does not, however, perform the analysis that would provide the level of information which is useful for management such as trends, exceptions, comparisons and the context of the information. Project-control software suffers from a lack of integration and separate software has been developed for cost-control purposes and for schedule-control purposes. Lack of integration causes the manager difficulty in making decisions due to the inherent trade-offs between cost and schedule in construction.

These points are widely accepted in the construction industry and they form key elements in the Form 'X' Control Mechanism presented in Chapter Three.

2.7 Financial Control

Barnes (65) states that the object of project management is to produce a completed project which complies with the client's objectives. These objectives are a combination of the objectives for performance of the completed scheme, for achieving this performance within a budget cost limit and for getting the project into use by a target date. There are many projects which have been completed within budget, although the cost control paperwork and systems were inappropriate and handled inefficiently. Barnes maintains that attitudes towards completing the work within the budgets have more impact than the quality and efficiency of the paperwork and systems.

The next best way to run a project in order to achieve completion within the budget is to ensure that all those people making decisions affecting cost believe that the budget is an absolute top limit on expenditure. Where completion within budget is the main objective of the project, establishing and sustaining the right attitude to control is all important. If the work on a project is to be completed within budget, the effect of all decisions affecting cost must be forecast before the decision is made as illustrated hereunder:

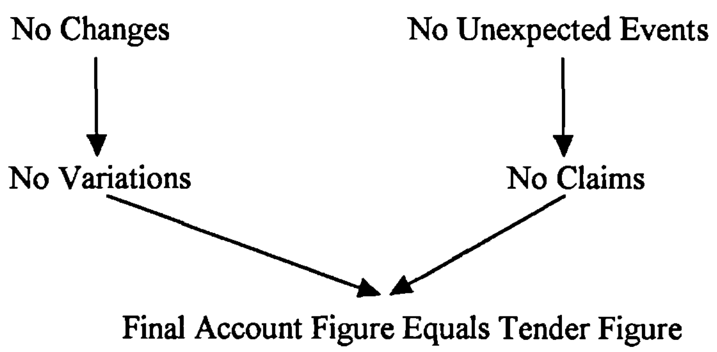


Figure 2.6 Control of Variations and Claims

Source: **Construction Project Management** by Barnes in Project Management, Volume 6, Number 2, May 1988, page 74.

All cost control decisions are essentially in the same form. If all levels of management have the same objectives this simplifies the control process. If objectives differ in parts of the organisation then control suffers. Unity of decision making objectives is perhaps the most important requisite for control. Where it is present, control can be achieved with little formal technique or paperwork. This is why large organisations often evolve groups, comprising a manager and his, or her team of personnel, who all seem to think and act alike. They work well together, are well controlled and make little use of cost reports.

Their success relies upon the quality of the group and individual plans for how the remaining work is to be carried out.

This should be contrasted with the style of organisation which is traditionally associated with cost control using retrospective "cost to date" reports. Here the budget is set by an estimator, usually in collaboration with the Project Manager. Cost allowances are worked out from the budget and communicated down the organisational structure. Work done is multiplied by the allowance and the result compared with costs to date. A loss, or unfavourable variance, in the most efficient systems, is communicated to the Project Manager within a very short time.

At this point the theory says that the Project Manager communicates with his subordinate and asks why the variance has occurred and why the budget has been exceeded. The subordinate is apparently motivated by this intervention from above to do better next time.

This would appear to be somewhat improbable and, in practice, it is argued that this style of control is ineffective. Even in theory it places the junior and senior manager in roles which real managers do not play.

Over the last 10 years, cost modelling systems have been developed which express plans in terms of work content, resource usage, cost cash-flow and time. The plans can be modified so that the system is used to help answer the "what would it cost if ?" questions, which are at the heart of decisions affecting cost.

Computer based cost modelling enables Project Managers to work up their plans using work content, unit cost and timing data contributed by other managers. Such an information system provides comprehensive forecasts of completion of cost, cash-flow and resource requirements whenever senior management asks for a project report.

The value of such a system or model is self evident and **Ireland (66)** suggests that there is a considerable advantage to be gained by having models of parts of the building process as well as a model encompassing the whole process. In this context the process is seen to include the feasibility study, information on client needs, outline proposals, schematic design, detailed design cost determination and progress reports on actual construction.

Ireland states that such models are normally more useful if they identify the relevant elements, show relationships between such elements and allow manipulation of these elements and relationships in order to determine how the results are affected. He also believes that acceptance of the role of managerial choice and direction is a pre-requisite to modelling.

Modelling is not a new phenomena and **Alexander (67)** states that over the past two decades a great deal of energy has been expended in the analysis of the construction process, with a view to suggesting ways by which some of the problems that beset the industry could be resolved.

Several models of the building process have been formulated in an attempt to clarify the source of the problem. Alexander states that some researchers have concentrated their efforts upon the organisational structure of the industry and have proposed a model that shows the relationship between participants in the building team in use.

This is based on the Royal Institute of British Architects' Plan of Work, which is a model of the building process sub-divided into twelve sequential work stages, intended for use as a management tool in aid of the allocation of resources available for a project. The plan of work, although gaining general acceptance in the industry, has been attacked and Alexander argues that it is the pattern of communications in the building process that is important. He states, however, that communications cannot be studied in isolation from the organisational structure of the building process and he argues that many reports and studies share his view that fragmentation of the industry, communications and structure are the major problems. This is perhaps inevitable as long as the main actors are unable to overcome their prejudices or are unwilling to go beyond the sectoral view of their profession.

Alexander considers the strategic importance of feedback from site-based personnel of design decisions relating to both single groups of operations and their effect upon ultimate technical performance criteria, and states that models exist for the construction industry, taking the systems view, that identify the basic claims that systems models are a valuable contribution towards a more complete understanding of the construction process.

Whilst there may be some debate as to the level of authority of the Project Manager, the industry is now committed to the use of the Project Management approach.

Reynolds (68) argues that cost control is both a predictive action, in providing a rationale for future action, and a monitoring process, in which reality is compared with a hypothesis, and appropriate corrective action initiated where necessary.

However, Reynolds states that, for control to be effective, the money available for a building must be distributed over its various elements. When an allocation to the constituent parts of each building has been made, the designer will be able to see which elements form an important part of the cost of the project and which are of relatively minor cost importance. By using his knowledge of these factors, the designer is able to adjust the cost plan as the planning proceeds to suit the design.

Reynolds argues that it is at the earliest stage in the design process that a project needs to be most carefully considered. Procedures should be designed to ensure that full, careful, consideration is given to the content of the project, the site and the building shape. Thus, before any detailed design wok is started, the project team will have a clear statement of functional need and a soundly based estimate of the total cost of the project.

Reynolds believed that the construction professions have to develop techniques in a systematic manner and acquire the information necessary to enable it to influence, directly, the early stages of a design. Decision making, therefore, depends on prediction, and prediction in turn depends on an adequate mathematical model being used to describe the behaviour of the system under scrutiny.

There are two levels of model which can be of assistance in formulating an overall pattern. One is a comparison of the one solution with another in terms of cost-benefit, and the other is the optimisation of evaluation techniques of the design decision process.

Generally, in construction design, the designer is not given a single criterion, but a schedule of client desires, and the criteria considered can give results whose numerical values do not put the objectives in the same order of preference. There is a tendency, therefore, towards attempting to optimise several design functions at the same time, and the designer should decide what priority will be allocated to the variables making up the pattern before moving on to the use of an evaluation technique.

Without a single criterion for the assessment of value, alternative solutions for parts of a design cannot be combined nor the best overall solution found. If, however, cost is the criterion then the minimum cost to achieve a certain objective can be ascertained and compared with others.

Drake (69) noted, however, that the clearest point to emerge from the various papers which exist on the topic of cost control was the fact that there is no systematic control of construction costs during the design stage. There are, however, many systems of estimating in use. Systems are usually based on area or volume and may feature the application of algebraic methods to describe, and price, the geometry of standardised forms. While such systems are used to test the cost of design proposals none have made the conceptual leap to the principle of deciding the allocation of a budget amongst design elements and then controlling the development of the design within the strategic allocation. Indeed it can be argued that such a methodology is unlikely to manifest itself in the near future.

Turner (70) states that in running building or engineering contracts, one of the most difficult problems met by architects or engineers is that of keeping the cost within the prescribed limit.

Turner's article examines a way by which this situation can be prevented and he suggests that there are two distinct viewpoints, namely the client's and the designer's.

From the client's view-point, the finance available for a particular project is normally both fixed and limited. The client expects that, once the contract is let, the final cost will be within the amount available.

However, there are a number of reasons for increased cost during the duration of a project:

- Changes in Statutory Requirements
- Unforeseen site conditions
- Work covered by Provisional or PC Sum
- Changes in design
- Changes in specialist requirements
- Clashes between different trades
- Errors or omissions in design.

It is essential that all changes involving cost, including expenditure against provisional and prime cost sums, should be recorded and circulated to all concerned by means of variation orders. It is essential that no additional costs should be incurred without a variation order.

Turner states that it is only by the maintenance of a procedure that effective control can be maintained and it is this basic, fundamental, principle which is the heart of the Form 'X' Control Mechanism described in Chapter Three.

The key to cost control is the role played by the primary design consultant under the traditional contracting mechanism and **Irwig (71)** states that this role is being increasingly questioned. He states that the Supervising Officer's role as leader of the design team is implied in "the system", and incorporates a range of activities which can be grouped quite clearly into two separate but interdependent functions namely design and administration.

Design involves the selection and prescription of the nature, form and interrelation of the various materials, components and elements of a building in order that, together, they satisfy a particular need or set of objectives. It involves the creative work required to integrate information and ideas in a concept that achieves a synthesis of objectives and resources.

Administration, on the other hand, involves securing the resources, primarily consultants and contractors, required to accomplish the tasks and defined, initially, by the nature of the facility required and then later, by the design as it evolves. It also involves monitoring and controlling the outputs of these resources in order to ensure that they conform with the specifications established.

Much of the work which constitutes this function consists of the clerical routines involved in manipulating the range of widely-accepted procedures and regulations which have, over time, become incorporated in the "system".

As important as the nature of these functions are, the relationships which exist between designer and client while they are being undertaken is of greater importance. In the "system", with its strictly sequential order of project stages, there exists only one set of relationship between Supervising Officer and client at any one time.

More specifically, the Supervising Officer acts as adviser to the client during programming and design, as the representative of the client in the preparation of contract documentation and during negotiation, and as arbitrator in terms of the contract between client and contractor once it is signed. Clearly in this idealised situation, the Supervising Officer is never required to act simultaneously as both the designer and administrator of a particular project.

The leadership role of the Supervising Officer, in project organisations formulated using the contracting, co-operation and coalition strategies mentioned earlier, is widely accepted as incorporating the functions of design and administration. However, the scope of these functions have changed. The most important reason for this change is that the processes which in "the system" are regarded as distinct and sequential, are now overlapped resulting in the participation of additional resource controllers in the early stages of projects where conceptual decisions are made.

Firstly, designing has become more complex in that more diverse and more dynamic requirements need to be synthesised in obtaining acceptable design solutions.

Secondly, it has become more exposed to interference and control by persons and organisations who have a stake in the pursuit of the function. Thus, the creative process which lies at the heart of this function becomes, at one and the same time, more challenging and more arduous.

By removing the control function from the lead designer, the project control mechanism seeks to give greater control to the party funding the work.

Maevis (72) makes the point that the single most effective method of control is to place a construction cost limit on the architect or engineer. The **United States Postal Service (USPS)** had a policy on charge orders in that they require the design to be reviewed by Headquarters personnel if design changes reach 30% of the estimated cost. This discourages casual changes.

The USPS policy required changes to be characterised under:

- Design deficiencies
- Changed site conditions
- Owners changes

This approach is similar to the approach described by **McDermott and Newcombe (73)** who state that a classification system of the potential causes of variations has been derived from the study of communications and consideration of the factors influencing design decisions. They argue that there are many different causes of variation with some arising from unforeseen changes in circumstances, some arising from a late decision on the part of the client and others resulting from poor or inadequate communication.

The study showed that changes in design (35%) and additional information (27%) were the most common reasons for the issue of variation orders.

Chan and Yeung (74) have also researched this topic and they make the point that an important strategy for time and cost management is the reduction of contractual variations, given that time and cost over-runs are closely associated with contract variations.

They argue that, in their survey of 32 construction contracts, the two major sources of variations were design/documentation (40%) and client needs (20%).

From the literature survey, the following strategies for reduction of variations were identified:

- Establishing and sustaining the right attitude to control
- Clear and thorough project brief
- Thorough detailing of design
- Appointment of an independent cost manager for cost control
- Quality contract documentation
- Good communication systems

Chan and Yeung also interviewed a large number of construction professionals and they advocate the following as the means to secure effective financial control of construction projects:

- Use of a Cost Manager
- Right attitude to the project and its control system
- Existence of good communication channels

All of these measures are covered in the Form 'X' procedures which are described in Chapter Three.

2.8 Intervening Factors

It should, however, be noted that a number of factors will have an effect on the imposition of a change control mechanism and these intervening factors may prevent the system from impacting in the desired manner. Organisations engaged in the commissioning of facilities vary in size and operate in a variety of social, economic and culture environments. They have a variety of organisational structures and also deal with projects which vary significantly in terms of size, scale and complexity.

Pollard and Tayeb (75) state that organisations and their employees do not live in a vacuum, separated from their societal surroundings. National culture, as a set of values, attitudes and behaviour includes those which are relevant to work and to organisation. These are carried into the workplace as part of the organisation's cultural inheritance.

Work-related values and attitudes are part of the cultural identity of a nation and society will have certain cultural expectations from its organisations and exerts influences on them through various formal and informal means. Political, social and economic institutions and factors such as economic structure, social stratification, level of educational attainment will all exert an influence on the organisation.

The societal context will also influence the means by which managers may perform their task and implement organisational strategies and policies. A comparison between Japanese companies, from a collectivist culture, with those originating in an individualist one, such as the United Kingdom, shows that the goals may be similar but the methods of achievement may be different. It is also argued that the differences appear to be cultural specific.

The Japanese company typically considers its employees as an asset rather than a liability and invests in the long-term development of its staff. The company employs staff on a long-term basis training them through rotation in various departments in order to enhance their flexibility.

The British company and its employees typically have a short-term perspective wherein employees join their work organisation as a step on their career development ladder, leaving the company when better prospects exist elsewhere. The company, on its part, recruits staff to fill specific posts and dispose of them when the need is over.

National culture is inextricably linked to management processes and practices and the adoption of new management processes and procedures will affected by the cultural norms which exist.

Hampton-Turner (76), however, makes the point that it is important to distinguish between the culture inside the organisation and the broader culture of the nation, economic region or racial group. This is particularly true in the case of the Hong Kong Mass Transit Railway Corporation, the organisation to be studied in Chapter Five.

Whilst the Corporation operated in a Hong Kong environment its senior managers were, virtually without exception, British. The exceptions were from New Zealand, Australia and South Africa. These executives operated in a **"British"** cultural environment and the **"Hong Kong"** cultural dimension was not of significant importance when determining the effect of the imposition of rules and regulations. It is, however, argued that it is impossible to appreciate the concept of corporate culture until national cultural considerations have been understood.

Pollard and Tayeb (77) also make the point that management control systems have an impact on and are affected by culture-specific aspects of organisation as noted hereunder:

Organisational Dimension	Examples of Relevant Underlying Process	Examples of Relevant Cultural Trait
Centralisation	Power relationship	• Attitudes to power & authority • Trust & confidence in others • Respect for people's views
Specialisation & Formalisation	Clear-cut Job Specifications Job territory	• Ability to cope with uncertainty • Attitude to privacy
Formalisation & Standardisation	Control and discipline	• Attitude to control & discipline
Direction of Communication	Information sharing	• Attitude to information sharing • Respect for people's views
Span of Control	Power relationship	• Attitude to power & authority

These factors need to be considered when designing a change management system as the introduction and implementation of the system will affect the culture of the organisation.

The degree of centralisation, latitude for action and direction of communication will all have an impact on the corporate culture and the staff will need to appreciate the reason for the control methodology if they are to provide the level of support which will be necessary for effective use.

The concept of national culture has been explored by **Lewis (78)** who stated that cultures can be ranked on a linear/multi-active scale as illustrated hereunder:

Ranking	**Country or Regional Grouping**
1	Germany and Switzerland
2	United States of America (White Anglo-Saxon Protestant)
3	Scandinavia and Austria
4	Britain, Canada and New Zealand
5	Australia and South Africa
6	Japan
7	Belgium and Holland
8	United States of America (Others)
9	France
10	Czechoslovakia, Slovenia, Croatia and Hungary
11	Italy (North)
12	Chile
13	Russia
14	Portugal
15	South East Asia and Polynesia
16	Spain, Italy (South)
17	India and Pakistan
18	Latin America, Arabia and Africa

Lewis makes the point that managers from a country with a high linear activity score, such as Germany, will be more inclined to follow correct procedures and provide information in written form than managers from Latin America or Africa.

The work of **Hofstede (79)** is of particular importance in the field of culture and he argues that many of the differences in employee motivation, management style and organisational structure of companies throughout the world can be traced to differences in the collective mental programming of people in different national cultures. Culture, according to Hofstede, is the collective mental programming of the people who occupy a specific environment and he argues that collective conditioning is resistant to change.

Hofstede undertook a large research project on national cultures and he determined the four main criteria by which national culture could be defined, as described hereunder:

Power Distance	This dimension indicates the extent to which a society accepts the fact that power in institutions and organisations is distributed unequally;
Uncertainty Avoidance	This dimension indicates the extent to which a society feels threatened by uncertain and ambiguous situations and tries to avoid these situations by providing greater career stability, establishing more formal rules and not tolerating deviant ideas and behaviour;
Individualism-Collectivism	This dimension determines whether a society has a tight social framework where need is addressed by society collectively or by families individually;
Masculinity	This dimension determines the extent to which society is assertive, seeking the acquisition of money or caring in its approach to people and the quality of life.

The dilemma for the international organisation is to determine whether to adopt local or national cultural characteristics or to impose corporate values in an alien environment.

In the case of the Hong Kong Mass Transit Railway Corporation the need of the organisation to establish order and stability in cost-related matters did not pose problems as the new change management mechanism reinforced the local culture which emphasised the collective cultural traditions of South East Asia.

The Corporation wished to impose a centralised system on Junior Managers who were pre-disposed to accept such an arrangements. The dissenting voices were likely to be among the Senior Managers as their cultural tradition tended to emphasise individualism.

Hofsted's concepts are of particular importance in determining whether the national culture will prevent the imposition of corporate measures. Two of Hofstede's concepts need to be considered in the light of the research project and particular attention will be given to the relationship between **Power Distance and Uncertainty Avoidance** and **Power Distance and Individualism**.

The Power Distance - Uncertainty Avoidance map indicates that people in large Power Distance cultures prefer decisions to be taken centrally whereas people in small Power Distance cultures wish decisions to be decentralised. While Power Distance relates to centralisation, Uncertainty Avoidance relates to Formalisation which can be defined as the need for formal rules and regulations and the assignment of specific tasks to experts.

The Power Distance and Uncertainty Avoidance and Power Distance and Individualism maps appear below.

The position of 40 countries on **Power Distance - Uncertainty Avoidance** scale appears hereunder:

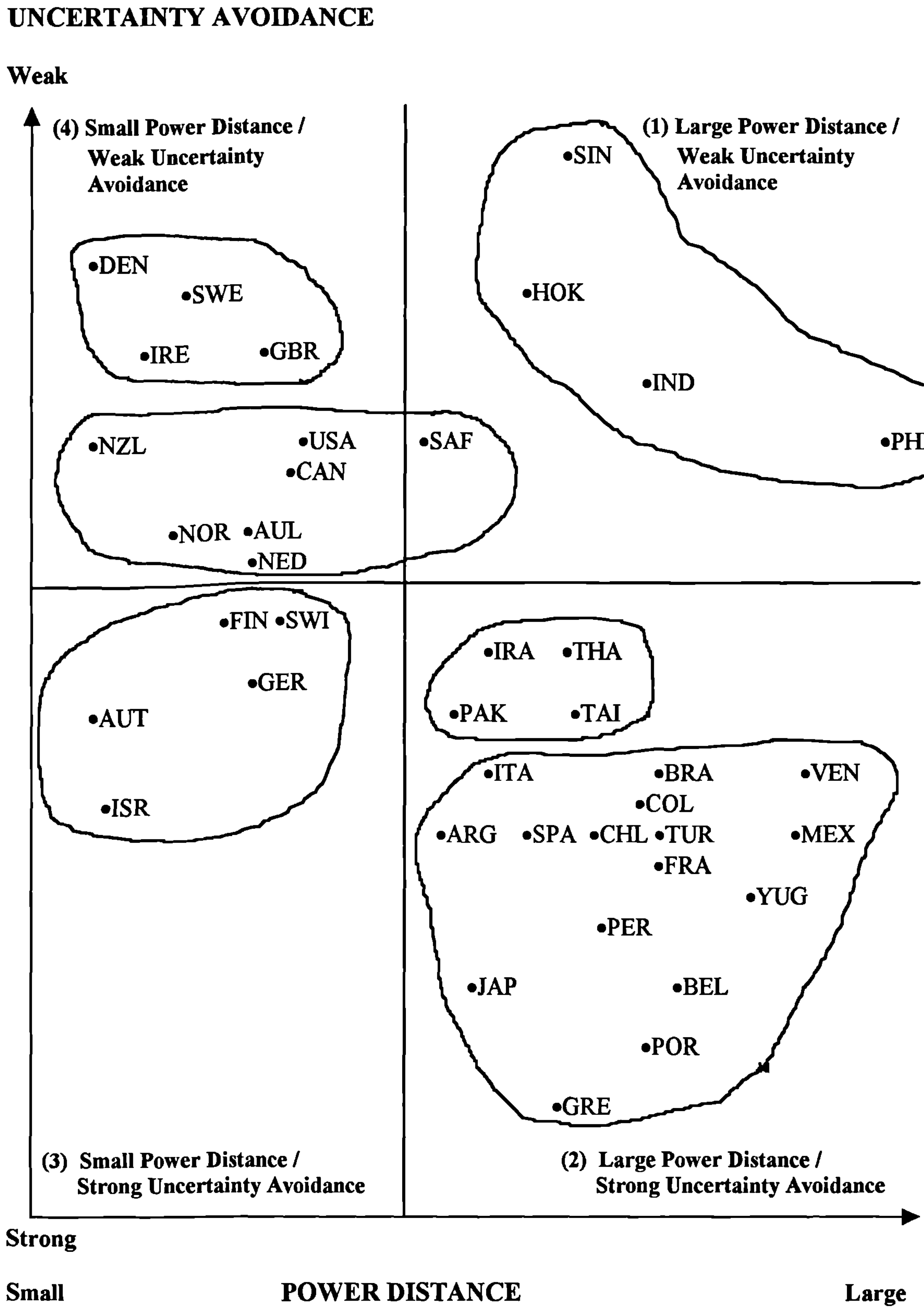


Figure 2.7 <u>The Position of 40 Countries on Power Distance and Uncertainty Avoidance</u>

Source: **Motivation, Leadership and Organisation - Do American Theories Apply Abroad?** by Hofstede, in Organisational Dynamics, published by the American Management Association, Summer 1980, Page 51.

The position of 40 countries on **Power Distance - Individualism** scale appears below:

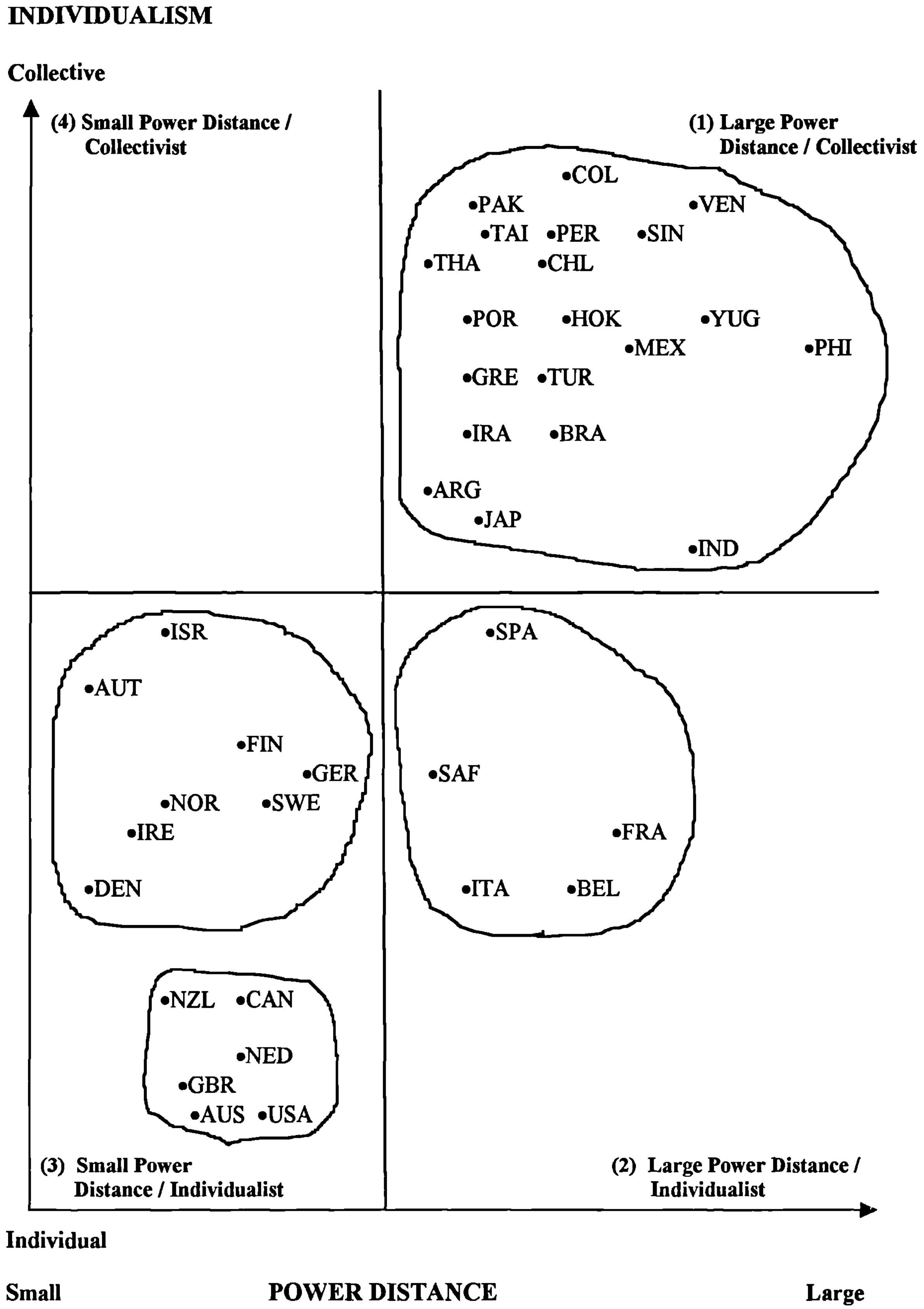


Figure 2.8 <u>**The Position of 40 Countries on Power Distance and Individualism**</u>

Source: **Motivation, Leadership and Organisation - Do American Theories Apply Abroad?** by Hofstede, in Organisational Dynamics, published by the American Management Association, Summer 1980, Page 52.

Having stated that national cultural characteristics may affect the imposition of control or management systems it should be noted that other factors may prevent the envisaged system from operating effectively.

The concept of control also needs to be explored and **Luthans (80)** has made the point that the position one occupies in an organisational structure is a determinant of power, with those at the top of the hierarchical structure having power sources such as formal position, resources and control of decision premises, whereas lower level managers get their power from physical location or information flow.

Beside the power implications of vertical structuring, there are also power differentials on each horizontal level of the structure.

Grimes (81) echoes this point and states that power is mankind's most pervasive social phenomenon and the consequences of power are experienced at every level of social organisation.

He states that there are four properties of authority:

(a) Authority is invested in a position;

(b) Voluntary compliance by subordinates is characteristic of an exercise of authority;

(c) Subordinates suspend their judgement in favour of a command decision;

(d) Authority can arise only in a collective context.

These properties help explain why what is usually labelled as an exercise of authority in a formal organisation may actually be an exercise of power.

Power and **authority**, two forms of **control**, can be conceptualised as the end points of a continuum of control where power is defined as control or influence over the action of others to promote one's goals without their consent, against their will, or without their knowledge or understanding, while authority is defined as the direction or control of the behaviour of others for the promotion of collective goals based on some ascertainable form of their knowledgeable consent.

These concepts help to explain how the implementation of management systems may be conceived as an exercise in control or power depending upon one's point of view.

Simon, Smithburg and Thompson (82) state that, from a psychological standpoint, the exercise of authority involves a relationship between two or more persons. On the one hand one has a person who makes proposals for the action of others whilst on the other hand one has a person who accepts the proposal.

A person may accept another's proposal under three sets of circumstances:

(a) He may examine the proposal and decide, on its merits, whether to accept it;

(b) He may carry out the proposals without being convinced of the merits;

(c) He may carry out the proposal even though he disagrees with the proposal.

Both of the final two cases are instances of the acceptance of authority

The working relationships in an organisation are dictated by the hierarchical structure of the entity and the procedure for handling the authority of legitimacy. Both of these facts are material to the concept of control and to the operation of a control mechanism.

Acceptance of the working procedures of an organisation, by its members, includes acceptance of the obligation to go along with the proposals of an hierarchical superior and there is widespread acceptance of the fact that hierarchical authority is legitimate.

Hierarchical behaviour is an institutionalised behaviour that all organisational members bring with them to an organisation. Hierarchy receives a tremendous emphasis in nearly all organisations and this is the means of corporate control in most organisations.

Newcombe, Langford and Fellows (83) have also been active in this field and they state that power within organisations depends on the persons power base and on the culture of the organisation and they advise that seven basis for power have been identified:

- Reward Power
- Coercive Power
- Position Power
- Personal Power
- Expert Power
- Information Power
- Connections Power

In the case of a large construction-commissioning organisation, its management or control systems will rely upon a combination of Position Power, Expert Power and Information Power to operate and it is important to appreciate that the correct people and procedures need to be in place if the system is to be effective.

It should also be appreciated that the success of a project is due, in large part, to the quality of the project management team and this fact has been acknowledged by **Rowings and Federle (84)** who states that the critical ingredients for team leadership and project leadership must be present within the core management team.

Rowings and Federle argue that the management of a successful project requires more than mere technical skills and systematic reporting. They state that personal attributes are of fundamental importance and a lack of such skills will prevent the correct operation of a management system.

Another factor which needs to be considered is the dysfunctional effects of control systems and **Lawler and Rhode (85)** state that their investigations indicate that control systems often meet with strong resistance from the people who are subjected to them.

They also argue, however, that discussions with staff indicate that control systems can also fulfil some important needs because the systems provide the feedback which the staff desire and also provide a structure for reporting.

The question that remains concerns why control systems are generally seen as such significant threats to the satisfaction of employees and the most significant reasons given as:

(a) Control systems can automate expertise;
(b) Control systems can create new experts and give them power;
(c) Control systems have the potential to accurately measure individual performance;
(d) Control systems can change the social structure of an organisation;
(e) Control systems can reduce opportunities for intrinsic need satisfaction.

All of the factors mentioned above can intervene to reduce the effectiveness of a control mechanism.

Luck and Newcome (86) have also studied the imposition of control systems and they state that there are many characteristics of the construction industry which make control difficult and these include:

(a) The short term tenure of project personnel;

(b) The role ambiguity of project personnel;

(c) The complex structural patterns which exist within construction organisations;

(d) The difference in size, complexity and duration of construction projects.

The hierarchy and the structure of project organisations varies with project size, complexity and contract duration, and the control mechanisms which are suitable for major international infra-structural projects would not be suitable for minor domestic projects. The formality of style and complexity of documentation which would be warranted on a major project would be too cumbersome and bureaucratic for a small project.

Construction management systems need to be tailored for the project in hand as the structure of the organisation and the size of the project may combine to prevent the Form 'X' mechanism from operating. These facts allied to national and corporate cultural factors may intervene in the operation of a change management system and the theoretical considerations which have been advanced need to be viewed in this light.

These factors were fully considered and it is argued the projects which were undertaken by the Hong Kong Mass Transit Railway Corporation, and reviewed in Chapter Five, were of such complexity as to overcome the problems of size, scale and duration while the fact that the organisation had a distinctive, discrete, and well established corporate culture overcame all of the problems associated with cultural ambiguity.

2.9 Summary

This chapter is somewhat lengthy due to the need to explain individually the threads which are interwoven to make up the control methodology described in Chapter Three.

The chapter began by defining Project Management and by stressing the importance of human factors and communications to the process of control. The chapter goes on to describe Project Management's historical base and the systems theory which underpins the concept. The chapter then explains its development in respect of military projects in the immediate post Second World War period.

A variety of Project Management tools, such as PERT, CPM, PERT / COST, CPM / COST, GERT and POEM, are described and it is noted that these tools are all designed to forecast, or plan, project progress and to monitor performance against programme.

It is important to stress that project management research, relating to the construction industry, has tended to concentrate on the mechanics of planning and control. This has given an organisational, systems, bias to the literature and a concentration on planning tools rather than on how control is achieved and why such control is necessary. Having made this point, the chapter proceeds to cover, in some detail, the project management structures and systems which are necessary to achieve financial control.

It can be seen from the literature that the Project Manager brings much needed managerial expertise to the client's design team and, in accepting the leadership role, the Project Manager becomes responsible for co-ordinating the various consultants and ensuring that they perform in a manner conducive to the well being of the team as a whole.

The main technical functions of the Project Manager revolve around planning, contract administration and financial control. It is for these reasons that systems and organisational forms have evolved.

The key to effective project management structures and systems lies in their ability to ensure the involvement of the design team in the decision making process. As a recognition of the importance of this involvement the chapter focuses on the structures and systems which are available to ensure that the Project Manager is able to interact with the design team in order to achieve effective control.

Having studied various project management organisational structures and related systems, attention was turned to various methods of achieving both project and financial control. In this respect the role of information was noted as being of crucial importance.

The elements of control, namely, structure, systems and information flow were then examined and a general consensus emerged as to the need to exercise control over the contract works using a project management approach to technical and financial control.

It is argued that project management systems and structures must be tailored to the project in hand and this must recognise the nature, size, location and duration of the project.

This is a fact which has been overlooked in much of the project management literature which has been published to date and the chapter goes on to look at the interpersonal factors which prevent the use of generic structures and systems.

The chapter provides evidence of the importance of interpersonal factors and it is argued that the human resource element is of fundamental importance to project success.

The literature review indicates that control systems and organisational structures recognise the special nature of construction projects and it should be appreciated that the personnel working on a contract may not have worked together prior to engagement and may not work together after contract completion.

It is for this reason that the management techniques which have been designed to achieve staff empowerment and adherence with corporate values, and which are prevalent in both manufacturing and service industries, are unlikely to be effective in the case of construction projects.

It is argued that for project management to be successful it is necessary to match organisational systems and structures to the culture of the organisation. The chapter recognises that interpersonal relationships affect project control and that it takes time to inculcate cultural values in an organisation.

In the case of project teams assembled on major international projects it is likely that staff will have been recruited from a variety of countries and the majority of staff are unlikely to have worked together.

As a result, it is argued that the imposition of a formal control system will be much more effective in achieving effective financial control than relying upon motivational or cultural factors.

The chapter then proceeds to examine the role of communication in general and information management in particular. Communication is seen as being of fundamental importance and the use of management information systems, to ensure the effective distribution of crucial data, is described.

The chapter advocates the use of a centralised system as this has the advantage of minimising the duplication of data recovery and effort.

The increasing use of computers has resulted in easy data transfer from site to corporate headquarters and this fact has been recognised in the development of the cost control methodology described in Chapter Three.

The chapter described the development of a number of complex computer programs which can be used to ease data interchange and to provide decision making support.

The Form 'X' procedure has been devised following the debate outlined earlier in the chapter, which concluded that an appropriate control system will overcome the inability of many Project Managers to effect adequate financial control due to their willingness to sanction variations to the contract works.

As a result of the developments described earlier, it is argued that the key to successful project management is the achievement of project objectives and in the case of financial control objectives this can be achieved by using a financial control methodology.

It is important to stress that project control has much more to do with the use of project management control devices than with the use of project planning techniques.

The chapter advocates the establishment of a strong Project Management Group, with access to modern communication devices, to control the construction process using rules, procedures, goal setting, targets and hierarchical referral to aid vertical information flow and the cementing of lateral relations.

The literature review concludes by examining current financial and project control concepts and it is argued that the key to ensuring that cost over-runs are kept to a minimum lies with ensuring that design changes after contract award are drastically reduced. The chapter also states that making use of cost managers, having the right attitude to the project, and its control systems, and having good communication channels will ensure that projects are completed within budget.

The literature review indicates that, whilst there have been a number of studies into the use of planning and forecasting models, there has been little research into the use of change control systems. The literature review indicates the need for a comprehensive change control mechanism which can be used on a wide variety of building and civil engineering projects under a variety of contract conditions.

In conclusion it can be argued that the literature review has provided ample evidence to support the argument that a change control methodology will assist Project Managers effect project control. The important factors which should be considered in formulating the cost control procedure are systems design, interpersonal relationships and information processing models.

These concepts will be to the fore in the Form 'X' procedure detailed in Chapter Three.

CHAPTER 3

A NEW APPROACH TO CHANGE MANAGEMENT

CHAPTER 3

A NEW APPROACH TO CHANGE MANAGEMENT

3.0 Introduction

The previous chapter dealt with the concept of **project management** in general and **change management** in particular. The research deals with the problem of ensuring that change management within projects is controlled in a manner which obviates financial, programme and technical difficulties.

This chapter sets out a new **Change Management**, or **Claims for Extras**, mechanism, which will prevent many of the difficulties inherent in using the present, designer-led, system and describes the procedures necessary for implementing the methodology.

3.1 The Form 'X' Concept

The Form 'X' concept requires individual designers and construction personnel to obtain formal approval for revisions to the design, or construction methodology etc., and, in doing so, justify their actions, and those of their colleagues, to an independent body representing the client organisation.

The aim is to control costs and this is achieved by relating change to a **Contract Control Total**, as amended by authorised additions and deductions, with authorisation for such an amendment only arising as a result of the approval, by the client, of a Form 'X', or an "Extras" application.

The procedure applies at all stages of the project as, prior to the award of the contract, Project Managers will be held responsible for the management of the **Estimated Contract Control Total** for all works under their jurisdiction.

Prior to contract award, the Contact Control Total will be the Net Estimate of Expenditure with Prime Cost and Provisional Sums and Dayworks allowances, separately identified.

After the award of the contract, Project Managers will be held responsible for the control of costs against the current Contract Control Total for all contracts under their direct management.

The **Contract Control Total**, following contract award, will be the **Contract Sum** less:

(a) All Prime Cost Sums, Provisional Sums and Provisional Items;

(b) Daywork Provisions.

All Contingency Sums, including (a) and (b) above, will be held by the client and these sums may be held by either the Project Manager, or by senior personnel within the client organisation, including the Chief Executive or the Director of Finance.

This does not imply a lack of confidence in the individual Project Managers, or their design teams, but stresses the importance of a corporate approach to the allocation of scarce resources.

Following the award of the contract, applications to raise a Form 'X' will be required in respect of proposals to :

(a) Commit Prime Cost or Contingency Sums;

(b) Instruct additional works which fall outside the obligations of the Contractor under the terms of the Contract;

(c) Issue drawings, or other further information, in respect of work which will modify the client's liability in respect of the Contract;

(d) Grant an extension of time to the Contractor;

(e) Accelerate or delay the progress of the Works, either in full or in part.

The **Change Management Methodology** is discussed under the following headings:

3.1.1 Cost Centres

The Bills of Quantities are divided into **Cost Centres** with each Cost Centre being a trade element, with the exception of Cost Centre 'A', which comprises the preliminaries or general items applicable to the whole Contract. Cost Centre 'A' also includes Prime Cost Sums for Nominated Sub-Contracts and Supplies, Provisional Sums for any work not defined in detail at the time of tender and Dayworks.

The Cost Centres can be either based upon SMM6 or Work Category classifications.

As stated above, at the commencement of each Contract, and for the purpose of establishing a Cost Control Total, the following contractual adjustments are made:

(a) Prime Cost Sums for Nominated Sub-Contracts and Nominated Supplies together with associated items for attendance and profit are deducted;

(b) Provisional Sums included in the Bills of Quantities for work not defined at time of tender are deducted;

(c) The various Dayworks sums are excluded.

The value of the above items form part of the Contact Sum, but do not form part of the payment process and are held in reserve as a **Contract Contingency Fund**.

During execution of the work, adjustment to the various **Cost Centre Values** may become necessary owing to the changing nature of the design, or construction related difficulties, and the various types of adjustment are given below:

(a) Addition of the total value of each Nominated Subcontract or Nominated Supply Contract into which the Main Contractor has been instructed to enter together with the total amount due against associated items for attendance and profit;

(b) Adjustment to each Nominated Sub-Contract or Nominated Supply contract arising from the measurement and preparation of the Final Accounts of Nominated Sub-contractors and Suppliers;

(c) Addition of the total value of supplementary Bills of Quantities to cover work originally covered by Provisional Sums for work not defined at the time of tender;

(d) Adjustment to the value of measured work items arising from changes in quantities from those shown in the Bills of Quantities at the time of tender;

(e) Correction of errors in description or omission from the original Bills of Quantities;

(f) Adjustment to the rates and amounts of measured items in the Bill of Quantities where the Quantity Surveyor has stated a "Prime Cost" for the supply of certain materials to be nominated by the Supervising Officer. The Contract rate will be adjusted by the net difference between the Prime Cost rate and the invoiced price paid at the time of presentation of the invoice;

(g) Addition or Deduction of the value of Supervising Officer's Instructions;

(h) Deductions on account of advance payments or down-payments which may or may not affect the Cost Centre values.

The method by which the Clients' Project Manager gives his approval to the above is the subject of this chapter.

3.1.2 Adjustment of Cost Centre Totals

The vehicle for instructing a Contractor in respect of a variation, and for incorporating accepted claims, is the issue of a Supervising Officer's Instruction by the Supervising Officer acting in accordance with the provisions of the contract.

The financial terms and programme adjustments which occur must be accurately quantified and, where it is necessary to instruct the Contractor prior to final agreement as to cost and/or programme implications, this must be shown to be to the benefit of the Client. The intention of the procedure outlined below is to ensure that it is the client's Project Manager, or authorised representative, who has the final decision as to the varying of the contract works. The methodology envisages that specific and discreet application will be made for each proposed adjustment to the "Contract Control Total", for each contract, by means of a Form 'X' submission.

In the case of building contracts, Form 'X' submissions will arise from one of five sources: the Architect or Supervising Officer, the Structural Engineer, the Building Services Engineer, the Quantity Surveyor or the Project Manager, acting on behalf of the client organisation. In the case of engineering contracts, Form 'X' submissions will be raised by the Resident Engineer, the Engineering Consultants or the Project Manager.

The procedure to be adopted will depend on the nature of the revision and this will be either due to a design change, a site-originated, construction-related, circumstance, or a contractual claim.

The procedure to be adopted in each case is detailed hereunder:

3.1.2.1 <u>Design Changes</u>

The production of working drawings will be monitored by the consultants and the Project Manager, to ensure that they reflect the cost and scope intentions of the contract, as amended by previously approved variations.

Project Managers, in conjunction with their Quantity Surveyor, will cost the work proposed in the working drawings or specifications in advance of the construction, or manufacture, of the element and will establish the cost trends implied by the change.

Where clear, specifically-identifiable, potential cost changes are revealed, Project Managers will not allow the issue of the drawings to Contractors until the Supervising Officer has :

(a) Had the design appropriately amended, or

(b) Obtained approval to a Form 'X' submission in respect of the change.

Where a more gradual adverse trend is revealed by the "cost appraisal before construction process", the Supervising Officer will draw the matter to the attention of the Project Manager who will require formal assurance that appropriate economies will be incorporated into subsequent working drawings/specifications, failing which a **Form 'X' - Design** submission will be raised by the Supervising Officer seeking allocation of appropriate additional funds. The accumulated total cost will be compared with the interim cost assumptions of the contract, as awarded, at the state of construction or manufacture reached.

The Project Manager will be held responsible for all projected and current overspend against the projected contract cash flow, as amended by any approved Form 'X' applications. The Project Manager will, therefore, prove to be a vigilant monitor of excess cost arising as a result of the design process. It is important to note, however, that the detailed work undertaken for the purpose of raising a Form 'X' should be strictly limited to that necessary to explain the proposal. An estimate of the order of cost is all that is necessary at this stage.

3.1.2.2 <u>Changes in Construction Method</u>

Approval must be sought prior to instructing a change to the sequence or method of construction which will affect the Contract Price either:

(a) Chargeable against Provisional Sums or Provisional Items contained in the Contract; or

(b) Resulting in revised rates or prices.

An Emergency Instruction may be given on the authority of:

(a) The Clerk of Works up to **HK$10,000**;

(b) The Supervising Officer up to **HK$25,000**;

in respect of any single instruction without recourse to the Form "X" procedure.

Retrospective confirmation, by allocation of appropriate funds to the Contract Control Total, must, however, be sought by means of a **Form 'X' - Construction** submission in respect of each aggregate total of approximately **HK$50,000** of Supervising Officer's Instructions previously issued.

The issue of individual Supervising Officer's Instructions in excess of **HK$25,000** in value (or potential value) will be subject to a Form 'X' submission and will be subsequently confirmed.

3.1.2.3 <u>Claims</u>

The assessment of claims notified by the Contractor under the contract is the responsibility of the Supervising Officer. The function of the Client in this regard will be delegated to the Project Manager.

Contractor's claims generally fall into three categories:

(a) Contractual Claims

These are claims which can be demonstrated to be due under the contract. It is not sufficient to regard the circumstances giving rise to the claim as being within the broad meaning of a particular contract clause. The Supervising Officer must be satisfied beyond any doubt that the claim is admissible under the actual terms of the relevant clause, or clauses, of the contract before any payment can be made, or extension of time awarded.

(b) Extra-Contractual Claims

These are claims which, although not legally admissible under the contract, appear to be an obligation by the client which the Courts might uphold. Such an obligation will usually be attributable to the client's action, or inaction, in relation to the contract.

(c) Extra-Gratia Claims

Even though there is no entitlement under the contract for the submission of a claim and no basis for the client to make an extra-contractual payment, Contractors sometimes submit claims requesting an "ex-gratia" payment. The usual basis of such a claim is that the Contractor has suffered a substantial overall loss on the contract which he cannot recoup. Such claims are rarely entertained by the client.

Whilst the Project Manager should not bring undue influence to bear upon the Supervising Officer in regard to his assessment of claims, he is entitled to make his views known to the Supervising Officer with regard to his assessment and to advise him of the client's interpretation of his obligations and rights under the contract. The Project Manager will represent the client's view to the Supervising Officer.

As soon as a claim notification has been received, and notwithstanding the fact that the claim may be deficient in factual, contractual or financial information, the Contractor should be approached for substantiation of the claim.

The Project Manager should, on behalf or the client, open a separate file for each claim and, in conjunction with the consultants, should take a view on the consequences of the claim.

The Supervising Officer should reject claims where, in his view, they are ill-founded or inadequately justified in the initial notification. Whilst there will clearly be many cases where such immediate rejection is justified, the emphasis must be to inform the Contractor that his claim in unacceptable in its submitted form.

A Contractor will frequently notify his intent, or "reserve his right", to claim when he first perceives that he is in a possible claim situation. He may, however, decide not to pursue the matter further.

The initial action on this type of claim should be an acknowledgement with a simple statement that the claim will be considered when full particulars are lodged. The decision on whether or not to pursue a claim must be left to the Contractor.

However, a Form 'X' should be raised at this stage. If a Contractor proceeds further with a claim, he should be requested to submit clear evidence in its support by reference to the appropriate wording of the conditions of contract.

Pursuant to the requirements of the conditions of contract it will be necessary in such cases for the Supervising Officer, in the first instance, to check that the claim has been submitted under the provisions of one or more of the appropriate clauses of the conditions of contract.

The Quantity Surveyor shall investigate and advise on the contractual efficacy of the claim.

In many cases a Contractor will lodge a claim in respect of an on-going event, the eventual outcome of which will not become known for some time. If it appears that the Contractor may be able to substantiate his claim, arrangements should be made with the Contractor for the maintenance of agreed factual records so that these are available for analysis in subsequent claims assessment. The arrangements to maintain such records must be made without commitment as to the Supervising Officer's eventual view of the claim.

The Supervising Officer is responsible for the preparation of a complete analysis of the Contractor's claim and all the facts relevant thereto, and the preparation of a detailed report for submission to the Project Manager. If this was not possible at the initial "proposal" stage of the **Form 'X' - Claims** submission, due to lack of detailed information, the Supervising Officer should seek further information form the Contractor. Each claims report prepared by the Supervising Officer should be set out in the following format:

(a) **Introduction**

(b) **Summary of the Claim**

(c) **Contractor's Contention of Principles and Value**

(d) **Analysis of the Principles of the Claim**

- (i) Circumstances giving rise to the claim
- (ii) Principles on which claim is considered including an analysis of the relevant conditions of contract
- (iii) Description and Justification of the Claim
- (iv) Recommendation on Principles of the Claim

(e) **Analysis of the Quantum of the Claim**

- (i) Analysis of Contractor's Justification
- (ii) Apparent Discrepancies
- (iii) Recommendation for Quantifying Claim

(f) **Appendices**

(i) Index and Copies of Correspondence

(ii) Tables

(iii) Drawings

In the assessment of the claim the Supervising Officer must consider whether the Contractor has:

(a) clearly made out his case to justify and substantiate the principles on which his claim is based, and

(b) correctly and properly marshalled all of the true facts of the circumstances leading up the claim and the matters of the claim itself, and

(c) explained and justified, by means of sufficiently detailed calculations, the elemental build-ups of the monetary or time amounts of his claim.

If, in respect of any of the matters referred to above, it is considered that the Contractor has failed to provide sufficient justification or substantiation then the Contractor must be told by the Supervising Officer that he has the opportunity of providing further and better particulars before a final decision on the claim is made. However, if individual aspects of a claim appear to be clearly defined and acceptably evaluated, certification of monies on account of the claim as a whole should be considered and referred to in the claim report.

If there is a difference of opinion with regard to historical fact, then, as far as is possible, agreement of the true facts should be reached by discussion and the outcome of these discussion recorded by letter.

The Contractor will frequently lodge a claim for circumstances which are likely to prevail for some considerable time and which may affect other elements of the work.

It is important that the principle of a claim should not be conceded at too early a stage. The full effects on other elements of the work, and other claims or potential claims, must be ascertained before a final assessment is made. In this particular regard, caution should be exercised in considering the "overheads" on an individual claim-by-claim basis in order to avoid the risk of duplication of payment. It is important that the principles governing any extension of time which may be warranted are clearly established before proceeding to deal with the cost effects. There will be cases where an award of an extension of time is made but the determination of additional costs has to be deferred until other related claims have been considered.

Upon the receipt of the Supervising Officer's claim report, the Project Manager should assess the content and recommendations contained in the report. Depending upon the complexity or degree of contentious content of the claim and/or report, the Project Manager or, if requested by the Project Manager, the Quantity Surveyor will produce a summarised report to be submitted, with the Supervising Officer's report, with the Claims Form 'X' proposal.

If the Supervising Officer's report signifies that there appears to be differences of view between himself and the Contractor then, prior to proposing or resubmitting a Claims Form 'X', the Project Manager should convene a meeting with the Contractor. At this meeting he will be supported by the Quantity Surveyor, the Supervising Officer and such other staff as he deems necessary.

The object of such a meeting is to endeavour to reconcile differences of principle and the approach to quantification of any award if such is justified. A brief record of the meeting should be kept by the Supervising Officer and, prior to the submission of the Claims Form 'X', together with the Project Manager's report incorporating his final opinion, the Supervising Officer's Report should be amended to reflect the conclusions reached at the meeting. When negotiations have been concluded by the Supervising Officer, the Project Manager or, if requested by the Project Manager, the Quantity Surveyor will prepare a summary report for signature by the Project Manager and submission for final approval through the Form 'X' Procedure.

This report will take the following format:

(a) Introduction

(b) Summary of Claim and Recommendation

(c) Summary of Contractor's Contention

(d) Principles of Assessment

(e) Quantum of Assessment/Reasons for Rejection

(f) Recommendation

(g) Appendices

Following final approval through the Form 'X' Procedure, the Project Manager will convene a formal meeting with the Contractor to convey to him the final assessment of the claim. Normally this meeting will be chaired by the Project Manager who will be supported by the Quantity Surveyor and the Supervising Officer.

In all cases, the decision must be confirmed, in writing, to the Contractor by the Supervising Officer in line with the provisions of the contract.

The Quantity Surveyor must ensure that all the contracts administered by Supervising Officer are managed in accordance with the provisions governing each contract. To this end he will advise the Supervising Officer and his delegates on the interpretation and application of the provisions of the contract. It is his duty to ensure that the Supervising Officers', and his delegates', interpretations are applied uniformity across all contracts and that all variations and claims are dealt with in accordance with sound contractual principles. It is also part of his function to ensure that the client's obligations in respect of public accountability are met. He will ensure that the documentation on the settlement of all Contractor's claims is properly prepared in a format which clearly establishes that the provisions of the contract have been observed and that the judgements made in arriving at awards are soundly based.

The Quantity Surveyor must assist the Project Manager in the management of the contracts under his control but should also have a functional responsibility to the Supervising Officer.

The Quantity Surveyor should seek guidance and advice from the Project Manager on the principles used in assessing claims and will ensure that these principles are observed. He should have a duty to report any departure from these principles to the Project Manager.

3.1.3 <u>Flow Diagram and Control Documentation</u>

This rather complex procedural mechanism attempts to ensure that the client and his, or her, consultants are totally aware of the effect of their decisions on the project. The Form 'X' procedure ensures that views are communicated and that knowledge is imparted to all participants in the process. As noted in Chapter Two, the free flow of information is the key to successful systems control.

The procedure to be adopted and the control documentation to be utilised is illustrated in **Appendix 'B'**.

3.2 <u>The Modified Form 'X' Procedure</u>

A method of change management control, which is very similar to the Form 'X' Control Mechanism outlined in the previous section, has been used by the Hong Kong Mass Transit Railway Corporation since 1982.

The mechanism was, however, modified by the researcher to suit the Corporation's requirements as the approach, as described earlier, was originally designed for building works. The Corporation is primarily concerned with civil engineering construction although a number of their contracts have large architectural elements.

The Form 'X' concept was originally put forward, by the researcher, for the control of change on contracts for the construction of multi-storey residential and commercial developments above the Corporation's stations and depots. The Corporation's Projects Director decided that the Form 'X' procedure could be used to control design changes on civil engineering projects and the researcher was requested to modify the control mechanism as detailed hereunder:

(a) <u>Cost Variation due to Design-Related Changes</u>

Under the Corporation system all proposals in respect of design changes originating from Corporation Departments, or its Consultants, are communicated to the appropriate Design Manager. This will include contention by Construction Managers that working drawings, and/or detailed specification requirements, constitute a change to the original requirement. Design Managers advise the Chief Engineer as to the assessment of all such proposals, seeking such other input as necessary. The Chief Engineer informs the proposer of his decision in respect of the proposals and the reasons therefore.

The Engineering Director recommends the adoption of the proposals by means of:

(a) A draft **Executive Briefing Note**, where more than two contracts are directly or consequentially affected, forwarded to the Projects Director. Following approval of the Note by the Executive Committee, the Chief Engineer will raise a Form 'X' as indicated in (b) hereunder, in respect of each affected contract making reference to the approved Executive Briefing Note as an appropriate justification.

(b) Endorsing a Form 'X' which will be raised by the Chief Engineer and initiating the processing of the Form 'X' in accordance with the procedure.

The endorsement of a Form 'X' proposal by the Engineering Director is the authority to commence.

Both prior to and after the raising of Form 'X', all correspondence with the Contractor, in respect of proposed changes to the contracted requirement, is routed through the appropriate Construction Manager.

(b) <u>Cost/Variation due to Construction-Related Changes</u>

Under the Corporation system, approval is sought prior to instructing additional temporary work, changing temporary works or changing the sequence/method of construction of permanent works which may result in a change to the Contract Control values, either:

(a) Chargeable against Provisional Sums, or Provisional Items, contained in the contract; or

(b) At contract or negotiated rates or prices.

(c) Cost Variation due to Circumstances Leading to Contractual Claims

The assessment of the Claims notified by the Contractor under the contract is the responsibility of the Engineering Director. The function of the Engineering Director in this regard is delegated to Construction Managers.

Whilst the Corporation, as employer, should not bring undue influence to bear upon the Engineering Director in regard to his assessments of claims, it is entitled to make its views known.

Flow charts and procedural documentation illustrating the Mass Transit Railway Corporation's Form 'X' approval mechanism are depicted in **Appendix 'C'**.

Having described the procedures adopted by the Corporation in these critical areas it is appropriate to note that the Corporation's contract documentation has certain unique features to cater for the operation of the procedure in that the Bills of Quantities were divided into **Cost Centres**.

Each Cost Centre, with the exception of Cost Centres 'A', was a complete Bill of Quantities for either:

(a) A Station; or

(b) The tunnels between Stations or between a Station and the boundary of a Contract; or

(c) Other specified major elements of work as may be applicable.

Cost Centre 'A' contained general items applicable to the whole contract and also included Provisional Sums for Nominated Sub-Contracts and Suppliers, Provisional Sums for other work not defined in detail at time of tender, Provisional Items for general application to the Contract and Dayworks. At the commencement of each Contract and for the purposes of interim payment certification, the following contractual adjustments were made to the value of the Cost Centres:

(a) The total value of the Dayworks provision was excluded.

(b) Provisional Sums for Nominated Sub-Contracts and Nominated Suppliers together with associated items for charges and profit and for general attendance were deducted.

(c) Provisional Sums included in the Bills of Quantities for work not defined at time of tender were deducted.

Whilst the conditions of contract sets out the contractual process to be followed, the Corporation requires that sums in the Bills of Quantities for:

(a) Provisional Items, and

(b) Prime Cost Items

be separately monitored and internal authority sought via the Form 'X' procedure, as and when expenditure against these items was necessary. Hence, the value of these items, together with the values of the items listed above, are effectively omitted from the tender sum and transferred to a **Contract Contingency Fund**.

The sum of money remaining and thereafter committed to the contract, was known as the **Initial Contract Control Total**. During the execution of the work, adjustments to the Cost Centres are necessary for interim payment certification purposes and internal authorisation to these adjustments was obtained through the Form 'X'.

A list of the types of adjustments which rose, together with a reference and notes on the type of Form 'X' raised, to seek approval of the adjustments is given below:

Adjustment	**Procedure**
Addition of value of each Nominated Sub-Contract, into which the Contractor has been instructed to enter together with total amounts due against associated items for charges and profit and for general attendance.	**Design Form 'X'**
Adjustments to the above arising from measurement and preparation of the Final Accounts of Nominated Sub-Contractors and Suppliers and at the time these adjustments are identified.	**Design Form 'X'** **or** **Construction Form 'X'**
Addition of the total value of supplementary Bills of Quantities to cover the work instructed under Provisional Sums for work not defined at time of tender.	**Design Form 'X'**

Adjustment	Procedure
Adjustment to the rates and amounts of measured items in which the Engineer has stated a "Prime Cost" for the supply of certain materials to be nominated by the Engineer.	**Design Form 'X'**
Addition/deduction of the value of Engineer's Instruction at the time the Form 'X' instructions are issued.	**Design Form 'X'** **or** **Construction Form 'X'**
Adjustment to the value of measured work items arising from changes in quantities from those shown in the Bill of Quantities at time of tender and identified during the execution of the works by measurement.	**Design Form 'X'** **or** **Construction Form 'X'**
Correction of errors in description and/or omission from the original Bill of Quantities	**Design Form 'X'** **or** **Construction Form 'X'**
Deduction on account of vested materials	**Construction Form 'X'**
Deduction on account of advance payments which may or may not affect the Cost Centre values.	**Construction Form 'X'**

Adjustment	Procedure
Expenditure against Provisional Quantities in the Bills of Quantities.	**Design Form 'X'** **or** **Construction Form 'X'**

The Conditions of Contract made provisions for the Engineer to give instructions to the Contractor.

Therefore, formal instruction were required to have some contractual basis and, where pertinent, reference to the appropriate clause in the conditions of contract were given on the standard Engineer's Instruction Form. Strict cognisance of delegation of the Engineer's powers and authorities were observed to ensure that the appropriate person signed the Instruction.

In respect of cost control, Engineer's Instructions were issued to the Contractor when expenditure of any of the following were required :

(a) Provisional Sums for Nominated Sub-Contracts;

(b) Provisional Sums for work to be done by the Contractor;

(c) Provisional Quantities;

(d) Prime Cost Items;

(e) Dayworks.

Engineer's Instructions for Dayworks were given pursuant to the conditions of contract with approval being given in batches not exceeding **HK$100,000** in value.

Before instituting any change, which would lead to a variation, the direct and consequential effects of the various alternatives were considered. Realistic estimates were prepared by senior staff so that the best alternative could be progressed through the Form 'X' procedure.

Item descriptions had to be sufficiently detailed to ensure precise identification of the location and extent of the work required and/or the changes to be made. Where applicable they were itemised as in the Bill of Quantities.

Examples of matters which require the issue of Engineer's Instructions pursuant of the conditions of contract are as follows:

(a) Issues of drawings or details amending the Works;

(b) Additions to, and omissions from, the Works described;

(c) Changes in the specified sequence, method or timing of construction;

(d) Measures taken to deal with adverse physical conditions and obstructions;

(e) Changes in Specification;

(f) Changes in dimensions or locations.

The Corporation procedure, therefore, covers all design-related, construction-related and claims-related situations and is comprehensive in scope.

3.3 Summary

This chapter describes a change control methodology which imposes a system of approval on members of the design team.

The methodology imposes control on the design process from project inception through construction to completion and financial reconciliation. It is primarily a systems-based approach with the design and construction team being required to describe and justify all proposed changes, and to quantify their proposals in cost and programme terms.

In doing so the client is able to determine, at an early juncture, the possible effect of the changes thereby avoiding funding difficulties. The system is flexible in that it can be utilised for varying contract values and duration.

The procedure can be used on a variety of projects and it does not rely on the conditions of contract for legitimacy.

It can be argued that the Form 'X' methodology represents a major step towards achieving control over the change management process and this argument will be tested using the research methodology detailed in Chapter Four.

CHAPTER 4

RESEARCH METHODS

CHAPTER 4

RESEARCH METHODS

4.0 Introduction

The previous chapter set out a new Change Management Control Mechanism which will prevent many of the difficulties inherent in using the present, designer-led, system.

This chapter describes the research methodology used to test the hypothesis and this involved the setting up of an experiment to determine whether the approach actually achieved the objective of obtaining greater financial control over the project. However, due to the complexity of the research material, and the inter-dependence of the issues raised, it was considered necessary to undertake a detailed exploration of the research methods which were available.

This chapter will review the theory behind the techniques for collecting and analysing data to ensure that the results are valid and accurately reflect the situation. The way in which the population is sampled will reflect the validity and accuracy of the results and will be dependent upon the characteristics of the data and the organisation within which the research is taking place.

Research may be categorised under two headings namely **qualitative** and **quantitative**.

Qualitative research involves the analysis of complex descriptive data in which the researcher may increase his or her involvement and probe to obtain additional information.

Quantitative analysis, however, has the advantage of higher construct and internal validity as the experiment may be repeated with similar results experienced. The data is normally subjected to statistical analysis and clear statements may be made concerning causal and inter-dependent relationships between variables.

In this chapter the focus will be on qualitative data analysis due to the nature of the data collected during the research process. Qualitative data may be collected by a number of means including observation from outside the organisation and observation from within. The researcher may take an independent look at the organisation or embark on a joint venture with the client. The choice of research design will be contingent upon the context within which the research resides.

An alternative research design will be described in which the researcher worked with the client organisation to introduce change through the topic being researched. This methodology, known as **action research**, may take a number of forms and presents the researcher with a variety of data collection and analysis methods.

Finally, the theoretical discussion will argue the need for an interaction of various modes of research in order to reflect the complex, adaptive, organisational setting within which it is required to take place. A new paradigm in research methods using an holistic, interactive, approach is described.

The chapter concludes with a description of the research methods employed for this particular study based on the conclusions of the literature review.

A variety of data collection methods were used during a collaborative exercise with the client organisation. The requirement for change leading to the introduction of a change control model led to the use of action research techniques whereby the envisaged cost control methodology was agreed with the client and the consequences on organisational performance analysed. The organisation was supportive of the research and allowed the researcher access to both documentation and personnel.

4.1 Research Design

In designing a research methodology it is necessary to identify the aims of the research project and the required format of the conclusions. **Gill** and **Johnson (87)** state that the first stage of the research design is to define the problem. This research project seeks to design a mechanism which will ensure that construction projects are completed within budget, with full control over the change management process.

The nature of the research methods employed should reflect these aims by careful analysis of the following elements of research theory:

- Theory and data
- Sampling the population
- Design of data collection method
- Data analysis techniques

Each of these areas will be individually discussed in the context of the research project in question, in order to devise an appropriate research method.

4.1.1 Theory and Data

Concepts do not occur in a vacuum. They are part of the representations of reality, or parts of models or theories. **Martin (88)** states that the aim of a model or theory is to simplify reality, allowing a number interrelated variables to be mapped together showing their overall effect. The nature of this model is dependent upon the nature of the data being modelled. A broad split can be made into quantitative and qualitative research data, the former labelled as the traditional approach to research.

Walker (89) argues that this is due to the positivist tradition of searching for causal relationships and empirically testing explanatory theories into which the deductive quantitative methods fit. The fact that qualitative research relies on inductive reasoning leads to an uneasy fit with this positivist ideology. This gap has been reduced by the creation of causal explanations of social actions.

Quantitative methods of research analysis rely on measuring variables by experimental techniques resulting in structured, concise and explicit data. The main forms of quantitative data collection are survey methods, laboratory experiment and educational testing. These methods rely on the creation of laboratory conditions in which to conduct the research, such that it can be repeated.

Experimental research design allows the researcher to control which units are exposed to which conditions. Having spent the time to set up precise conditions and structure the experiment to record the level of information required, the analysis is conducted by statistical testing. The outcome of these quantitative techniques is usually in the form of causal relationships between variables.

The benefits of construct and internal validity gained by the quantitative approach is highly suited for testing of large populations where one can obtain a sample which represent the whole population. However, when the information required is of a non-quantifiable nature these benefits are reduced. In the case of qualitative data analysis, experimental research is unsuitable as the researcher is required to record the events as they occur.

It can also be argued that experimental techniques may be prone to bias due to changes affecting the members of the experimental group, changes in the measurement process and the subject's reaction to the processes and context of the experiment. As a result of these weaknesses, researchers have tried to take the experiment into the field in order to avoid the artificiality of laboratory conditions. This has lead to the development of less structured data collection methods resulting in qualitative data.

Qualitative research methods are generally testing for the existence of variables, rather than their frequency, and qualitative methods normally yield large volumes of rich data obtained from a limited number of individuals. Compared to quantitative techniques the researchers collecting qualitative data exploit the context of data gathering to enhance the value of the data.

When testing the processes within an organisation it is often the case that the researcher must investigate the nature of interaction and observe the processes as they are taking place. The results from this type of data collection will be personal and will, therefore, require interpretative, creative, analysis.

It is for this reason that the **Open University (90)** has stated that concerns exist over the validity of qualitative research, referred to as having low internal validity, low reliability and low population validity.

Kidder and Judd (91) argued that qualitative research is "impressionistic" as its central tenet lies in the attempt to keep an open mind and to foster new lines of enquiry. They state that this expression of naivety leads to "messy" research in the absence of the clear paths that quantitative methods tread. It can be argued, however, that this can be reduced by making the research as systematic as possible.

Kidder also argues that qualitative methods are non verifiable. In order to verify the data the circumstances should be capable of being repeated by others so the outcomes may be confirmed. The difficulty with the qualitative methods is due to their flexibility. The fact that the researcher can develop themes as they emerge, without being held to a rigid formula, means that the likelihood of replicating the data collection method is minimal.

In discussing the uses of quantitative and qualitative methods, **Walker (92)** distinguishes three phases of research namely, preliminary, principal and validation. He suggests that quantitative and qualitative research methods may be used to complement each other with early qualitative studies leading to quantitative research at a later stage.

The choice of qualitative techniques as the main approach to the research will depend upon the topic under study. Walker states that it may be suited to topics that are complicated or sensitive, concerned with relationships or interaction or with the process of change. It may also be the objective of the research to seek feedback from the research subjects.

The characteristics of this research project lead toward the use of qualitative methods for the following reasons:

- The project management process relies on communication, interaction and relationships and these are the areas for investigation;
- The research is taking place within an organisation which is in the process of implementing the change control methodology;
- In order to gain support from within the organisation, participation from the subjects is encouraged in order for the methodology to gain acceptance.

This research project involves identifying variables, seeking interdependencies and building up theory. The data that will be collected for this process will be both qualitative and quantitative. Having defined the nature of the data it is necessary to identify the persons from whom the data will be collected, this is termed the sample.

4.1.2 Sampling the Population

The second area of research theory to be considered is the choice of subjects. The aim of sampling is to select a group of subjects typical of the population to which they belong and **Kidder and Judd (93)** states that a sample can be defined as **"a portion of the units or elements in a population."**

A number of researchers including **Mason (94)**, **Kidder and Judd (95)** and the **Open University (96)** state that sampling methods vary according to the population in question and the objectives of the study. The two main categories have been identified as **probability sampling** and **non-probability sampling**.

Probability sampling includes any technique that ensures a random sample. Quantitative research makes use of **random sampling** wherein every member of the population has an equal chance of selection. From this sample, errors can be estimated and the deviation from the result expressed statistically. However, it is only suitable for large populations where a random sample can represent the total population. A variation of simple random sampling is **stratified random sampling** using random selection for each subgroup in the sampling frame, where the sampling frame is the available population.

The second type of sampling, **non-probability sampling**, includes methods whereby the research subjects are chosen for specific attributes rather than from a random selection. **Quota sampling** whereby the researcher selects elements on the basis of categories assumed to exist within the population is one method while **judgement sampling** chooses samples as they are believed to be representative of the sample. **Accidental sampling** relies on self selection, normally based on availability or ease of inclusion.

Kidder says that the latter of these sampling methods are termed **purposive procedures** as they are directed toward obtaining a certain type of element. He also states that sample design in qualitative research is usually purposive. He argues that, rather than taking a random cross section of the population to be studied, small numbers of people with specific characteristics, behaviour or experience should be selected to facilitate broad comparisons between certain groups that the researcher thinks are likely to be important.

When sampling for group discussions, two alternative approaches may be used. An homogeneous group can be selected to increase the chances of full participation without particular members feeling threatened or inhibited.

Alternatively it may be advantageous to bring together people whose views are likely to diverge markedly. Again this will depend upon the objectives of the research.

4.1.3 Design of Data Collection Method

Having selected the population from which to gather the sample, it is necessary to optimise the data collection by using an appropriate research method. Research is a process through which questions are asked and answered systematically. It can take a number of forms described by Kidder as **exploration, prediction, explanation** and **action**.

Exploration attempts to determine whether a particular phenomenon exists while **prediction** examines the relationship between two variables so that educated guesses can be made about one by knowing the other. **Explanation** determines whether or not two variables cause each other and **action** involves using research to attempt to solve a social problem.

The chosen method is dependent upon the above categorisation and the nature of the data for collection.

The discussion will focus on qualitative research methods which include survey research, ethnography and action research as well as a combination of all of these techniques within an interactive strategy.

Gill and **Johnson (97)** place these within a matrix, as seen in **Figure 4.1**. The main research strategies are located within a matrix, describing their inter-relation and the different aspects they attempt to fulfil.

Gill and Johnson use this matrix to assist the researcher in choosing the appropriate method to obtain information. It can be argued that the experimental researcher is concerned primarily with precision, the survey methodologist with generality, the ethnographer with the character of the particular context and the action researcher with issues of utilisation.

The attributes of these methods will be discussed by considering the data collection methods held within each category.

Prescriptive Deductive Obtrusive 'from the outside'	**I** **ANALYTICAL SURVEYS AND EXPERIMENTAL RESEARCH DESIGN** *(concerned with precision)*	**II** **ACTION RESEARCH** *(concerned with utilisation)*
Descriptive Inductive Unobtrusive 'from the inside'	**III** **DESCRIPTIVE SURVEY RESEARCH DESIGN** *(concerned with generality)*	**IV** **ETHNOGRAPHY** *(concerned with character of context)*
	General Extensive	**Particular Intensive**

Figure 4.1 Analytical Table of Research Strategies

Source: **Research Methods For Managers** by Gill and Johnson, Paul Chapman, London, 1991, page 146.

4.1.3.1 Survey Research Methods

The survey research may take the form of a questionnaire, administered either by interview or as a respondent completed form. These each have their place and the chosen method should be considered carefully to minimise bias.

Kidder and Judd (98) offer a rule of thumb for deciding the most beneficial survey research method. They suggest that if the researcher is more interested in the depth and quality of data than in having a large number of responses then the interviewing technique should be considered. If the questions are fairly easy to answer and a large number of responses are required to complete statistical analysis then self completed questionnaires may be more suitable. It is clear, therefore, that survey research may be used for either quantitative or qualitative research.

4.1.3.2 Ethnography

Ethnography is based upon **"naturalist"** modes of inquiry, such as participant observation, within a predominantly inductivist framework. Induction is described by **Gill** and **Johnson (99)** as general inferences induced from particular instances, or the development of theory from the observation of empirical reality. The first ethnographic studies were conducted by Charles Booth in the 19th century in which he used statistical data, interviewing and systematic participant observation to arrive at conclusions.

Mason (100) states that ethnography focuses on the manner in which people interact and collaborate in observable and regular ways.

Ethnographers generally place more emphasis on observation and semi-structured interviewing than on documentary data. It is not possible to define ethnography as a single mode of collecting information since it usually entails the varying application of many techniques so as to elucidate the subjective basis of the behaviour of people.

Ethnographers attempt to understand the culture of the situation and so interpret it in the way that its members do without conducting experiments or interviews in artificial environments. The problem of understanding social action lay in the fact that it is a world of interpretations and meanings. There are always multiple perspectives and one must look beyond the official versions of the information given by the participants, as recorded by the **Open University (101)**. **Kidder and Judd (102)** describes participant observation as the explanation of ethnography while **Gill and Johnson (103)** explain participant observation as the observer immersing completely into a social setting and adopting a role of full participation in the everyday lives of the subjects.

In contrast to this they describe non participant observation when the researcher takes the role as a spectator only observing events and processes and thereby avoids becoming involved in interactions with the subjects. The former method of observation allows the ethnographer to feel the effects of what is happening as well as observing them. It may be the only viable way of discovering what is actually happening. Non participant observation on the other hand relies on the honesty of the subjects.

However, participant observation may immerse the researcher into the culture thereby preventing him or her from taking a dispassionate view of events. The non participant observer may experience the opposite effect by judging the events from within his or her own culture.

However the spectator role may be more realistic as the subjects are not affected in any way by the observer. The observer can be presented in a spectrum of roles passing from **comparative involvement** using subjectivity and sympathy to **comparative detachment** using objectivity and empathy.

Figure 4.2 sets out the spectrum of participant and non participant observation:

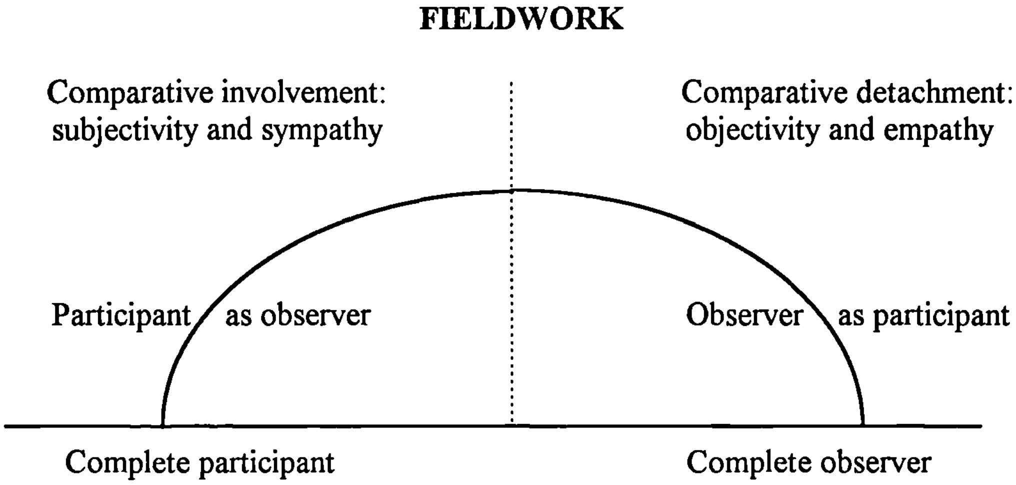


Figure 4.2 <u>**The Spectrum of Participant and Non Participant Observation**</u>

Source: **Research Methods in Education and the Social Sciences, Block 3, Research Design**, The Open University Press, Milton Keynes, 1979, Page 70.

The ethnographic method of research has a number of weaknesses in that it has low internal validity, low reliability and low population validity. It is generally suited to small scale exploratory work to discover areas worth further investigation, cross validating in a natural setting results achieved by other methods or investigating relatively unknown social phenomena, in detail, in their natural setting to develop theories to be validated by other research methods.

4.1.3.3 Action Research

Winter (104) states that, in most research projects, the researcher aims to be detached and not interfere with the topic being studied. In action research, however, the researcher is actively involved in planning and introducing a change in policy and then using research expertise to monitor and evaluate its effect. Action research involves the planned intervention by a researcher into a naturally occurring event. The effects are then monitored to discern whether or not the action has produced the expected consequences. The researchers involvement is an intrinsic part of the research design. **Gill and Johnson (105)** describe the action research route as an iterative one, whereby the problem is presented by either the client, or the researcher, with joint diagnosis between the two parties. This is reflected in the action research cycle indicated in **Figure 4.3** hereunder.

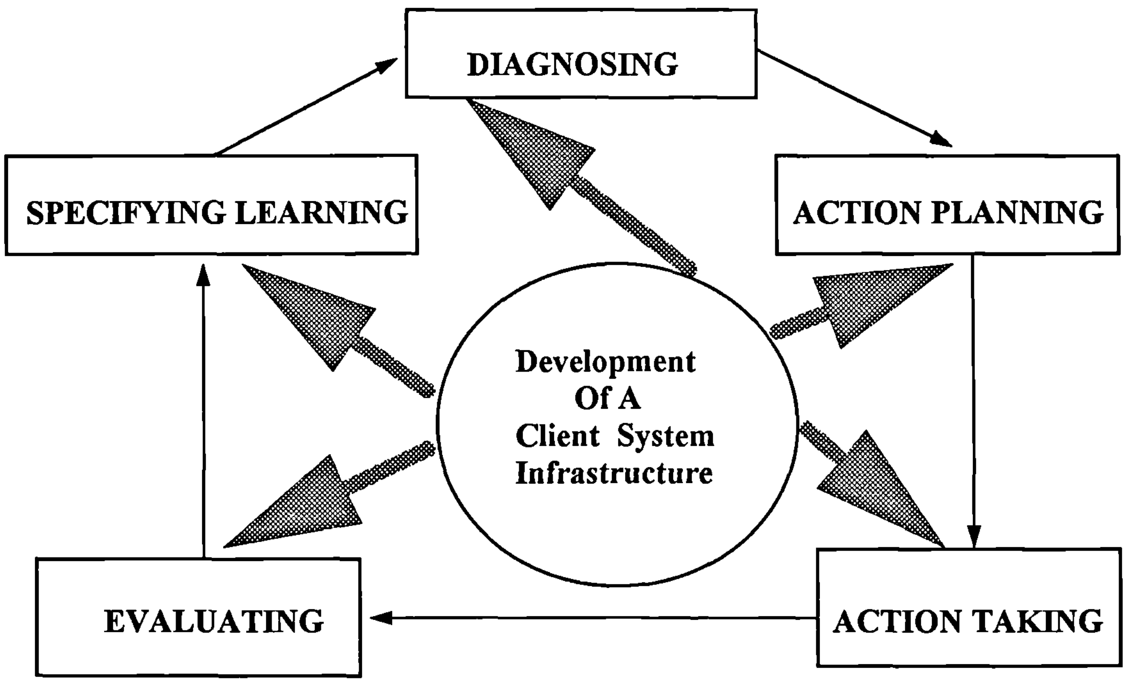


Figure 4.3 The Action Research Cycle

Adapted from Source: **Action Research - A Sociotechnical Systems Perspective** by Susman, in Beyond Method, Sage, 1983, page 95.

The commonest definition of action research is that by **Rapoport (106)** who states that:

> **"action research is a general mode of inquiry that seeks to contribute to the practical concerns of people in a problematic situation and to the goals of social science within a mutually acceptable ethical framework."**

Susman (107) describe six characteristics of action research:

(a) It is future oriented, trying to improve the future of people;

(b) It is collaborative, obliging researchers to indicate their own ethics and values;

(c) It implies system development;

(d) It generates theory grounded in action;

(e) It is agnostic in that future prescriptions are the produce of previous action;

(f) It is situational, based on actors defining their current situation.

Susman and Evered (108) and **Foster (109)** identify four types of action research:

Diagnostic : the researcher is only involved in collecting the data for diagnosis and feeding back into the client system;

Empirical : the research only evaluates the options undertaken by the client system and feeds data back to it;

Participant : diagnosing and action planning is carried out in collaboration between the researcher and the client system;

Experimental : researcher and client system collaborate in all phases to set up an experiment for taking an action.

Which technique to use will depend upon the research objectives and the access provided.

It should also be noted that **Winter (110)** states that action research has been criticised in the past for being a **"muddled science"** as it dismisses the outside observer and independent experimenter. It has also been dismissed as being idealistic and, because it sits in between practical and theoretical practice, it is said to lack theoretical definition.

In addition, **Rapoport (111)** highlights three dilemmas concerning this method of research.

- The first of these is the matter of ethics in terms of respondent protection, awareness of personal and political motives. A good action researcher will not become a captive of the organisation being studied;
- The second dilemma concerns the conflict of goals that may arise between the demands for help by the client organisation and the demands of the research;
- Finally the third dilemma concerns the shifting focus of initiative from the client to the action researcher as the research progresses. The client-researcher relationship is not a simple one and the action researcher must seek multiple support and participation.

Resolution of these three dilemmas is an important part of the work of action researchers.

Action research forms part of the action learning loop, which involves the whole organisation in a learning process through which senior managers are activated to handle key organisational matters. Senior management is activated to reconsider their thinking and the approaches of action research are disseminated to the wider employee base.

This is termed **"two loop learning"** as described by **Garratt (112)** hereunder.

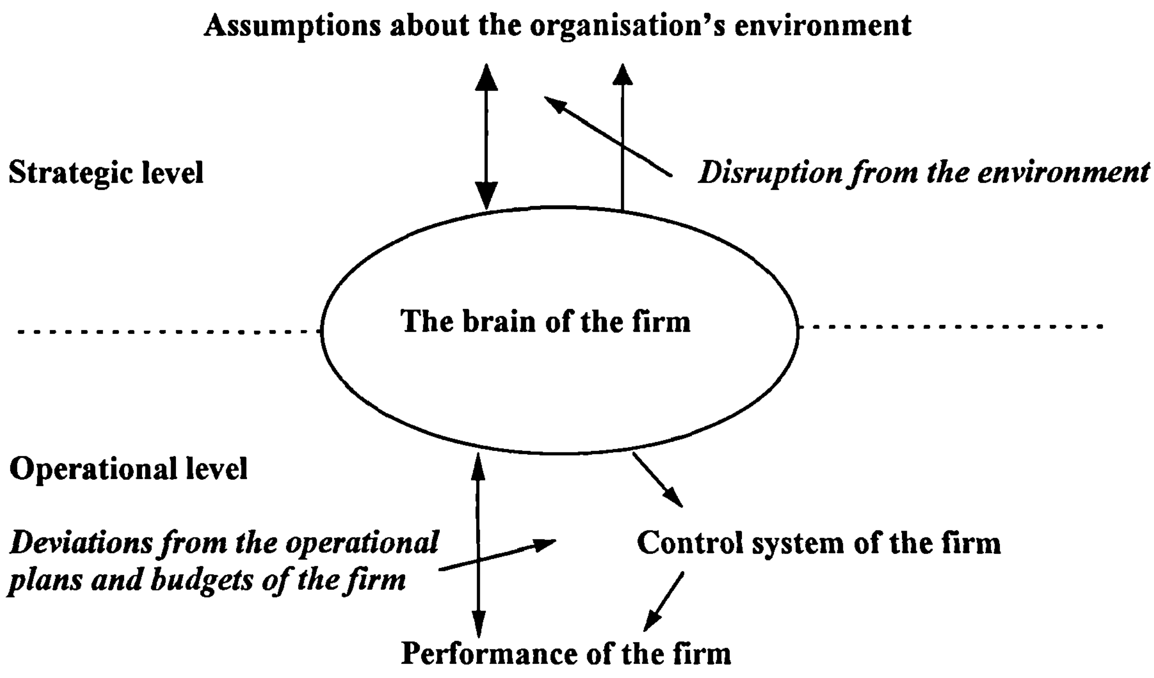


Figure 4.4 Operational and Strategic Learning Loops

Source: **The Power of Action Learning** by Garratt in **Action Learning In Practice** by Pedler (Ed), Gower, Aldershot, 1983, Page 26.

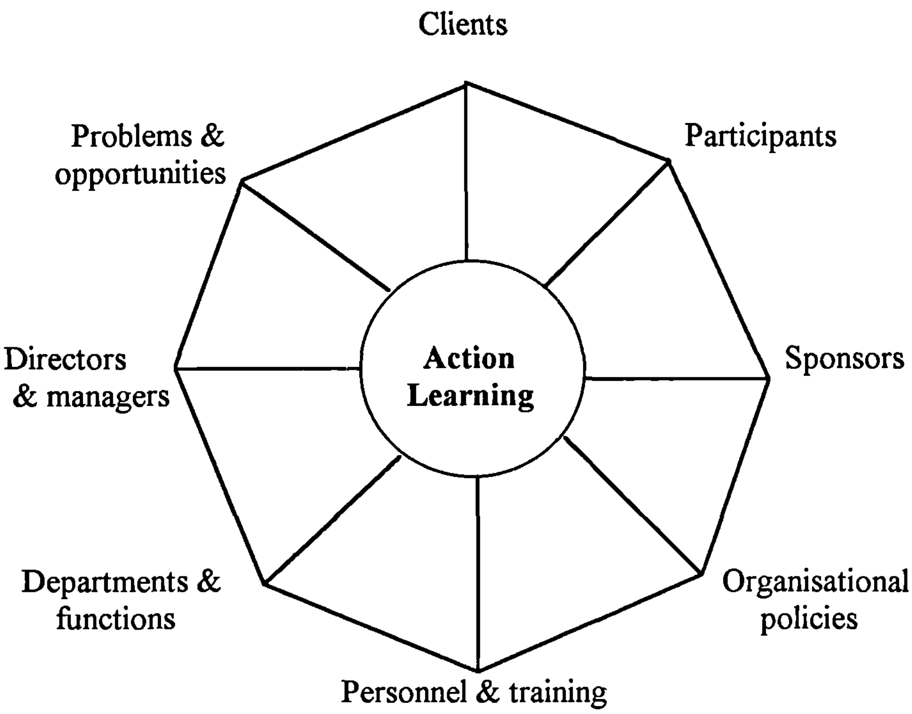


Figure 4.5 The Web of Activities Surrounding Action Learning

Source: **The Role of Personnel Specialists** by Garratt in **Action Learning In Practice** by Pedler (Ed), Gower, Aldershot, 1983, Page 32.

For this reason the action research methodology may involve many forms of data collection as discussed by **Cunningham (113)** in his description of **interactive holistic research**. This is based on the work of **Reason (114)** in which he describes the shift in research paradigm required for modern qualitative research as:

- Participation and holistic knowledge in a move away from the distance and separateness of objectivity;
- A shift from objective consciousness to a quality of awareness called subjectivity where we use our experience as part of the inquiry process;
- Knowledge is used as a means of achieving action rather than existing for reflection.

Heron (115) states that these thoughts build on the action research methodology, interactively enhancing the validity of the research by cycling between reflection and experience. He describes **validity** as the quality of being well founded. He concludes that holistic action research is far from being invalid since the research is consummated through action. It is here that the picture of the chosen research methodology begins to form.

The characteristics of the research project that led to the choice of the action research methodology are listed hereunder:

a) Full access to the organisation could be achieved by the researcher;
b) The research was inherently participative since the researcher was a member of the sponsoring organisation;
c) Members of the organisation had to be involved in order to gain commitment to the research;

d) Implementation was required during the research period in order to test the research model;

e) The change control process under consideration involved many aspects of the organisation;

f) Much of the research data was based on human interaction within the project management process.

It is, however, necessary to consider the effects of the research taking place within the researchers own organisation. The implications can be expressed in terms of **advantages** and **disadvantages**, as presented hereunder:

Advantages	Researcher already has access to the topic/organisation;
	Researcher is in good position to obtain authority to carry out research;
	Researcher has colleagues from whom to obtain information;
	Researcher is familiar with the jargon of the organisation;
	Researcher has working knowledge of routine tasks and schedules;
	Researcher has a stock of background information;
	Researcher may not suffer from the stressful aspects of field work;
Disadvantages	Researcher may find it difficult to distance himself from the organisation;
	Researcher will be part of existing organisational patterns;
	Researcher may encounter role conflict;
	Researcher's familiarity with the personnel, structure and systems of the organisation may prevent objectivity.

The nature of this research project requires one to collect data from a number of sources.

In order to inter-connect these, and use one to spark further inquiry in another area, it was necessary to take an holistic view of the research methodology.

The following is a list of some of the research methods that were considered necessary to achieve optimum coverage within the research period:

Simple dialogue	To understand the workings of the organisation and the nature of the various contracts, localities and departments;
Document analysis	To review the nature and completeness of documentation and track all design changes over time
Interviews	To investigate specific areas of interest and meet with personnel having influence within the sponsoring organisation

Cunningham (116) states that the interactive interplay of modes of research is necessary in order to gain optimum validity and coverage. The concept calls for the techniques to be run concurrently in order to investigate existing theories and ideas, understand the situations and contexts of human action, achieve interaction with others and acknowledge and utilise one's own knowledge and experience.

The data concerned here is essentially qualitative, requiring rich data collection techniques to ensure the issues are fully understood. In order to increase the validity of the research and to enable collection from a number of sources it becomes necessary to combine and triangulate the results from each of the research methods.

In this holistic approach to research the results build up as themes develop.

4.1.4 Data Analysis Techniques

Analysis of qualitative data has been identified as a problem area due to it's volume and diversity. The data collected by means of an interactive holistic approach, as recommended here, must be analysed as a whole.

Mason (117) state that there are two main methods for achieving this. In the first method the research effectively goes by frequency of events converting the qualitative data into numbers which are seen as politically more acceptable. The second method, known as **grounded theory** allows the researcher to go by "feel and intuition" aiming to produce common and contradictory themes and patterns.

As noted above, a research method has been developed based upon the available theory. The early decision that the data would essentially be qualitative was based upon the requirement for rich data, interpreting the interactions found during a construction project. This focused the sampling investigation to a number of non probabilistic techniques, whereby specific performance on individual contracts could be investigated to form interpretations from specific perspectives.

In order to increase the validity of the research data, it was decided to combine a number of data collection techniques holistically. In this way the results from a variety of data collection methods could be aggregated to draw conclusions from the data collected. The discussion also introduced the action research method acting as an enveloping methodology to surround the whole research project.

The fact that the objective was to introduce a new methodology within the sponsoring organisation, led to the necessity to manage the change and introduce the system in a controlled manner.

The remainder of the chapter will discuss the specific techniques to be used, relating each technique to the research framework. The samples used will be presented and the data collection methods discussed. The next section will, therefore, build upon the conclusions of this section by describing how the research method was implemented during the research period.

4.2 Chosen Research Methodology

The research process has attempted to build a picture or model of the change control process, by combining information from a number of sources. The process was sequential and two principal research methods were used:

4.2.1 Document Analysis

Objective	To obtain data to establish whether the change control methodology has affected the cost characteristics of the various contracts;
Reason for Choice	The analysis of documents allowed the researcher to draw specific information and recognise changes in practice over time;
Sample	The documents consisted of cost control reports, Form 'X' submissions, monthly progress reports and guidance notes for project staff on the management of contracts;
Results	The results are detailed in **Appendices 'D'** to **'G'**.

4.2.2 Interview Analysis

Objective To obtain an opinion from the participants on the effectiveness of the methodology;

Reason for Choice The information which has been assembled was extremely detailed and required probing and discussion with particular members of the client organisation and its external design and contractual consultants;

Sample: Purposive sampling was used to target the personnel who could provide the necessary information. Senior Executives within the Corporation, together with a Partner or Associate from the consultants familiar with the methodology, were interviewed;

Results: The results are detailed in **Appendix 'I'**.

4.3 Data Analysis Techniques

The data which was collected was both quantitative and qualitative in nature, rich in content and voluminous. The data is analysed in quantitative and qualitative terms in Chapter Five.

4.4 Implementation Through Action Research

During the research period feedback was given to the sponsoring organisation. As a result the model was introduced through liaison with the researcher and the senior executives of the enterprise.

Due to this **participant action research** methodology aspects of the model were interactively developed with and communicated to the organisation. At the time of completion all aspects of the model had been implemented as part of the change control process.

Final validation of the model was achieved by a presentation to the Executive Committee of the sponsoring organisation and the results were conveyed to the sponsoring organisation at the end of the research period.

4.5 Summary

This chapter had identified four areas of concern when choosing a research strategy, namely, theory and data, sampling and population, design of data collection and data analysis techniques. Quantitative and qualitative data were introduced comparing the techniques and problems in dealing with each.

Having identified that the research data being dealt with in this study is both quantitative and qualitative, the discussion went on to introduce the sampling methods available to represent the population and collect the required data when dealing with qualitative samples.

Probabilistic sampling methods whereby all members of the population have an equal chance of being selected were identified as unsuitable for qualitative data. It is normal that purposive sampling is conducted whereby the sample is selected to achieve specific objectives.

After reviewing the methods available for qualitative data collection it was argued that an holistic interactive methodology was suited to this research study. By this method the results from many forms of data collection are combined in an attempt to increase the validity of the collected data.

In addition the action research methodology would form part of this holistic approach since the objective is to introduce a new control model into the sponsoring organisation. This allowed the researcher to gain full support and collaboration of the sponsoring organisation as the model was jointly developed by iteration with it's members.

In conclusion, therefore, the chosen research strategy combined the use of the following methods of data collection in an interactive, holistic, strategy using action research:

- Document analysis, culminating in a statistical analysis of the data obtained;
- Interview analysis, resulting in a summary of the themes which have emerged.

Sampling was achieved according to the requirements of the research method. By combining and interacting the results from each of these methods a change control methodology was designed and then developed in conjunction with the sponsoring organisation.

The use of action research allowed elements of the model to be injected into the organisation through dialogue and implementation.

Having collected and analysed the data, Chapter Five will present the results following the development of the cost control methodology through the action research process.

CHAPTER 5

THE APPROACH IN ACTION

CHAPTER 5

THE APPROACH IN ACTION

5.0 Introduction

The previous chapter detailed the methods by which the research would be conducted in order to test the hypothesis. It was concluded that a variety of research methods should be used and both quantitative and qualitative techniques have been utilised in the sections which follow.

This chapter reports on both the **quantitative research**, being the statistical analysis of contract information derived from the review of documentation, and the **qualitative research**, being a review of the themes which emerged from structured interview of the principal participants in the change management process.

The Corporation had experienced difficulties in controlling expenditure on a number of contracts including the two contracts noted hereunder:

Contract No	Title	Contract Sum (HK$)	Final Account Sum (HK$)	Percentage Variation
101	Waterloo & Argyle Stations	249,615,109	444,695,773	+ 78.15
106	Admiralty & Central Stations	304,750,150	450,982,150	+ 47.98

Both contracts were undertaken utilising a system whereby change management was solely in the hands of the on-site construction personnel. Although there were a number of reasons for the high cost over-run, the major problem for the Corporation was its inability to control the level of expenditure. As result of these problems the Corporation adopted the Form 'X' approach on a number of its Island Line Contracts. The procedure described in Chapter Three was used, subject to the modifications described.

It is the comparison of the approval characteristics of certain of these contracts which forms the subject of this chapter. The chapter compares five contracts undertaken by the Mass Transit Railway Corporation utilising the Form 'X' approach with three similar contracts, also undertaken by the Corporation, but using traditional site based control.

These contracts are described below:

(a) Contract Control using the Form 'X' Approach

Contract No	Title	Contract Sum (HK$)	Final Account Sum (HK$)	Percentage Variation
401	Sheung Wan East Station	259,392,076	284,155,114	+ 9.55
402	Western Fruit Market Cross Over Box	733,252,206	788,649,561	+ 7.56
406	Fortress Hill Station	263,897,278	278,979,412	+ 5.72
427	Wanchai Station	166,378,839	173,893,469	+ 4.52
431	Tin Hau Station	175,150,936	196,714,195	+12.31

(b) Contract Control using Traditional Site-Based Methods

Contract No	Title	Contract Sum (HK$)	Final Account Sum (HK$)	Percentage Variation
403A(A)	Advance Works at Admiralty Lot 2 Station (West)	32,536,786	49,149,713	+51.06
403A(B)	Advance Works at Admiralty Lot 2 Station (East)	32,680,004	37,300,287	+14.14
406A	Advance Works at Fortress Hill Station	25,500,000	26,446,137	+ 3.71

5.1 Contract Information

For completeness the information relating to each contract has been reproduced as **Appendices 'D'** to **'G'** (inclusive) as detailed hereunder:

(a) Appendix 'D' - Cost Centre Control Totals

The Cost Centre Control Totals give a breakdown of the Contract Sums given in the introduction to this chapter. These relate to contracts 401, 402, 406, 427 and 431.

(b) Appendix 'E' - Cost Centre Revisions

This details the manner in which the original Cost Centre figures have been revised due to the issue of Engineer's Instructions, Dayworks Orders and Claims Settlements as authorised under the Form 'X' procedure.

(c) Appendix 'F' - Form 'X' Summary Sheets

This details the variations approved by the Corporation's Executive Committee on contracts 401, 402, 406, 427 and 431.

(d) Appendix 'G' - List of Engineer's Instructions

This details the various Engineer's Instructions issued on contracts 403A(A), 403A(B) and 406A.

Chapter Two outlined, in some detail, the documentary evidence behind the research concept, namely that client organisations can suffer financial problems due to the lack of an efficient change control mechanism. The acceptance of this fact led to the formulation of the Form 'X' approach outlined in the Chapter Three and this chapter is concerned, primarily, with the testing of the hypothesis, namely that the Form 'X' approach is an effective change control methodology

This chapter compares the original Contract values and Final Account values applicable to the three site controlled contracts with those of the five Form 'X' controlled contracts.

The Form 'X' contracts show a high degree of correlation between the original and the final Cost Centre values. The Form 'X' contracts clearly show that the introduction of a change control mechanism reduces the level of cost increases.

Cost control becomes the order of the day as opposed to cost reporting.

This trait can be clearly seen when the cost increases are seen on a contract-by-contract basis, starting with the Form 'X' contracts :

5.1.1 Contract 401 : Sheung Wan East Station

Contract Commencement :	1 May 1982
Contract Completion :	16 June 1986

The Change Control Procedure outlined in Chapter Three was not applied in the correct manner due to a misunderstanding on the part of the contract administration personnel who prepared the initial Cost Control values.

The staff responsible for this contract failed to understand the importance of deducting the Provisional Sum element from the Contract Total and inflated Cost Centre values were used as Control Totals.

This oversight was due, in the main, to their failure to understand the nature of the Corporation's change management procedures.

During the design and construction period **234** Form 'X's were proposed with the following result:

	Form 'X' Proposals					
	Design		**Construction**		**Claims**	
	Value (HK$)	**No**	**Value (HK$)**	**No**	**Value (HK$)**	**No**
Total	22,818,811	82	14,023,066	100	13,533,304	52
Rejected	2,265,120	4	401,120	8	-	1
Accepted	20,553,691	78	13,621,946	92	13,533,304	51
Final Valuation	**HK$21,138,418**		**HK$11,638,580**		**HK$23,035,680**	

Total Final Valuation of Accepted Proposals	**HK$55,812,678**
Total Variation Between Contract Sum and Final Account Sum	**HK$24,763,038**

The Control Procedure indicates that, in value terms, **90.07%** of Design revisions were approved while **97.14%** of Construction revisions were found to be acceptable.

The Claims procedure merely serves to indicate a possible financial liability arising out of an event which could give rise to a claim under the conditions of contract.

As claims notifications are unpredictable, and are not controllable by the Corporation, they have been excluded from this study.

The value of design and construction revisions was originally estimated at **HK$34,175,637** or **13.18%** of the original contract value.

On a civil engineering contract this represents an acceptable level of change.

Including claims notifications the Corporation accepted that an additional **HK$55,812,678** might have to be paid to the contractor. In the event the Contracts Administrators were able to keep the final increase down to **HK$24,763,038** by not expending monies provided for under Provisional Sums.

This was also partly due to the fact that many of the construction cost claims had been overstated by the contractors and the site-based staff had initially accepted the validity of the figures.

The Client was, at all times, aware of his maximum exposure and was able to budget accordingly. The strict control imposed by the change control methodology was effective in that the difference between the accepted and final values for design and construction revisions was a mere **HK$1,398,639** or **4.09%** of the approved variation figure.

5.1.2 Contract 402 : Western Fruit Market Cross-Over Box

Contract Commencement :	1 July 1982
Contract Completion :	5 June 1986

Unlike the case of contract 401, the Control Procedure was correctly applied in the case of Contract 402 and the Cost Control values were altered to take cognisance of the existence of Provisional Sums.

Contract 402 was one of the largest and most complex contracts on the Island Line and during the design and construction period **326** Form 'X's were proposed with the following results:

	Form 'X' Proposals					
	Design		Construction		Claims	
	Value (HK$)	No	Value (HK$)	No	Value (HK$)	No
Total	38,366,710	109	53,551,024	141	396,130	76
Rejected	9,411,034	18	18,467,370	15	-	-
Accepted	28,955,676	91	35,083,654	126	396,130	76
Final Valuation	**HK$27,315,607**		**HK$40,105,959**		**HK$6,967,450**	

Total Final Valuation of Accepted Proposals	**HK$74,389,016**
Total Variation Between Contract Sum and Final Account Sum	**HK$55,397,355**

The Contract Procedure indicated that, in value terms, **75.47%** of Design revisions and **65.51%** of Construction revisions were approved. The low approval rate illustrates that fact that the client was conscious both of the importance of the project and of the danger of cost-over run.

With **24.53%,** of Design revisions rejected and **34.49%** of Construction revisions suffering the same fate one can see that the staff associated with the project were submitting requests to vary the contract which were being consistently rejected by the Executive Committee.

The value of design and construction revisions was originally estimated at **HK$64,039,330** or **8.73%** of the original contract value.

The client was again kept aware of this maximum exposure and the effectiveness of the post-approval process can be illustrated by the fact that the difference between the accepted and final value for design and construction revisions was only **HK$3,382,236** or **5.28%** of the approved variation figure.

5.1.3 Contract 406 : Fortress Hill Station

Contract Commencement :	1 May 1982
Contract Completion :	13 June 1985

As was the case with Contract 402, Contract 406 was administered in accordance with the requirements imposed by the Form 'X' Control Procedure.

The procedures outlined in Chapter Three were fully complied with and the Contracts Administration team were particularly vigilant in their approach to construction variations.

During the design and construction period **114** Form 'X's were proposed as indicated hereunder:

	Form 'X' Proposals					
	Design		Construction		Claims	
	Value (HK$)	No	Value (HK$)	No	Value (HK$)	No
Total	33,477,900	80	9,760,030	20	-	14
Rejected	1,772,600	13	(131,000)	2	-	2
Accepted	31,705,300	67	9,891,030	18	-	12
Final Valuation	**HK$31,705,328**		**HK$10,688,043**		**HK$1,400,625**	

Total Final Valuation of Accepted Proposals	**HK$43,793,996**
Total Variation Between Contract Sum and Final Account Sum	**HK$15,082,134**

The Control Procedure indicates that, in value terms, **94.71%** of Design revisions and **98.68%** of Construction revisions were approved.

The value of design and construction revisions was originally estimated at **HK$41,596330** or **15.76%** of the original contract value.

The contract was, however, unusual in that very few Construction Form 'X' proposals were raised, thereby indicating that the project progressed as originally anticipated and that there were few problems on this particular contract.

There are, however, a high number of Design Form 'X' submissions of which **5.29%** were rejected. The design staff, therefore, appeared to have submitted a large number of design proposals, many of which were subsequently rejected.

The Design Managers, and their consultants, did not appear to have an unfettered hand in formulating the design for the site.

Including Claims notifications, the Corporation accepted that an additional **HK$43,793,996** might have to be spent. However, as on the other contracts, the Corporation's Contracts Administrators were able to keep the increase down, in this case, to **HK$15,082,134** by not expending monies covered by Provisional Sums.

This contract was well controlled and the design appears to have been well advanced by construction stage resulting in very few revisions and even fewer claims notifications. This contrast sharply with Contracts 401 and 402 where **51** and **76** claims notification Form 'X's were accepted as opposed to only **12** on Contract 406.

Contract 406 was an example of excellent change control with the Contract Administrators being reluctant to process claims submitted by the contractors responsible for the construction works.

The difference between the accepted and final values for design and construction revisions was only **HK$797,041** or **1.92%** of the approved variation figure.

5.1.4 Contract 427 : Wanchai Station

Contract Commencement :	1 May 1982
Contract Completion :	10 July 1985

Contract 427 represents the smallest of the Form 'X' Control Mechanism contracts and during the design and construction period **150** Form 'X's were proposed with the following result:

	Form 'X' Proposals					
	Design		**Construction**		**Claims**	
	Value (HK$)	**No**	**Value (HK$)**	**No**	**Value (HK$)**	**No**
Total	25,034,598	37	28,806,356	93	13,085,428	20
Rejected	793,000	8	2,773,430	9	-	-
Accepted	24,241,598	29	26,032,926	84	13,085,428	20
Final Valuation	**HK$23,765,948**		**HK$24,542,266**		**HK$75,001**	

Total Final Valuation of Accepted Proposals	**HK$48,383,215**
Total Variation Between Contract Sum and Final Account Sum	**HK$7,514,630**

The Control Procedure indicates that, in value terms, **96.83%** of Design revisions and **90.37%** of Construction revisions were approved by the Corporation.

The value of design and construction revisions was originally estimated at **HK$50,274,524** or **30.22%** of the original contract sum.

Even for a civil engineering contract this represents a large degree of change. The Corporation imposed tight control and the possible cost over-run figure of **HK$48,383,215** was reduced to **HK$7,514,630** after negotiation.

There was little variation between the originally estimated Form 'X' value and the final valuation. The difference was **HK$1,966,280** or a **3.91%** reduction from the original estimate.

5.1.5 Contract 431 : Tin Hau Station

Contract Commencement :	1 May 1982
Contract Completion :	28 May 1985

Although Contract 431 had a relatively small contract value compared to the other contracts forming part of the study, the work itself involved some of the most difficult civil engineering operations required for the construction of the Island Line.

There was also potential for confusion on the contract as similar works within the construction area were being performed by other contract staff using traditional approaches to contract control.

During the design and construction period **110** Form 'X's were proposed with the following result:

	Form 'X' Proposals					
	Design		**Construction**		**Claims**	
	Value (HK$)	**No**	**Value (HK$)**	**No**	**Value (HK$)**	**No**
Total	19,816,200	38	26,580,151	53	-	19
Rejected	(242,990)	6	692,000	7	-	-
Accepted	20,059,190	32	25,888,151	46	-	19
Final Valuation	**HK$20,250,793**		**HK$19,517,531**		-	

Total Final Valuation of Accepted Proposals	**HK$39,768,324**
Total Variation Between Contract Sum and Final Account Sum	**HK$21,563,259**

The Control Procedure indicated that, in value terms, **98.79%** of Design and **97.40%** of Construction revisions were acceptable to the Corporation's hierarchy.

The value of design and construction revisions was originally estimated at **HK$45,947,341** or **26.23%** of the original contract value. This figure is relatively high and reflects the fact that the project was an extremely difficult one.

There was, however, a difference of **HK$6,179,017** or a **13.91%** reduction between the originally estimated Form 'X' value and the final valuation.

The Corporation acknowledged that an additional **HK$39,768,324** might have to be raised although, after negotiation, the actual total increase was reduced to **HK$21,563,259**.

The Contract is unusual in that whilst there were **19** notification of possible claim situations no claims were actually made by the Contractor.

Having examined the five contracts using the Form 'X' control system it is appropriate to also study the three contracts using the traditional site-based control system:

5.1.6 Contract 403A(A) : Advance Works at Admiralty Lot 2 Station (West)

Contract Commencement :	1 September 1981
Contract Completion :	19 January 1983

Contracts 403A(A) and 403A(B) were awarded to the same contractor and a joint letter of contract award was issued.

The Corporation's senior personnel were not involved in the administration of the contract and the site-based staff issued instructions without a reference to, or consultation with, senior construction personnel.

During the design and construction period the Engineer issued **21** Engineer's Instructions as can be seen from the summary below:

	Engineer's Instructions					
	Design		Construction		Claims	
	Value (HK$)	No	Value (HK$)	No	Value (HK$)	No
Final Valuation	**HK$1,196,500**	11	**HK$3,334,100**	9	**HK$5,350,000**	1

Total Final Valuation of Instructions (21)	**HK$9,880,600**
Total Variation Between Contract Sum and Final Account Sum	**HK$16,612,927**

The estimated value of Instructions amounted to **30.37%** of the Contract Sum and while this percentage is high it pales into insignificance when compared to the final valuation of revisions on the Contract.

The final valuation represents an increase of **51.06%** and the reason for the disparity between the estimated and final valuations was due to a non-realistic appraisal of the changes which had been approved.

It was the magnitude of the cost increase on this contract which caused the introduction of the Form 'X' Control procedure and it was the Corporation's view that the cost over-run on this contract was caused by a lack of effective financial control at the site level.

5.1.7 Contract 403A(B) : Advance Works at Admiralty Lot 2 Station (East)

Contract Commencement :	1 September 1981
Contract Completion :	19 January 1983

This, the sister contract of 403A(A), was under the control of the same team of construction personnel who issued **16** Engineer's Instructions as detailed below:

	Engineer's Instructions					
	Design		Construction		Claims	
	Value (HK$)	No	Value (HK$)	No	Value (HK$)	No
Final Valuation	HK$2,888,500	8	HK$1,005,780	7	HK$7,359,000	1

Total Final Valuation of Instructions (16)	**HK$11,253,280**
Total Variation Between Contract Sum and Final Account Sum	**HK$4,620,283**

The estimated cost value of design and construction related instructions amounted to **HK$3,894,280** or **11.92%** of the Contract Sum. This percentage is normal for a contract of this nature. The Contract Administrators were realistic in their assessment of value and were also able to negotiate the final figure down from **HK$11,253,280** to **HK$4,620,283**. The only disturbing feature of the contract was the fact that the site-staff approved claims totalling **HK$7,359,000** without reporting the matter to senior Corporation personnel.

5.1.8 Contract 406A : Advance Works at Fortress Hill Station

Contract Commencement :	1 November 1981
Contract Completion :	15 November 1982

This contract was both the simplest and the smallest of the contracts studied. Despite this fact the Engineer still issued **21** Engineer's Instructions as detailed below:

	Engineer's Instructions					
	Design		**Construction**		**Claims**	
	Value (HK$)	**No**	**Value (HK$)**	**No**	**Value (HK$)**	**No**
Final Valuation	**HK$1,047,000**	3	**HK$1,694,769**	16	**HK$1,423,280**	2

Total Final Valuation of Instructions (21)	**HK$4,165,049**
Total Variation Between Contract Sum and Final Account Sum	**HK$946,137**

The estimated value of the design and construction related instructions totalled **HK$2,741,769** or **10.75%** of the contract sum. The Contract Administrator controlled the contract well and the estimated cost over-run of **HK$4,165,049** was reduced to **HK$946,137** representing an increase of **3.71%** on the original contract sum.

The Contracts detailed above show the operation of the Form 'X' approach in exercising control over design and construction variations. The Form 'X' contracts indicate that the Corporation approved over 90% of all requests for changes in design and construction methodology.

The exception was Contract 402 and this was due to the fact that the contract was very large and the Contract Administrators continually supplied inadequate information to support their requests for change. Once the revisions had been approved the Contract Administrators had exercised excellent control in keeping the final value of Form 'X' submissions close to the originally estimated figures. Variations figures ranged from **1.92%** to **13.45%** with an average variation of **5.73%**. These relatively small variations, both positive and negative, can be contrasted with the large variation which occurred on Contract 403A(A). In the case of Contract 403A(A) there as a **68.14%** increase on the originally forecast cost over-run.

In the case of the other two Contracts which operated on the principal of site-based control the Contracts Administrators were effective in imposing their own discipline on the project. It is, however, the events depicted under Contract 403A(A) which illustrates both the need for, and effectiveness of, a Change Control Mechanism.

The people responsible for the contract administration of the various works were similar in experience and qualifications and in many cases the staff responsible for the Form 'X' contracts were also responsible for the traditional contracts.

The organisational structures relevant to the eight contracts are given as **Appendix 'H'** together with structures detailing the other parties involved in the contracts under scrutiny.

The contracts themselves were very similar in nature and there is **nothing** in the works to suggest that control should not have been executed to a constant standard on all contracts. It should, therefore, be noted that certain contracts appear, on face value, to have been better controlled than others.

This point should not obscure our view of the fact that the Form 'X' Control Procedure forced the various Contracts Administrators to justify all changes and to produce evidence relating to claims and other contract-related circumstances.

On all of the contracts using the Form 'X' Control Procedure the Contract Administrators were able to produce the required level of documentation, or justification, and, with the possible exception of Contract 402, appear to have had little difficulty in persuading the Corporation's senior executives of the validity of their requests. In cases where there was no real reason for change the Form 'X' was rejected.

The procedure was also effective by erecting a **psychological barrier** which made the Contracts Administrators reluctant to put forward Form 'X' submissions which they might not be able to justify. Without this mechanism it could be argued that many unnecessary, yet cost significant changes, would have been implemented.

It also needs to be pointed out that the considerable difference between the high "Total Final Valuation of Accepted Proposals" and the lower "Total Variation Between Contract Sum and Final Account Sum" is due to the ability of the contract administration teams to negotiate reductions for prompt settlement/payment and to decide on the need to expend monies detailed under Provisional Sums.

This is not unusual in contracting and it is normal to anticipate significant cost reductions at this stage if the original estimate has been accurate. However, as illustrated in the case of Contract 403A(A), cost increase can also occur at this stage especially if the Contract Administrator's valuation of the changes has been unrealistic.

5.2 Quantitative Analysis of Contract Information

The information detailed above can be summarised in tabular form :

(a) Contracts Completed Using Site-based Control Procedures

Contract No.	Contract Sum (HK$)	Final Account Sum (HK$)	Overspend (%)
101	249,615,109	444,695,773	78.15
106	304,750,150	450,982,150	47.98
403A (A)	32,536,786	49,149,713	51.06
403A (B)	32,680,004	37,300,287	14.14
406A	25,500,000	26,446,137	3.71

(b) Contracts Completed Using Form 'X' Control Procedures

Contract No	Contract Sum (HK$)	Final Account Sum (HK$)	Overspend (%)
401	259,392,076	284,155,114	9.55
402	733,252,206	788,649,561	7.56
406	263,897,278	278,979,412	5.72
427	166,378,839	173,893,469	4.52
431	175,150,936	196,714,195	12.31

From this data one can calculate the mean and standard deviation percentage overspend for those contracts without Form 'X' control as:

mean W = 39.01% standard deviation s_w = 30.09%

And similarly for the contracts with Form 'X' control one computes:

mean X = 7.89% standard deviation s_x = 3.10%

The difference between the statistics for the two sets of data is significant. However, the principal question which must be answered is " **is the difference merely coincidental ?**"

In other words, one must determine whether it is pure chance that the Form 'X' contracts have a lower overspend than the other contracts, and whether these projects could have had the same low overspends without using the Form 'X' procedure.

5.2.1 Statistical Background

From a statistical viewpoint, the overspend on any project is considered as a **random variable (rv)** which essentially means that it is a variable whose value cannot be determined in advance. If one could examine all possible contracts then it would, theoretically, be possible to produce a **probability distribution function (PDF)** for this random variable which would tell us the proportion of contracts which fell within a given overspend region, or equivalently the **probability** that any particular project will experience an overspend in a given region.

Clearly, however, one cannot examine all projects and one can only examine a sample of projects.

From this sample one can make estimates about parameters which define the PDF for the random variable. This is essentially what has been done in estimating the mean and standard deviations from the samples above.

The information, thus derived, lends itself to analysis using the **Central Limit Theorem**. The Central Limit Theorem states that any random variable, whose value is a function of a large number (>30 say) of other random variables, will have a particular PDF called the **Normal Distribution**. Since the overspend on any project is the result of a very large number of statistically random alterations to the contract, the central limit theorem can be used to infer that the distribution of all possible overspends is a Normal distribution.

The Normal distribution is characterised by what is often referred to as a bell shaped curve.

The maximum point of the curve occurs at the mean value of the distribution and the spread of the curve is determined by the standard deviation of the distribution.

Thus there are, in fact, an infinite number of possible Normal distributions, parameterised by the particular mean and variance. However, a relatively simple relationship can be developed between this infinity of distributions and the standard Normal distribution which has a mean of 0 and a variance of 1.

The probability that a Normally distributed random variable takes on a value in a given interval is determined by the area under its graph for that particular interval. This area has been extensively tabulated for the standard Normal curve. As an example of their use, one can consider a random variable which has the standard Normal distribution. If one wished to calculate the probability that any such **rv** will take on a value between 0 and say 2, one would use the tables to find that the area under the curve between 0 and 2. This is 0.4772, and therefore one can say that 47.72% of the time this rv will have a value in the range 0 to 2.

Mathematically this can be expressed as: $\mathbf{P(0 \leq z \leq 2) = 0.4772}$

As mentioned above the Normal curve is symmetrical, and therefore

$$\mathbf{P(-2 \leq z \leq 2) = 2 \times P(0 \leq z \leq 2) = 0.9544}$$

A random variable X which is normally distributed with mean μ and standard deviation ó is written $X \sim N(\mu, ó^2)$. The reason for the use of the square of the standard deviation is that statisticians generally work with the variance, which is expressed as $ó^2$.

Thus the random variable Z, which has the standard Normal distribution, is written as $Z \sim N(0,1)$.

These random variables are related by the following equation:

$$Z = \frac{X - \mu}{ó}$$

For example, if one were to consider a rv X~N (100,64), and one wished to find $P(84 \leq x \leq 116)$, i.e. the probability that the value is within ± 16 of the mean, one would first convert the critical X values into equivalent Z values:

$$x = 84 \Rightarrow z = \frac{x-\mu}{\sigma} = \frac{84-100}{8} = -2$$

$$x = 116 \Rightarrow z = \frac{x-\mu}{\sigma} = \frac{116-100}{8} = 2$$

Hence one can find the equivalent probability, $P(-2 \leq z \leq 2)$, which, from the previous example, is 0.9544.

Therefore, one can calculate the probability that a Normally distributed random variable lies within a given range, if its mean and variance are known.

In general , however one is faced with a rather different problem. Normally one has an estimate of the mean and variance and one requires to determine how accurate this estimate is.

Assume that one has a random variable which is approximately Normally distributed, $X \sim N(\mu,\sigma^2)$, where one knows the variance, but not the mean. In order to estimate the mean, one takes a number of samples of the variable, and call the estimate X. Clearly, if one takes a different set of estimates, one will get a different X.

Hence, X itself can be viewed as a random variable.

The sampling distribution of the mean, one of the most important statistical theories, says that X will be Normally distributed if one of two conditions holds:

(i) the number of samples taken is large (>30), or

(ii) the underlying distribution of the random variable can be reasonably be assumed to be approximately Normal.

For a sample size of n, the sampling distribution of the mean states that the distribution of X is $X \sim N(\mu, \acute{o}^2/n)$ i.e. the mean of all the estimates will be the actual mean, and the variance of the estimates is the variance of the distribution divided by the number of samples.

This theory agrees with common sense in that as one takes more estimates, one would expect the average of these to get closer and closer to the actual mean. If one increases the number of samples, one would expect the variance of the estimates to decrease.

As a brief example, consider a sample size of 10 gives an estimate of $X = 100$ and assume one knows that the variance for this rv is 64, and one wishes to know the probability that the true mean lies somewhere between 95 and 105. One knows from the sampling distribution of the mean that the distribution of X is $X \sim N(\mu, \acute{o}^2/n)$ or, substituting the variance and the sample size, $X \sim N(\mu, 6.4)$. What one wishes to find is the probability that given $\mu = 95$ or $\mu = 105$, the measured value of $X = 100$.

If one first take the case where X~N(90,6.4), one can calculate $P(X \leq 100)$ as before

$$P(95 \leq X \leq 100) = P(0 \leq z \leq \frac{100-\mu}{ó})$$

$$= P(0 \leq z \leq \frac{100 - 95}{2.53}) = P(0 \leq z \leq 1.97)$$

which from tables is 0.4756. For the other possible value of the mean one will get the same value, and hence one gets $P(95 \leq X \leq 105) = 0.9512$.

Hence, in this case one can say with 95% certainty that the true mean lies between 95 and 105. It should be noted that an implicit assumption has been made here, namely that the underlying distribution of X is Normal, since the sample size is not large enough to validate the use of the sampling distribution of the mean on its own.

Before one moves on to an analysis of the contract overspends discussed in the introduction, it is important to make one important point.

In the above example it was assumed that one knew the correct variance of the random variable being investigated. If this is not the case, and there is only an estimate of the variance, then one would follow a similar procedure, but instead of using the standard **Normal distribution** one would use the **Student's t-distribution**. This distribution is similar to the Normal, but flatter and more spread out to take into account the uncertainty in the variance. In fact there are a whole family of t-distributions, which are characterised not just by the mean and variance, but also by a third parameter, the number of **degrees of freedom (df)**. If the sample size from which the estimate is made is n, then df = n-1.

5.2.2 Analysis of Contract Data

From tables it is possible to calculate the mean and standard deviation of the overspends on contracts without Form 'X' control as mean $\mu = 39.01\%$, standard deviation $ó = 30.09\%$.

It is also possible to perform a similar exercise to get an estimate of the mean overspend for the projects with Form 'X' control : $X = 7.89$.

From the discussion of the previous section it is possible that X will be approximately Normally distributed, $X \sim N(\mu, ó^2)$. It is impossible, however, to determine either μ or ó.

What one must determine, therefore, is not the actual values of the mean and standard deviation for the Form 'X' projects but rather the answer to the question:

"is it likely that the mean overspend for the Form 'X' projects is in fact the same (or even greater) as that for the projects without Form 'X' control ?"

In statistical terms one needs to determine what P is ($\mu \leq 39.01$) given $X = 7.89$, or equivalently, if the true mean, $\mu = 39.01\%$, what is the probability of our sample yielding an estimate of the mean $X < 8\%$.

Before analysing the data, one needs to set a level of significance for the test.

This means one should decide in advance at what level one will accept that the new mean is just a statistical aberration, and at what level one will reject this hypothesis and accept that the underlying mean for the Form 'X' projects is less than 39%.

A standard level of significance for such tests is 5%. This means that, if, given an underlying mean of $\mu = 39\%$, the probability of getting a sample mean $X < 8\%$ is less than 0.05, one will reject the hypothesis that the true mean is 39%, and hence accept that the Form 'X' control mechanism has lowered the underlying mean overspend.

We have $\mu = 39\%$, and our estimate of the standard deviation, $s = 31\%$, with a sample size of 5.

We wish to find $P(X \leq 8)$. As before we convert our critical X value into a critical Z value:

$$X = 8 \Rightarrow Z = \frac{8-m}{s/\sqrt{n}} = \frac{8-39}{13.86} = -2.24$$

Therefore, on the standard distribution one needs to find $P(Z \leq -2.24) = P(Z > 2.24)$. As one is using an estimate of the variance, one must use the Student's t-distribution to calculate this probability, rather than the standard Normal distribution. In this case the number of degrees of freedom is 4.

From the tables, $P(Z > 2.24) < 0\ 05$ (approx. 0.04), and hence with 95% certainty one can reject the hypothesis that the underlying mean of the overspends for Form 'X' projects is still 39%, and so accept that the Form 'X' control has reduced the mean overspend.

Our analysis suggests that, at a 95% level of certainty, one can accept that the Form 'X' control mechanism has lowered the mean overspend. One cannot, however, say much more about the new mean. It is, however, possible to calculate confidence limits for the new mean using the estimated mean and a new estimate of the variance calculated from the Form 'X' figures.

Doing this results in confidence limits of ±11% on our estimate of 8%, at 95% confidence.

Thus one can say that if other samples were taken of Form 'X' contract overspends, then 95% of the time we would expect the estimated mean from these samples to be between -3% and +19%.

A number of caveats should be made about the results obtained herein.

> Firstly, it has been assumed that overspends have an underlying Normal distribution. While the central limit theorem suggests that this should be the case, there is no substitute for hard facts. It have been preferable to have available a large number of randomly drawn contracts without Form 'X' control on which to fully test this assumption.
>
> Secondly, and related to this, is the fact that the sample sizes used here are very small, thereby forcing reliance on the Normal distribution assumption. It would have been preferable to have a larger number of samples (>30) for both types of contract, randomly drawn from all contracts undertaken by the Corporation but this level of information was not available at the time the research was undertaken.

It is important to insert a note of caution, at this stage, and to stress the limitations of the data set used in the study. The statistical analysis was based on the data from only **ten** contracts and these contracts varied in size, complexity and project duration.

Contracts 101, 106, 401, 402, 406, 427 and 431 were all large bored tunnelling contracts whereas contracts 101 and 106 were cut and cover contracts. Contracts 101 and 106 were undertaken between 1976 and 1980 whereas the other large contracts were undertaken between 1982 and 1986. Contracts 403A (A), 403A (B) and 406A were much smaller projects, being contracts for advance works associated with the major civil contracts and undertaken between 1981 and 1983.

While it can be argued that the contracts were similar, it is acknowledged they were not identical and it is possible that like was not being compared with like. It can also be argued that it is inappropriate to use data derived from the two large cut and cover contracts in conjunction with the data derived from the minor advance-works contracts.

This problem was appreciated at research stage and it was for this reason that the decision was taken to use action research techniques to determine whether the hypothesis could be proved.

In a similar vein, it is acknowledged that the statistical analysis is limited and other more appropriate methods could have been used. In the context of a research project of this nature it would be appropriate to consider the use of **cluster sampling**, in order to give some measure of random selection, and **regression analysis**, to analyse the data thus derived. Both these measures could be contemplated in order to give greater validity to the statistical component of the research.

5.3 Qualitative Analysis of Participant Interviews

These interviews were conducted at the end of the research project. In general each interview was of 30 to 45 minutes duration with the researcher visiting the interviewee in his home base.

Appendix 'I' details the interviewees together with the main points arising from each interview. The full transcripts have not been reproduced as it was considered more beneficial to highlight the points of interest.

The **themes** which emerged were:

(a) The Form 'X' procedure represents a considerable advance on previous methods of recording proposed and agreed changes to the contract works;

(b) The procedure had forced design and construction personnel to justify their desire for change;

(c) The procedure had generated copious quantities of support material which the Executive Committee had found useful but which the proposers had found tedious and time consuming to produce;

(d) A number of senior site-based Construction Managers stated that they found the procedure bureaucratic and time consuming and they queried whether the procedure was actually necessary;

(e) The Design Managers were more enthusiastic about the procedure than the Construction Managers and Contracts Administrators;

(f) The higher ones position in the organisation the more the Form 'X' procedure was viewed as an essential tool;

(g) The external consultants fully supported the Form 'X' methodology and stated that they would be keen to see the procedure adopted on non Mass Transit Railway Corporation projects;

(h) There was general consensus that the use of the claims element of the Form 'X' procedure was unnecessary due to the nature of the claims process;

(i) There was general agreement that the process of communication needed to be accelerated and the bureaucracy reduced;

(j) The Construction Managers complained about their lack of empowerment in respect of change management;

(k) The methodology could be improved by the use of computer technology including the use of e-mail and other forms of communication linkage;

(l) A number of the interviewees stated that the methodology could be used on a variety of contracts, irrespective of size, nature and location;

(m) The interviews clearly showed that the driving force behind the Form 'X' procedure was the Projects Director and that he exerted considerable control over the entire organisation partly because of his position and partly because of his abrasive personality.

The results of the interview process, indicated in **Appendix 'I'** clearly indicate that the vast majority of the Corporation's senior managers and design and contractual consultants believe that the Form 'X' procedure is an excellent methodology for change control.

The adverse comments which have been made are, in the main, directed at improving the procedure, as the only significant criticism revolves around the time required for the production of a Form 'X' submission and the level of supporting documentation necessary to ensure that the revision was approved by the Executive Committee.

These points have been acknowledged by the researcher and are covered in Chapter Six.

5.4 Summary

The Hypothesis stated that a Change Management Control Mechanism would assist Project Managers exercise greater financial control as it would help them control the nature and level of variations. This led to the formulation of the Form 'X' Control Mechanism which has been studied in action in section 5.2 above.

Essentially the Form 'X' procedure allows the client to determine the need for a variation and also ensures that information relating to cost and programme etc. is to hand when the decision is being taken.

This chapter has illustrated five contracts which were carried out using the Change Management Control Mechanism, as modified for use with the Mass Transit Railway Corporation, and compared them with three contracts carried out using traditional site-based control techniques.

The various tabulations compare the final contract values and the study clearly shows that the Form 'X' Control Mechanism can help reduce the level of cost over-run on a project for a variety of reasons including:

(a) Various members of the design and construction team are required to justify their proposal;

(b) The client controls the approval process and is actively involved in decision making;

(c) The mechanism involves the circulation of proposals and requires all parties to participate in the process;

(d) The overall effect of design-related and construction-related revisions can be seen by all parties.

The Form 'X' Control Mechanism forces the client and its advisors to consider the effect which their proposals will have on the target of completion within time, within budget and to specified qualitative standards. The study clearly illustrates that the Form 'X' procedure pressurises the design and construction team to adhere to cost levels etc.

The quantitative data was less conclusive in proving that the use of the Form 'X' Control Mechanism reduced the level of project variation as the original and final cost centre values did show an increase.

However, it is contended that the variations which did occur, for the reasons stated above, do not disprove the validity of the hypothesis. Indeed, the qualitative analysis, in particular, argued that the Form 'X' control mechanism was extremely effective as it enabled the Corporation to control variations to the contract works.

The Form 'X' approach minimised the financial effect of these additions as the early revision of the Cost Centre Totals enabled the Corporation to calculate revised cash flow patterns. This can be contrasted with the site-based control mechanism which resulted in a significant cost over-run on one of the contracts under scrutiny.

It is concluded, therefore, that the validity of the Hypothesis has been proven by this study and that the adoption of the Form 'X' control mechanism in the management of design changes for two reasons:

(a) It forces the client and his advisors to ascertain the financial effect of revisions;

(b) It provides a detailed breakdown of the cost variations on a cost-centre by cost-centre basis which the various parties can utilise in programming their funding needs.

It can also be argued that it is particularly effective as a powerful motivator for the design and construction teams to achieve the original target costs.

CHAPTER 6

CONCLUSION

CHAPTER 6

CONCLUSION

6.0 Introduction

This chapter summarises the results and conclusions of the research project and indicates that further research studies should be undertaken to determine the effectiveness of the methodology in a United Kingdom context.

6.1 Summary of Findings

The literature review, outlined in Chapter Two, indicated that there has been a paucity of research activity in the field of change management in the construction industry in the period 1970-95 with most research activity in the cost control field concentrating on pre-contract cost estimation and value management.

The review has revealed that research activity has tended to concentrate on the use and development of management tools which are used to plan, or programme, construction duration or estimate construction cost.

The literature review also revealed that research has tended to focus on the development of corporate culture as a means to control activity and the use of information technology as the principal method of communication.

From the literature review, it was concluded that neither project management tools, with their focus on time, nor modern management approaches, with their focus on culture and empowerment, were addressing the need to control costs during the construction process.

The researcher then proceeded to develop a theoretical change control methodology which could be used to regulate the change management process and, as detailed in Chapter Three, this model was revised to suit the requirements of the researcher's employer, the Hong Kong Mass Transit Railway Corporation.

The agreed methodology facilitates the communication process by describing a series of stages inter-linked by document exchange. The chapter illustrates how the design team would be consulted by the Project Manager and how comments on the effect of design changes, in cost, programme and qualitative terms, would be taken cognisance of in the decision-making process.

The Form 'X' Control Methodology was used by the Hong Kong Mass Transit Railway Corporation on five projects to determine its applicability to major construction projects.

The researcher, due to his employment with the Corporation, had ease of access to all contract documentation relating to the five contracts and also to the documentation relating to three contracts which were undertaken, at the same time, using the traditional approach to change management.

Chapter Four has outlined how action research techniques were used to supplement the standard statistical techniques as it was appreciated that the results could be challenged on the basis of the relatively small sample size.

The use of action research techniques has meant that there is additional evidence available to support the hypothesis that the use of a change control methodology, in this case the Form 'X' Control Approach, can assist the Project Manager prevent cost over-runs due to design changes.

The findings of the research project have been detailed in Chapter Five and the statistical analysis and action research methodology provide evidence to support the conclusion that the procedure has been successfully used to limit the extent of cost over-run on five major construction contracts.

The Form 'X' methodology which has been devised represents a **major** contribution to knowledge in the Project Management field. The procedure can be used on a variety of projects as it is a "stand-alone" system which is designed to suit the corporate systems and structures of client organisations. It can be used on a wide variety of building and civil engineering projects, both in the United Kingdom and overseas, and the system can be used to complement the control procedures set down in the standard forms of contract.

The Form 'X' methodology also has the flexibility of approach to allow the inclusion of additional cost centres and the revision of cost centres during the currency of contracts.

The Change Management Control Mechanism has been shown to have a number of distinct advantages when compared to the traditional method of cost control and it has proven to be an effective management tool in co-ordinating project activities.

The methodology forces the design team to justify their need for change and ensures that the decision making process is made transparent.

This has the effect of making designers document the implications of the change request.

In doing so the designers have tended to reduce the number of change requests especially where there is a "knock-on" effect on other contracts in terms of cost or duration.

The methodology has been criticised as being **bureaucratic** and **time-consuming** and this criticism has been acknowledged. It should, however, be appreciated that the research was conducted at a time when Personal Computer technology and telecommunication links were in their infancy. The modern telecommunication systems which have now been developed did not exist in the mid/late 1980s.

Indeed, the development of **e-mail** systems and the **Internet** means that the criticism mentioned above can be overcome. The communication systems are now to hand to ensure that the decision making process does not have to rely upon the transmission of documentation and an e-mail transmission would be able to communicate the decision, **instantaneously**, to all members of the design team.

The development of communication systems of this nature will supplement the Form 'X' procedure and allow for its widespread use.

6.2 Recommendations for Future Research

During the course of the research it became apparent that the control methodology has tremendous potential as the system can be used to control a variety of building and civil engineering projects, irrespective of location, as the system can be used to complement the procedures set down in the standard forms of contract.

The research project has clearly demonstrated that the procedure can be effective in managing the change process on major, overseas, civil engineering projects and it is argued that the methodology would be suitable for use on major building projects.

The change control methodology would also be suitable on smaller projects but the system requires a considerable investment in terms of time and effort. On smaller contracts the size of the project may not justify the investment.

Opportunities exist within the United Kingdom to replicate this research project and it is suggested that the major infrastructure developments being undertaken under the present Government's Private Finance Initiative would be suitable areas to explore.

Opportunities also exist to **publish** the change control methodology as a **procedural document** which could be used to guide clients, and their consultants, in setting up the organisational structures and systems which are necessary to achieve effective control of capital projects.

LIST OF REFERENCES

LIST OF REFERENCES

(1) **Weinberg S**; Project Organisation as Effected by Construction Management; Proc. CIB Second Symposium on Organisation and Management in Construction, Israel, October/November 1978, Volume 1, Page I-192.

(2) **Walker A**; Project Management in Construction; Granada; London, 1985, Page 5.

(3) **Harrison F L**; Advanced Project Management; Gower; Aldershot, 1992, Page 13.

(4) **Ryder W J** and **Mercer J H**; Project Management; Management of Large Capital Projects; Institute of Civil Engineers, London, 1978, Pages 69-82.

(5) **Hammond D**; Project Management - What's It All About?; Contract Journal, 11 November 1982; IPC Business Press Ltd, London, 1982, Pages 34 and 35.

(6) **Webb A**; Project Management - 40 Years Young And Still Looking For A Philosophy - Part 1; Project Manager Today, April 1996; Pages 8-11 and Project Management - 40 Years Young And Still Looking For A Philosophy - Part 2; Project Manager Today, May 1996; Pages 8 and 9.

(7) **Kast F E** and **Rosenzweig J E**; The Modern View - A Systems Approach; Systems Behaviour; Harper and Row, London, 1981, Pages 44-58.

(8) **Morris P W G**; The Management of Projects; Thomas Telford Services Ltd, London, 1994, Pages 19-37.

(9) **Sears G A**; CPM / COST - An Integrated Approach; ASCE Journal of the Construction Division, Volume 107, June 1981, Pages 227-238.

(10) **Morris P W G**; The Management of Projects; Thomas Telford Services Ltd, London, 1994, Pages 79-81.

(11) **Pultar M**; Progress-Based Construction Scheduling; ASCE Journal of Construction Engineering and Management, Volume 116, Number 4, December 1990, Pages 670-688.

(12) **Dawson C W** and **Dawson R J**; Generalised Activity-on-the-node Network For Managing Uncertainty In Projects; International Journal of Project Management; Volume 13, Number 6, 1995, Pages 353-362.

(13) **Howes R**, **Little W** and **Fong D**; Dynamic Project Control Utilizing A New Approach To Project Control; Building Research and Information, Volume 20, Number 5, 1992, Pages 291-294.

(14) **Morris P W G**; The Use and Management of Project Control Systems; Paper to CICC Conference 'Financial Policy and Control in Construction Projects', London, 15-16 May 1980, Pages 37-47.

(15) **Walker A** and **Hughes W P**; A Project Managed By A Multi-Disciplinary Practice - A Systems Based Case Study; Construction Management and Economics; Volume 5, 1987, Pages 123-140.

(16) **Morris P W G**; Project Management Organization; Construction Papers, Volume 2, Number 1, 1983, Pages 5-18.

(17) **Thompson P**; The Client Role In Project Management; Proc. Internet 90, Volume 2, Vienna, Austria, 1990, Pages 90-92.

(18) **Shirazi B**, **Langford D A** and **Rowlinson S M**; Organizational Structures In The Construction Industry; Construction Management And Economics, Volume 14, 1996, Pages 199-212.

(19) **Tatum C B** and **Teague F G**; Managing the Engineering / Construction Interface for Improved Project Performance; Proc. PMI/Interest Joint Symposium 'The Work of Project Management', Boston, September 1981, Pages 157-169.

(20) **Harding P**; Pattern of Authority and Grouping of Functions; Building Trades Journal, 12 September 1980, Pages 22-24.

(21) **Harding P**; Organisation Pattern Relates to Authority Distribution; Building Trades Journal, 10 October 1980, Pages 19, 20, 22 and 31.

(22) **Harding P**; Functional Approach to the Structure of Enterprises; Building Trades Journal, 22 August 1980, Pages 24, 26 and 27.

(23) **Bissett M J**; A Structured Approach to Project Planning and Progress Control; Project Manager, July 1982, Pages 2-5.

(24) **Hayward J D**; Practical Experience of Organisational Form for Large Construction Projects; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume 1, Pages A.1 305-320.

(25) **Weinberg S**; Project Organization as Effected by Construction Management; Proc. CIB Second Symposium on Organisation and Management in Construction, Israel, October/November 1978, Volume 1, Pages 191-203.

(26) **Partington D**; The Project Management of Organizational Change; International Journal of Project Management; Volume 14, Number 1, 1996, Pages 13-21.

(27) **Ryder W J** and **Mercer J H**; Project Management; Management of Large Capital Projects; Institute of Civil Engineers, London, 1978, Pages 69-72.

(28) **Hollands M L** and **Wilson O D**; Project Organization - A Case Study; Australian Institute of Building Paper, Volume 3, 1988-89, Pages 3-19.

(29) **Webb A**; Project Management - 40 Years Young And Still Looking For A Philosophy - Part 1; Project Manager Today, April 1996; Pages 8-11 and Project Management - 40 Years Young And Still Looking For A Philosophy - Part 2; Project Manager Today, May 1996; Pages 8 and 9.

(30) **Craig A**; Project Financial Controls; Proc. ICE Conference 'Civil Engineering Project Procedure in the European Community', Heathrow, London, 24-25 January 1991, Pages 77-88;

(31) **Barnes M**; Project Management by Motivation; Proc. PMI / Internet Joint Symposium 'The Work of Project Management', Boston, September 1981, Pages 341-346.

(32) **Edmonstone J** and **Havergal M**; Empowerment - Holy Grail or a Blinding Case of the Obvious?; Health Manpower Management, Volume 19, Number 2, 1993, Pages 22-28.

(33) **Newcombe R**; Empowering the Construction Project Team; International Journal of Project Management; Volume 14, Number 2, 1996, Pages 75-80.

(34) **Naoum S G** and **Pryce A F**; Organizational Culture - Some aspects of the relationship between the Construction Industry Environment and Organizational Culture with respect to Financial Performance; Proc. Association of Researchers in Construction Management (ARCOM), 8th Annual Conference, Isle of Man, September 1992, Pages 196-206.

(35) **Handa V K** and **McLaughlin W A**; Planning and Control of Management Teams; Proc. CIB Second Symposium on Organisation and Management in Construction, Israel, October/November 1978, Volume 1, Page I-97-I-112.

(36) **Barnes M**; Human Factors In Project Cost Control; Paper to 5th International Cost Engineering Congress, Utrecht, 1978, Pages 244-248.

(37) **Barrett P**; Measuring The Ability Gap For Construction Professionals; Construction Management and Economics; Volume 10, 1992, Pages 321-342.

(38) **Skitmore R M, Stradling S G** and **Tuohy A P**; Project Management Under Uncertainty; Construction Management and Economics; Volume 7, 1989, Pages 103-113.

(39) **Cormican D A**; Contribution of Organisation Theory to Construction Management; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume 111, Pages D.2.62-72.

(40) **Taylor D C, Benton D A** and **Kellogg J C**; The Role of Interdisciplinary Project Management Concepts in the Organisation of Construction Project Delivery Systems; Proc. CIB Second Symposium on Organisation and Management in Construction, Israel, October/November 1978, Volume 1, Pages I-183-190.

(41) **Dodd J** and **McDermott P**; Human Relations, Project Team Performance and the Incidence and Effect of Variations; Managing Construction Worldwide, Volume 2, Productivity and Human Factors In Construction, 1987, Page 978-988.

(42) **Buckley W**; Systems; Organizations As Systems; Open University Press, 1983, Pages 34-45.

(43) **Carter D J, Cheetham D W** and **Lewis J**; A Systems Approach to Information Flows in Construction Management; Habitat International 1990; Volume 14, Number 2/3, Pages 137-156.

(44) **Galbraith J R**; Organization Design - An Information Processing View; Organizations As Systems; Open University Press, 1983, Pages 105-111.

(45) **O'Brien W J**, **Fischer M A** and **Jucker J V**; An Economic View of Project Coordination; Construction Management and Economics, Volume 13, 1995, Pages 393-400.

(46) **Alexander K**; The Project System - A Model of the Building Process; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume 111, Pages D.2.74-93.

(47) **Spridharan G**; Essential Elements of Management Status Report; Professional Builder (Singapore), 5 December 1990, Pages 3-9.

(48) **Wright M G**; Controlling Costs; Building, 12 March 1971, Pages 143 and 144.

(49) **Beaton H R**; Project Controls - Manual v Machine; Paper to ASCE Fall Convention, Atlanta, Georgia, October 1979, Pages 1-14.

(50) **Nordqvist S**; Planning Model for the Functional Programming of Complex Building Projects, including Time and Cost Control; National Swedish Building Research Summary R65, 1975, Pages 1-4.

(51) **Harper D**; Communications in Building; Building, 25 February 1972, Pages 71 and 72.

(52) **Barnes N M L**; Cost Modelling - An Integrated Approach to Planning and Cost Control; Engineering and Process Economics, Volume 2, 1977, Page 45-51.

(53) **Branton M** and **Butler T**; Firm Foundations For Project Management; International Journal of Project Management, Volume 5, Number 4, November 1987, Pages 221-229.

(54) **Barney J** and **Howes R**; Project Management Control using Growth Curve Models applied to Planning, Monitoring and Forecasting within the Construction Industry; International Journal of Construction Management and Technology, Volume 2, Number 2, 1978, Pages 8-21.

(55) **Edwards D J**, **Shaw T** and **Holt G D**; Electronic Document Management Systems and the Management of UK Construction Projects; Building Research and Information, Volume 24, Number 5, 1996, Pages 287-292.

(56) **Hastak M**, **Halpin D W** and **Vanegas J**; COMPASS - A New Paradigm For Project Cost Control Strategy and Planning; Journal of Construction Engineering and Management, September 1996, Pages 254-264.

(57) **Kirby J G**, **Furry D A** and **Hicks D K**; Improvements in Design Review Management, ASCE Journal of Construction Engineering and Management, Volume 114, March 1988, Pages 69-82.

(58) **Munns A K** and **Bjeirmi B F**; The Role of Project Management in achieving Project Success; International Journal of Project Management; Volume 14, Number 2, 1996, Pages 81-87.

(59) **Harding P**; Management Should Ensure That Objectives Are Met; Building Trades Journal, 31 October 1980, Pages 16, 18, 20 and 22.

(60) **Bissett M J**; A Structured Approach to Project Planning and Progress Control; Project Manager, July 1982, Pages 2-5.

(61) **Hayward J D**; Practical Experience of Organisational Form for Large Construction Projects; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume 1, Pages A.1 305-320.

(62) **Morris P W G**; The Use and Management of Project Control Systems; Paper to CICC Conference 'Financial Policy and Control in Construction Projects', London, 15-16 May 1980, Pages 37-47.

(63) **Bennett J**; Simulating Construction Project Management; Managing Construction Worldwide, Volume 2, Productivity and Human Factors In Construction, 1987, Page 938-947.

(64) **Rowings J E**; Project-Controls Systems Opportunities; ASCE Journal of Construction Engineering and Management, Volume 117, Number 4, December 1991, Pages 691-697.

(65) **Barnes N M L**; Construction Project Management; Project Management, Volume 6, Number 2, May 1988, Pages 69-79.

(66) **Ireland V**; Time/Cost/Performance Objectives and Management Actions; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin July 1981,Volume III, Pages D.2.135-137.

(67) **Alexander K**; The Project System - A Model of the Building Process; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume III, Pages D.2.74-93.

(68) **Reynolds G**; On the Cost Model; Building, 20 October 1978, Page 91 and More on the Cost Model; Building, 27 October 1978, Page 67.

(69) **Drake B E**; European Practice in Controlling Construction Cost - Discussion; Chartered Surveyor, Building and Quantity Surveying Quarterly, December 1973, Pages 24-25.

(70) **Turner W**; Financial Control of Contracts; Building, 7 February 1969, Pages 136 and 318.

(71) **Irwig H G**; The Architectural Profession - Limits to Leadership; Architectural Science Review, Volume 23, December 1980, Pages 96-102.

(72) **Maevis A C**; Construction Cost Control By The Owner; ASCE Journal of the Construction Division, Volume 106, December 1980, Pages 435-446.

(73) **McDermott P** and **Newcombe R**; Post-Contract Design Changes and Documentation in Building Projects; Proc. CIB 10th Triennial Congress, Washington, September 1986, Volume 8, Pages 3539-3547.

(74) **Chan A P C** and **Yeung C M**; Effective Measures for Reducing Variations - An Australian Perspective; Australian Institute of Building Papers, Volume 6, 1995, Pages 113-120.

(75) **Pollard D J** and **Tayeb M H**; National Culture and the Transfer of Management Techniques Across Borders; International Journal of Human Resource Management, London, Volume 8, Pages 21-34.

(76) **Hampton-Turner C**; Corporate Culture - From Vicious to Virtuous Circles; Hutchinson, London, 1990, Pages 11-33.

(77) **Pollard D J** and **Tayeb M H**; National Culture and International Joint Ventures; Paper to 4th Annual Conference on Marketing Strategies for Central and Eastern Europe, Vienna, December 1996, Page 7.

(78) **Lewis R D**; When Cultures Collide - Managing Successfully Across Cultures; Nicholas Brealey, London, 1996, Page 40.

(79) **Hofstede G**; Motivation, Leadership and Organisation - Do American Theories Apply Abroad ?; Organizational Dynamics, American Management Associations, Beverley Hills, Summer 1980, Pages 42-63.

(80) **Luthans F**; Organizational Behaviour; McGraw-Hill, Singapore,1985, Pages 445-471.

(81) **Grimes A J**; Authority, Power Influence and Social Control - A Theoretical Synthesis; Academy of Management Review, October 1978, Pages 724-735.

(82) **Simon H A, Smithburg D W** and **Thompson V A**; Authority - Its Nature and Motives; in Organizational Behaviour and the Practice of Management; Scott Foresman and Company, Illonois, 1982, Pages 154-156.

(83) **Newcombe R, Langdford D** and **Fellows R**; Construction Management 1 - Organisation Systems; Mitchell, London, 1990, Pages 111-113.

(84) **Rowings J E** and **Federle M O**; People and Projects - Building Successful Combinations; The Organization and Management of Construction - Shaping Theory and Practice, Volume 2, Spon, London, 1996, Pages 669-679.

(85) **Lawler E E** and **Rhode J G**; Dysfunctional Effects of Control Systems; in Organizational Behaviour and the Practice of Management; Scott Foresman and Company, Illonois, 1982, Pages 453-462.

(86) **Luck R A C** and **Newcombe R**; The Case For the Integration of Project Participants' Activities within a Construction Project Environment; The Organization and Management of Construction - Shaping Theory and Practice, Volume 2, Spon, London, 1996, Pages 458-470.

(87) **Gill J** and **Johnson P**; Research Methods for Managers; Paul Chapman, London, 1991, Pages 11-22.

(88) **Martin G P**; The Production of a Policy Model for use by the Leisure Industry when entering into the Development Process; MSc Thesis Submission, Heriot-Watt University, 1991, Page 16.

(89) **Walker R**; Applied Qualitative Research; Gower Press, Aldershot, 1985, Pages 9-12 and 15.

(90) **Open University**; Research Methods in Education and the Social Sciences; Block 4 - Data Collection Procedures; Open University Press, Milton Keynes, 1979, Pages 9-31.

(91) **Kidder L H** and **Judd C M**; Research Methods in Social Relations; CBS College Publishing, New York, 1986, Pages 178-188.

(92) **Walker R**; Applied Qualitative Research; Gower Press, Aldershot, 1985, Pages 3-23.

(93) **Kidder L H** and **Judd C M**; Research Methods in Social Relations; CBS College Publishing, New York, 1986, Page 35.

(94) **Mason J**; Qualitative Researching; Sage Publishing, London, 1996, Pages 83-106.

(95) **Kidder L H** and **Judd C M**; Research Methods in Social Relations; CBS College Publishing, New York, 1986, Pages 149-163.

(96) **Open University**; Research Methods in Education and the Social Sciences; Block 4 - Data Collection Procedures; Open University Press, Milton Keynes, 1979, Pages 137-155.

(97) **Gill J** and **Johnson P**; Research Methods for Managers; Paul Chapman, London, 1991, Page 146.

(98) **Kidder L H** and **Judd C M**; Research Methods in Social Relations; CBS College Publishing, New York, 1986, Pages 265-278.

(99) **Gill J** and **Johnson P**; Research Methods for Managers; Paul Chapman, London, 1991, Pages 92-120.

(100) **Mason J**; Qualitative Researching; Sage Publishing, London, 1996, Page 60.

(101) **Open University**; Research Methods in Education and the Social Sciences; Block 4 - Data Collection Procedures; Open University Press, Milton Keynes, 1979, Pages 131-134.

(102) **Kidder L H** and **Judd C M**; Research Methods in Social Relations; CBS College Publishing, New York, 1986, Pages 171-173.

(103) **Gill J** and **Johnson P**; Research Methods for Managers; Paul Chapman, London, 1991, Pages 110-113.

(104) **Winter R**; Action Research and the Nature of Social Inquiry - Professional Innovation and Educational Work; Avebury, 1987, Pages 1-19.

(105) **Gill J** and **Johnson P**; Research Methods for Managers; Paul Chapman, London, 1991, Pages 108-119.

(106) **Rapoport R**; Three Dilemmas in Action Research; Human Relations, Volume 23, Number 6, 1970, Pages 499-513.

(107) **Susman G**; Action Research - A Sociotechnical Systems Perspective; Beyond Method, Sage, London, 1983, Pages 95-98.

(108) **Susman G** and **Evered R**; An Assessment of the Scientific Merits of Action Research; Administrative Science Quarterly; Volume 23, London, 1978, Pages 582-602.

(109) **Foster M**; An Introduction to the Theory and Practice of Action Research in Work Organisations; Human Relations, Volume 25, Number 6, Pages 529-556.

(110) **Winter R**; Action Research and the Nature of Social Inquiry - Professional Innovation and Educational Work; Avebury, 1987, Page 2.

(111) **Rapoport R**; Three Dilemmas in Action Research; Human Relations, Volume 23, Number 6, 1970, Pages 499-513.

(112) **Garratt B**; Action Learning in Practice; Gower, Aldershot, 1983, Page 96.

(113) **Cunningham I**; Human Inquiry In Action - Developments In New Paradigm Research; Sage Publishing, London, 1988, Pages 163-181.

(114) **Reason P**; Human Inquiry in Action - Developments in New Paradigm Research, Sage Publishing, London, 1988, Pages 1-14.

(115) **Heron J**; Human Inquiry in Action - Developments in New Paradigm Research, Sage Publishing, London, 1988, Pages 40-59.

(116) **Cunningham I**; Human Inquiry In Action - Developments In New Paradigm Research; Sage Publishing, London, 1988, Page 181.

(117) **Mason J**; Qualitative Researching; Sage Publishing, London, 1996, Page 142.

BIBLIOGRAPHY

BIBLIOGRAPHY

ARTICLES

Alarcón L F and **Ashley D B**; Modeling Project Performance For Decision Making; Journal of Construction Engineering and Management, September 1996, Pages 265-273.

Albanese R; Use of Team Building with Multi-organizational Teams - Models and Lessons Learned; American Professional Constructor, December 1994, Volume 18, Pages 20-25.

Ash T J A; The Quantity Surveyors Contribution to Effective Project Management in the Construction Industry in the United Kingdom; Proc. PMI / Internet Joint Symposium 'The World of Project Management', Boston, September 1981, Pages 143-156.

Ashley D B and **Levitt R E**; Expert Systems in Construction - Work in Progress; ASCE Journal of Construction Engineering and Management, Volume 1, Number 4, October 1987, Pages 303-311.

Austen A D and **Neale R H**; Development of Construction Management Skills in the Third World - The Institutional Dimension; Managing Construction Worldwide, Volume 2, Productivity and Human Factors In Construction, 1987, Page 1045-1055.

Austin S, Baldwin A and **Newton A**; Manipulating the Flow of Design Information to Improve the Programming of Building Design; Construction Management and Economics, 1994, Volume 12, Pages 445-455.

Barnes M; Cost Control During Construction; Paper to CCC Conference 'Financial Policy and Control in Construction Projects', London, 15/16 May 1980, Pages 49-54.

Barnes M; Effective Project Organisation; Building Technology and Management, December 1984, Pages 21-23.

Barnes M; Fast Building - Project Management; Architects Journal, October 1990, Pages 71-72.

Barnes M; Innovation - Why Project Management is Essential to Successful Businesses; International Journal of Project Management, Volume 9, Number 4, November 1991, Pages 207-209.

Barnes M; The Growth of Independent Project Management; Proc. Company Communications Centre Seminar 'Tendering and Contracting in the UK', London, April 1979, Pages 25.MB-29.MB.

Barnes M; Project Management Today - Part 1- Controlling Performance, Cost and Time; Civil Engineering Surveyor, February 1988, Pages 25 and 26 and Project Management Today - Part 11 - Controlling Costs and Performance, Time and Quality; Civil Engineering Surveyor, March 1988, Pages 24 and 25.

Barnett A M; Legal and Professional Liability of Project Managers at Common Law; Paper to CIB 90 Conference; Building Economics and Construction Management, March 1990, Sydney ,Volume 4, Pages 68-79.

Barnett A M; The Many Guises of a Project Manager; Australian Institute of Building Papers, Volume 3, 1988/89, Pages 119-134.

Barrett F W; A System for the Monitoring of Projects; Municipal Building Management, 1979, Volume 3, Pages 30-33.

Bennie F G; Control Procedures for Development Projects; Paper to CICC Conference 'Financial Policy and Control in Construction Projects', 15/16 May 1980, Pages 87-111.

Berny J and **Howes R**; The Growth of Independent Project Management; Proc. Company Communications Centre Seminar 'Tendering and Contracting in the UK', London, April 1979, Pages 25.MB-29.MB.

Berny J and **Howes R**; Project Management Control Using Growth Curve Models Applied to Budgeting, Monitoring and Forecasting Within the Construction Industry; Managing Construction Worldwide, Volume 1, Systems For Managing Construction, 1987, Page 304-313.

Birnberg H; Roles of a Project Manager; Architecture, July 1993, Pages 115-117.

Birrell G S; The Informal Organization Which Manages The Construction Process; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume II, Pages B.1.201-B.1.211.

Booth P B and **Crow T W**; Project Management - Should it be the Quantity Surveyor?; The Building Economist, Journal of the Australian Institute of Quantity Surveyors, September 1989, Pages 11-15.

Boutté F D; Enhancement of Project Execution Processes; American Professional Constructor, September 1994, Volume 18, Pages 12-25.

Brame K F; Project Management; Building Technologists, Malaysia, Volume 8, 1981-1982, Pages 17-23.

Bröcher J; Feedback From Facilities Management To Design and Construction - Systems Issues; International Symposium for the Organization and Management of Construction - Shaping Theory and Practice, 1996, Volume 3, Pages 238-246.

Brookes D; The Use of External Project Management Companies by Clients of the Construction Industry; Paper to CIOB Research Conference, Nottingham, November 1989, Pages 1-9.

Brown J J and **Bett C D**; "Epocsy" - An Extended Project Control System for the Graphical Display of Construction Networks Illustrating Physical Progress and Cost Monitoring; Proc. CIB W-65 4th International Symposium on Organisation and Management of Construction, Waterloo, Canada, July 1984, Volume 2, Pages 343-351.

Campbell K J and **Campbell J Y**; Project Management and the Law - Allies or Adversaries?; Paper to CIB 90 Conference; Building Economics and Construction Management, March 1990, Sydney, Volume 4, Pages 127-133.

Carter D J; The Use of Structured Information Systems In Building Contract Administration; Managing Construction Worldwide, Volume 1, Systems For Managing Construction, 1987, Page 437-447.

Catt R; More Than Managing; Chartered Surveyor Weekly, 17 August 1989, Page 27.

Cheeseman P G; What is Project Management and Who are Project Managers?; Project Manager, April 1981, Volume 2, Pages 19-21.

Cohen L; Portability of Project Management Skills; Project, May 1994, Pages 9 and 10..

Collard P; TheTransportability of Project Management Skills; Project, February 1996, Pages 22- 24.

Dallas D S; The Use of Linear Regression Analysis to Establish Network Time/Cost Relationships; Project Manager, Volume 2, July 1979, Pages 2-5.

Danks B; The Role of the Project Manager; Proc. IBC Legal Studies and Services Conference 'Effective Project Management For Construction Projects', London, 18 March 1992, Pages 1-6.

Davis R M and **Irwig H G**; Project Management Services - Effectiveness in Building Construction; Proc. PMI/Internet Joint Symposium 'The World of Project Management', Boston, September 1981, Pages 318-330.

Dinnat R M and **Murphree E L**; A Technique for Modeling Building Organisations; Proc. CIB Second Symposium on Organisation and Management of Construction, Israel, October/November 1978, Volume 1, Pages I.71-I.86.

Dorter J; Variations; Construction Law Journal; 1991, Volume7, Number 4, Pages 281-302.

Drake B; Cost Control in Construction; Project Manager, January 1980, Pages 11-13

Duffy P J and **Thomas R D**; Project Performance Auditing; International Journal of Project Management, Volume 7, Number 2, May 1989, Pages 101-104.

EtenkoV; Evaluating Housing Quality - A Systems Approach; Building Research and Practice, January/February 1974, Pages 39-41.

Evans B; Integrating Project Teams; Architects' Journal; 17 October 1996, Pages 40 and 41.

Fabi B and **Pettersen N**; Human Resource Management Practices In Project Management; International Journal of Project Management, Volume 10, Number 2, May 1992, Pages 81-88.

Fairweather L; Project Management - A Role for the Architect; RIBA Journal, June 1996, Pages 67, 68, 71and 72.

Farrow T; In Place of Strife; Building, 27 March 1981, Page 47.

Fleming Q W and **Koppelman J M**; Earned Value Project Management - The Concept and Its Origin, Part 1, Project, February 1996, Pages 15 and 16 and Earned Value Project Management - The Concept and Its Origin, Part 2, Project, March 1996, Pages 9 and 10.

Forrest R F; What Price Variations?; Contract Bulletin, November 1993, Pages 6-8.

Gabriel E; Teamwork - Fact and Fiction; International Journal of Project Management, Volume 9, Number 4, January 1991, Page 195-198.

Gameson R N; Client-Professional Communication During the Early Stages of Project Development; International Symposium for the Organization and Management of Construction - Shaping Theory and Practice, 1996, Volume 2, Pages 437-446.

Gilbert G P; Styles of Project Management; Project Management, Volume 1, Number 4, November 1983, Pages 189-193.

Giritli H and **Sözen Z**; Behavioral Aspects of Strategic Decision-making in Construction Business; Proc. CIB 10th Triennial Congress, Washington, September 1986, Volume 8, Pages 3487-3494.

Handa V and **Adas A**; Predicting the Level of Organizational Effectiveness - A Methodology for the Construction Firm; Construction Management and Economics 1996, Volume 14, Pages 341-352.

Hogarth R; Variations - Getting and Spending; Contract Bulletin, November 1993, Pages 1-4.

Howes R M W, Mair A J, Peebles K M and **Zakieh R**; Computer Aided Construction Project Management; Proc. 4th International Conference on Civil and Structural Engineering Computing, London, September 1989, Volume 1, Pages 29-38.

Hughes W P and **Walker A**; The Organisation of Public-sector Building Projects; Building Technology and Management, August/September 1989, Pages 29, 30 and 35.

Ireland L R; Customer Satisfaction - The Project Manager's Role; International Journal of Project Management, Volume 10, Number 2, May 1992, Pages 123-127.

Ive G; Structures and Strategies; Habitat International 1990; Volume 14, Number 2/3, Pages 45-58.

Jones A; Cost Control and Cost Management in State Government Building Projects; The Building Economist, Journal of the Australian Institute of Quantity Surveyors, Volume 19, June 1980, Pages 11-14.

King V; Constructing The Team - A US Perspective; A US Review of the Letham Report; International Symposium for the Organization and Management of Construction - Shaping Theory and Practice, 1996, Volume 2, Pages 414-423.

Kometa S T, Olomolaiye P O and **Harris F C**; A Review of Client-generated Risks to Project Consultants; International Journal of Project Management, 1996, Volume 14, Number 5, Pages 273-279.

Lambert A; You're in Charge; Project, February 1994, Pages 5, 6 and 13 and Which Method to Use?; Project, March 1994, Pages 9-10.

Langford D A and **Kendall R**; Subcontractors in Project Management; Building Technology and Management, April/May 1988, Pages 24-27.

Langford D A, Newcombe R and **Fellows R F**; A Perspective Model For Decision Making and Information Flow in the Building Industry; Managing Construction Worldwide, Volume 2, Productivity and Human Factors In Construction, 1987, Page 948-954.

Lansley P and **Riddick J**; The Implications of Small Group Interactions For Understanding Aspects of Organizational Culture, Construction Management and Economics, June 1991, Volume 9, Pages 219-229.

Lenard D; Cost Management in Project Delivery; The Building Economist, Journal of the Australian Institute of Quantity Surveyors, June 1992, Pages 12-14.

Leong C; Accountability and Project Management - A Convergence of Objectives; International Journal of Project Management, Volume 9, Number 4, November 1991, Pages 240-249.

Lewis A L Y; The Recruitment of Project Management Staff; Project Manager, Volume 2, April 1982, Pages 15-17.

Loosemore M; Managing the Construction Process Through a Framework of Decisions; Proc. Architectural Management Conference 1992, Pages 90-103.

Low S P; Lao Tzu's Tao Te Ching and its Relevance to Project Leadership in Construction; International Journal of Project Management, Volume 13, Number 5, September 1995, Pages 295-302.

Luck R A C and **Newcombe R**; The Case for the Integration of the Project Participants' Activities within A Construction Project Environment; International Symposium for the Organization and Management of Construction - Shaping Theory and Practice, 1996, Volume 2, Pages 458-470.

Mikkelson H and **Folmann E**; Selection of Managers for International Projects; Project Management, Volume 1, Number 4, November 1983, Pages 209-211.

Mitchell P; Managing Project Management; BIFM News, November 1995, Pages 4-11.

Morris D; Modelling Project Milestones - Dependent Activities; ASCE Journal of the Construction Division, Volume 108, Number CO2, June 1982, Pages 321-329.

Mortlock B; The Structure of Building Communications; The Building Economist, Journal of the Australian Institute of Quantity Surveyors, March 1981, Pages 226-229.

Naoum S G; Critical Analysis of Time and Cost of Management and Traditional Contracts; ASCE Journal of Construction Engineering and Management, Volume 120, Number 4, December 1994, Pages 687-705.

Nisbet J; Post-contract Cost Control - A Sadly Neglected Skill; Chartered Quantity Surveyor, January 1979, Pages 24-28.

Paton R; Power in Organizations; Organisations - Cases, Issues, Concepts; Open University, Milton Keynes, 1983, Pages105-110.

Reason J; Marching Project Management Skills to Project Requirements, Project, July1994, Pages24-25.

Reid T; Legal Aspects of Project Management; Project, May 1995, Pages 6-8.

Rowlinson S, **Ho T K K** and **Yuen P H**; Leadership Style of Construction Managers in Hong Kong; Construction Management and Economics, November 1993, Volume 11, Pages 455-465.

Rowlinson S and **Tsang M C**; Leadership Style of Construction Managers in Hong Kong; Paper to CIB 90 Conference; Building Economics and Construction Management, March 1990, Sydney, Volume 4, Pages 388-399.

Rwelamila P D; Group Dynamics and Construction Project Manager; ASCE Construction Engineering and Management, Volume 120, March 1994, Pages 3-10.

Ryan B D; Financial Control Procedures for the General Hospital Construction Programme of the Department of Health; Proc. CIB W-65 Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume I, Pages A.1.377-A.1.390.

Schaffer G B and **Ferdman I**; The Development and Implementation of a Contracts Management System; Managing Construction Worldwide, Volume 1, Systems For Managing Construction, 1987, Page 477-486.

Schlick H; Project Integrated Management System - "PRIM" (1); Proc. CIB W-65 Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume I, Pages A.1.69-A.1.82.

Sey Y, **Orhon I** and **Sözen Z**; The Proposal of the Framework of an Analytical Model of the Effectiveness of Project Organizations; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume III, Pages D.2.27-36.

Sharad D; Professional Manager's Role in Engineering and Construction Projects; Proc. PMI/Internet Joint Symposium 'The World of Project Management', Boston, September 1981, Pages 108-113.

Sidewell A C and **Ireland C**; A Conceptual Model for Designing Organisational Form within the Building Process; Proc CIB Second Symposium on Organisation and Management in Construction, Israel, October/November 1978, Volume 1, Pages I.151-I.163.

Skitmore M; Theoretical Framework For A Management Decision Evaluation System; Managing Construction Worldwide, Volume 1, Systems For Managing Construction, 1987, Page 153-164.

Skitmore M, **Lavelle D** and **Misiran Y**; The Use of Records In Predicting the Outcome of Contractors' Claims; Proc. Of the Association of Researchers in Construction Management (ARCOM), 9th Annual Conference, 'Advances in Construction Research', Oxford, September 1993, Pages 165-175.

Snowdon M; Project Management; The Quantity Surveyor, January 1980, Pages 2-4.

Sözen Z; Operationalization and Measurement of Three Strategic Variables in the Study of Building Organizations - Structure, Technology and Size; Proc. CIB W-65 Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume III, Pages D.2.17-D.2.26.

Stallworthy E A; The Impact of Design Changes; International Journal of Construction Management & Technology, 1987, Volume 2, Number 2, Pages 37-47.

Torrance V B and **Suiter M J**; Personality Characteristics of the First-Line Manager; Managing Construction Worldwide, Volume 2, Productivity and Human Factors In Construction, 1987, Page 1023-1034.

Tucker S N and **Mohamed S**; Introduction Information Technology in Construction - Pains and Gains; International Symposium for the Organization and Management of Construction - Shaping Theory and Practice, 1996, Volume 3, Pages 348-356.

Walker A and **Hughes W P**; An Analysis of the Management of a Public Sector Project - A Systems Based Case Study; Managing Construction Worldwide, Volume 1, Systems For Managing Construction, 1987, Page 72-80.

Walker D H T; Project Management in Perspective; Construction Computing, October 1995, Pages 14-16.

Walker D H T; What Sort of Person Makes a Good Project Manager?; The Building Economist, Journal of the Australian Institute of Quantity Surveyors, September 1996, Pages 26-29.

Wearne S H; Preparing For Privatized Project Management; International Journal of Project Management, 1994, Volume 12, Number 2, Pages 118-120.

Webb A; Project Organisations Structures - 3; Project Management Today, November / December 1994, Pages 16-17.

West L J; Job and Personality Differences Within The Building Management Team; Proc. CIB Third Symposium on Organisation and Management of Construction, Dublin, July 1981, Volume II, Pages B.1.1-B.1.13.

Whiteman W E and **Irwig H G**; Disturbance Scheduling Technique for Managing Renovation Work; ASCE Journal of Construction Engineering and Management, Volume 114, Number 2, June 1988, Pages 191-213.

Williams I; Project Management Software; Which Computer?; April 1990, Pages 81, 82, 84, 85, 88, 90 and 93.

Wirth I; How Generic and How Industry-specific is the Project Management Profession?; International Journal of Project Management, 1996, Volume 14, Number 1, Pages 7-11.

BOOKS

Adams E E and **Ebert R J**; Production and Operations Management - Concepts, Models and Behaviour; Prentice-Hall International, London, 1986.

Adams R, **Carruthers J** and **Hamil S**; Changing Corporate Values; Kogan Page, London 1991.

Atkinson I; Construction Management; Applied Science, Barking, 1974.

Barnes M; Measurement in Contract Control; Institute of Civil Engineers, London, 1981.

Bathurst P E and **Butler D A**; Building Cost Control Techniques and Economics; William Heinemann, London, 1973.

Beishon J and **Peters G**; Systems Behaviour; Harper & Row, London, 1981.

Bohl M; Information Processing with Basic; Science Research Associates, Chicago, 1984.

Burgess R A; Construction Projects - Their Financial Policy and Control; Construction Press, Harlow, 1982.

Burke R; Project Management - Planning & Control; Management Press, Stratford on Avon, 1992.

Calvert R E; Introduction to Building Management; Newnes - Butterworth, London, 1970.

Clough R H and **Sears G A**; Construction Project Management; John Wiley & Sons, New York, 1991.

Cooke B and **Jepson W B**; Cost and Financial Control for Construction Firms; MacMilllan, London, 1979.

Duncan-Wallace I N; Hudson's Building and Civil Engineering Contracts; Sweet and Maxwell, London, 1970.

Finn M D; Project Management in Development - A Checklist, Henry Stewart Publications, London, 1984.

Forster G; Building - Organisation & Procedures; Longman, Singapore, 1986.

Freund J E and **Williams F J**; Elementry Business Statistics - The Modern Approach; Prentice-Hall International, London, 1986.

Galbreath R D; Managing Construction Contracts - Operational Control for Commercial Risks; JohnWiley & Sons, New York, 1992.

Gobourne J; Site Cost Control in the Construction Industry; Butterworth, Sevenoaks, 1982.

Hampden-Turner C; Corporate Culture - From Viscious to Virtuous Circles; Economist Books, London, 1990.

Hampton D R, **Summer C E** and **Webber R A**; Organizational Behaviour and the Practice of Management; Scott Foresman, Glenview, Illinois, 1982.

Handy C B; Understanding Organisations; Penguin, London, 1993.

Harris F and **McCaffer R**; Modern Construction Management; Crosby Lockwood Staples, St Albans, 1977.

Harris F and **McCaffer R**; Worked Examples in Construction Management; Granada Publishing, St Albans, 1978.

Harrison F L; Advanced Project Management - A Structured Approach; Gower Publishing, Aldershot, 1992.

Hicks H G and **Gullett C R**; Modern Business Management - A Systems and Environmental Approach; McGraw-Hill, Tokyo, 1976.

Hughes G A; The Anatomy of Quantity Surveying; Construction Press, Harlow, 1978.

Huse E F and **Cummings T G**; Organization Development and Changes; West Publishing, St Paul, Minnesota, 1985.

Keating D; Building Contracts; Sweet and Maxwell, London, 1978.

Kerzner H; Project Management - A System's Approach to Planning, Scheduling and Controlling; Van Nostrand Reinhold, New York, 1979.

Kharbanda O P, Stallworthy E A and **Williams L F**; Project Cost Control in Action; Gower Publishing, Farnborough, 1980.

Kliem R L and **Ludin I S**; The People Side of Project Management, Gower Publishing, Aldershot, 1992.

Kliem R L and **Ludin I S**; The Noah Project - The Secrets of Practical Project Management, Gower Publishing, Aldershot, 1993.

Koontz H, O'Donnell C and **Weihrich H**; Essentials of Management; McGraw-Hill, New York, 1986.

Kotter J P; A Force For Change - How Leadership Differs From Management; Free Press, New York, 1990.

Leigh A; Effective Change - 20 Ways to Make it Happen; Institute of Personnel Management, Wimbledon, 1991.

Levin R I, Rubin D S and **Stinson J P**; Quantitative Approaches to Management; McGraw-Hill, Singapore, 1986.

Lock D; Handbook of Project Management; Gower Publishing, Aldershot, 1994.

Lockett M and **Spear R**; Organizations as Systems; Open University Press, Milton Keynes, 1980.

Luthans F; Organisational Behaviour; McGraw-Hill, Singapore,1985.

Mintzberg H; Structure in Fives - Designing Effective Organisations; Prentice-Hall International, London, 1983.

Morris P W G; The Management of Projects; Thomas Telford, London, 1994.

Oxley R and **Poskitt J**; Management Techniques Applied to the Construction Industry; Granada, St Albans, 1980.

Paton R, Brown S, Spear R, Chapman J, Floyd M and **Hamwee J**; Organisations - Cases, Issues, Concepts; Paul Chapman Publishing, London, 1988.

Pettigrew A and **Whipp R**; Managing Change For Competitive Success; Blackwell, Oxford, 1993.

Pilcher R; Project Cost Control in Construction; Blackwell Scientific Publications, Oxford, 1994.

Rafferty J; Risk Analysis in Project Management; E & F N Spon; London, 1994.

Reiss G; Project Management Demystified; E & F N Spon; London, 1995.

Ridgeway C and **Wallace B**; Empowering Change - The Role of People Management; Institute of Personnel & Development, Wimbledon, 1994.

Ritz G E; Total Construction Project Management; McGraw-Hill, Singapore, 1994.

Rosenblatt S B, Cheatham T R and **Watt J T**; Communication in Business; Prentice-Hall International, London, 1982.

Trauner T J; Managing the Construction Project - A Practical Guide for the Project Manager; John Wiley & Sons, New York, 1993.

Tricker R I; Effective Information Management; Beaumont Executive Press, Oxford, 1982.

Turner J R, Kristoffer V G and **Thurloway L**; The Project Manager as Change Agent; McGraw-Hill, Maidenhead, 1996.

Wainright W H and **Wood A A B**; Variation and Financial Account Procedure; Hutchison, London, 1979.

Walker A; Project Management in Construction; Granada, London, 1984.

Williams A, Dobson P and **Walters M**; Changing Culture - New Organisational Approaches; Institute of Personnel Management, Wimbledon, 1993.

Woodward J F; Construction Project Management; Thomas Telford, London, 1997.

APPENDICES

APPENDICES

LIST

APPENDIX 'A'

Appendix 'A' : Functions of a Project Manager

This Appendix details the duties of a Project Manager which are to:

(1) Agree the basis of his or her appointment with the client together with the fee and terms of reference.

(2) Assess the suitability of the particular development envisaged including land value, planning requirements, site difficulties, environmental concerns and marketability of end product.

(3) Undertake a preliminary assessment of total capital costs, estimated income and expenditure to determine anticipated return and also to determine whether adequate finance is available.

(4) Instruct solicitors to purchase site, deal with contracts, title restrictions and all documentation through to land transfer.

(5) Advise on the selection and terms of appointment of all consultants.

(6) Hold an initial briefing meeting with the professional team and prepare the pre-contract programme.

(7) Investigate site restrictions with the professional team and the client's solicitors and determine inter alia:

- (a) Improvement lines relating to road widening proposals;
- (b) Rights of ways or other easements;
- (c) Existence of restrictive covenants;
- (d) Rights of light and air either existing or to be negotiated;
- (e) Boundary and party wall proposals;
- (f) Arrangement for the diversion of foot-paths, highways and services.

(8) Prepare a detailed brief recording the principles to be adhered to by consultants at all stages of the design process.

(9) Consider supervising officer's recommendations on design concepts relating to accommodation, layout and gross and net areas of accommodation.

(10) Consult with supervising officer, quantity surveyor and letting agent until optimum scheme is produced.

(11) Consider overall viability of scheme having regard to market demand and likely completion date, and consider methods of finance and preliminary marketing proposals.

(12) Set out details of anticipated cost and income to the client and obtain approval in principle.

(13) Discuss with client the appropriate method of appointing a contractor.

(14) Consider the form of planning application with the supervising officer, taking care to:

(a) Investigate the necessity for special planning or other statutory approvals.
(b) Note the presence of any designated buildings and the existence of height restricted areas.

(15) Obtain adjoining owner's consent if necessary and commence party wall procedures.

(16) On receipt of planning permission proceed with the scheme design and initial cost plan.

(17) Check that statutory undertakers can provide all services required.

(18) Check that a proper site survey has been undertaken.

(19) Instruct the structural engineer to provide a soil investigation report.

(20) Consider forms of heating, ventilation or air-conditioning from cost efficiency and maintenance viewpoint.

(21) Agree lift specification having regard to the number of lifts, size, speed, finish and cost.

(22) Make preliminary analysis of building materials and their availability including taking steps to select nominated subcontractors and suppliers.

(23) Consult the insurers on the design of the project and its effect on insurance premiums and determine the necessity for sprinklers, fireman's lift, burglar alarms, smoke detectors and security provisions.

(24) Ensure that approval consent under the Building and Planning Regulations is obtained.

(25) Consult Fire Authority and seek their requirements on means of escape, fire fighting equipment, extinguishers, hose reels, dry or wet risers, foam inlets, smoke control flues and the like.

(26) Ensure the requirements of environmental legislation are complied with.

(27) Ensure that the design brief falls within the quantity surveyor's cost plan.

(28) Keep progress check on working drawings and ensure that the pre-contract programme is adhered to.

(29) Agree elevational details with the supervising officer and approve sample materials.

(30) Determine the amount of liquidated and ascertained damages, insurance provision and bond value to be inserted in the contract document.

(31) Determine the form of tendering with advice from the quantity surveyor.

(32) Ensure quantity surveyor receives all information necessary for preparation of tender documents to meet the pre-contract programme.

(33) Agree tender lists of main building contractors with consultants and take up references as necessary.

(34) Receive quantity surveyor's report and recommendations on tender received.

(35) Report to client on up-dated viability study and obtain approval for the acceptance of the appropriate tender.

(36) Approve and agree contract documents with consultants and arrange for execution of the contract and agree date for contractor's possession of the site.

(37) Check that all necessary insurances and bonds have been drawn up prior to granting contractor possession of the site.

(38) Appoint clerk of works and resident consultants if necessary and agree terms of employment after consultation with client.

(39) Approve site hoardings and site boards.

(40) Ensure approval to subcontract elements of the work is given.

(41) Apply for gas, electricity and water supplies after giving details of anticipated loading for completed scheme.

(42) Advise client on anticipated cash flow to facilitate payments under the conditions of contract.

(43) Attend site meetings and maintain a constant check on material supply position and labour availability. Report progress to client at regular intervals and ensure building works are kept on programme. Ensure the issue and honouring of certificates in accordance with the contract.

(44) Hold co-ordination and progress meetings as appropriate. Throughout the contract period monitor any changes in regulations or occupier's requirements and take appropriate steps to incorporate these where possible.

(45) Approve and record all variations to the contract and report to the client as to their cost implications.

(46) Ensure that equipment of statutory bodies such as the electricity supply company and water authority will be installed, tested and operational in accordance with the programme.

(47) Arrange for commissioning of all plant and equipment.

(48) Consider and, at the appropriate time, arrange marketing of property or future management arrangements.

(49) Advise on the form of lease to suit the client's requirements or to maximise the investment value.

(50) Obtain supervising officer's certificate of practical completion on the whole or parts required for occupation and arrange insurance on the client's behalf.

(51) Give permission for occupation to commence.

(52) Submit completion report to client including an assessment of final cost and details of building contractor's claims.

(53) Ensure proper 'as-built' drawings are prepared together with maintenance manuals and hand these to client.

(54) Analyse final cost.

(55) Obtain plant and machinery costs for tax, grant or other purposes.

(56) Ensure all statutory requirements are met.

(57) Ensure supervision, testing and inspection continues during the defects liability period and approve the final account.

(58) Approve the issue of the final certificate.

(59) Check total of all fee accounts and arrange for final payment.

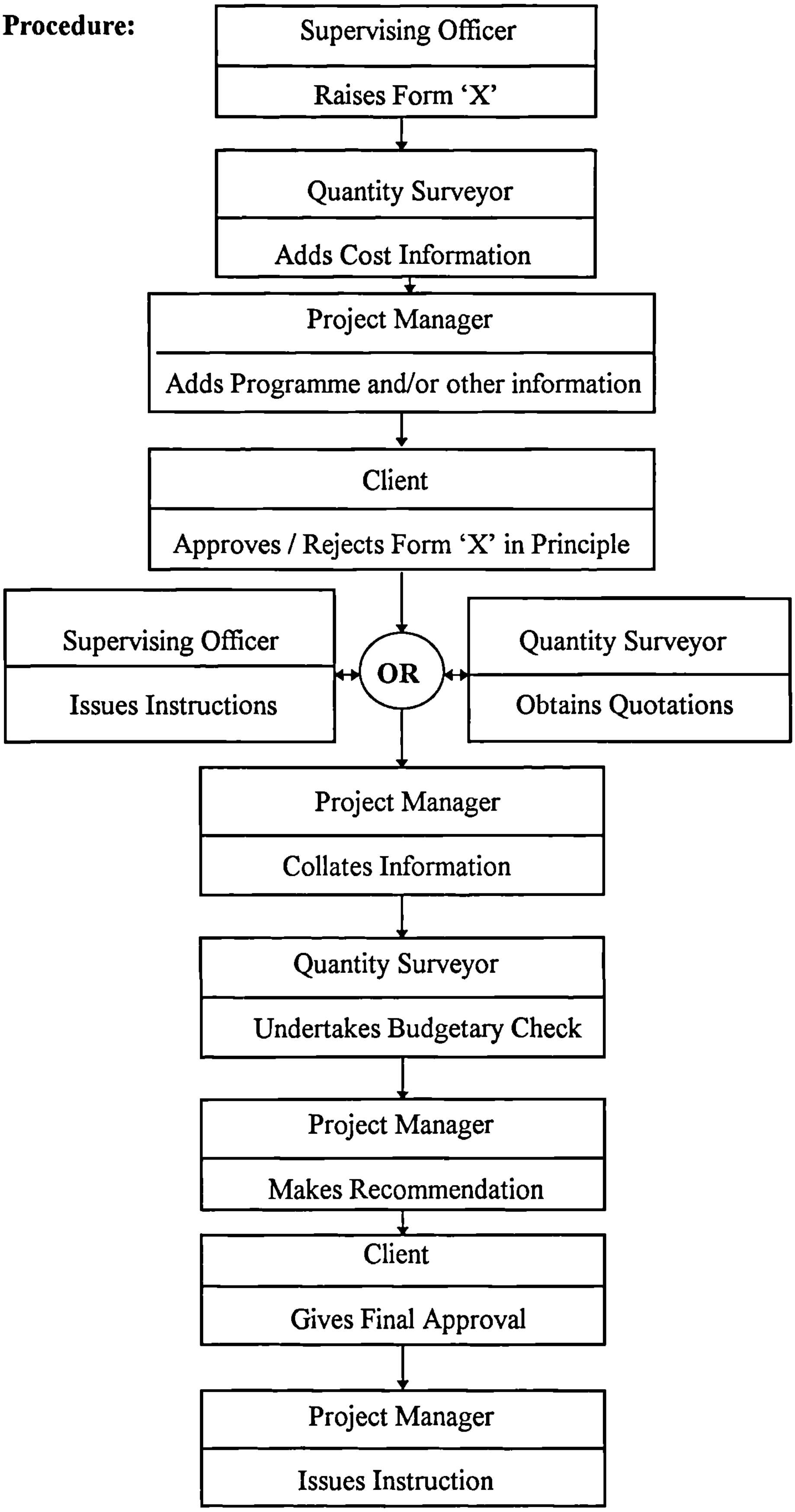
(60) Analyse the project and supply feedback to client.

APPENDIX 'B'

Appendix 'B' : Form 'X' Control Procedures

This Appendix details the various Form 'X' procedures:

Design Procedure:



Construction Procedure:

Supervising Officer
Raises Form 'X'

↓

Quantity Surveyor
Adds Cost Information

↓

Project Manager
Adds Programme and/or other information

↓

Client
Approves / Rejects Form 'X' in Principle

↓

Supervising Officer
Drafts Instruction

↓

Project Manager
Collates Information

↓

Quantity Surveyor
Undertakes Budgetary Check

↓

Project Manager
Makes Recommendation

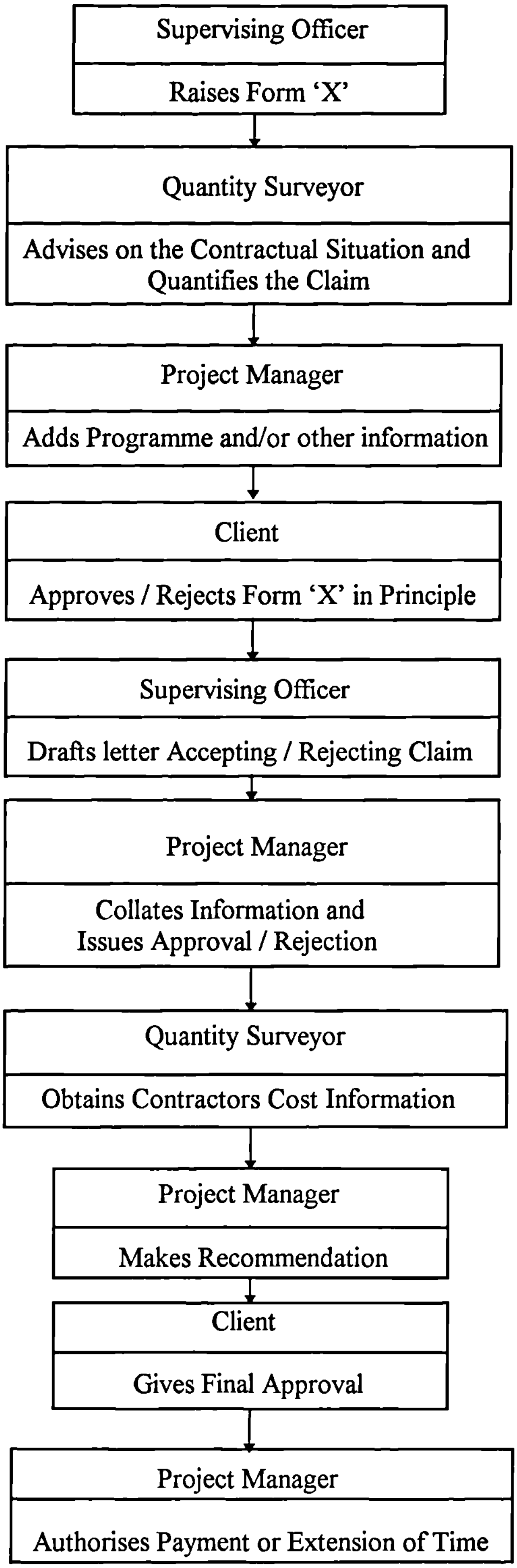
↓

Client
Gives Final Approval

↓

Project Manager
Issues Instruction

Claims Procedure:



CONTRACT COST CONTROL PROPOSAL FOR A FORM 'X' SUBMISSION	* Design Construction Claims

To:______________________________________ Date ___/___/___

Supervising Officer / Building Services Engineer / Structural Engineer / Quantity Surveyor

CONTRACT TITLE ________________________________

I recommend that a Form 'X' be raised in respect of the attached.

Proposer: ____________

Position: ____________

To:______________________________________ Date ___/___/___

Project Manager

My Comments / Draft Form 'X' in respect of the above are attached.

# Input Obtained From				

Signed: ____________

Supervising Officer / Building Services Engineer / Structural Engineer / Quantity Surveyor

To:______________________________________ Date ___/___/___

Client

* **Form 'X' Numbers**:____________________)
____________________) Raised & Attached
____________________)

or * Application Rejected / Referred Back (see attached)

Copy to the Proposer

Signed: ____________

Project Manager

* Delete as necessary

\# Enter "initials" of the firms consulted.

CONTRACT COST CONTROL	Form 'X' **DESIGN** X | D | |
CONTRACT TITLE ____________________________	Date ___/___/___
PROPOSAL	**Estimated Cost** HK$

Raised by:	**Costed by:**	**Endorsed by:**	**Principle Accepted**
Supervising Officer	Quantity Surveyor	Project Manager	Client

SUPERVISING OFFICER'S INSTRUCTION

+ Instruction No. ________________ ____________________________

Supervising Officer

Issued Date ___/___/___

VARIATION ORDER / NOM-SUB ORDER

Pricing Information Attached Comprising:

Quantity Surveyor

Date: / /

*** By Quantity Surveyor ( ) or**	*** By Supervising Officer ( )**
Recommended Sub-contractor / Supplier ________________________	
Prime Cost Sum in BQ HK$ Recommended Sum HK$	Indicate any significant programme or other contractual effects hereunder:
Difference +/ - HK$	
________________ Supervising Officer Date / /	

Proposed NSO/VO Attached	Signed:	Project Manager / /
Commercial Aspect Checked	Signed:	Project Manager / /
Costed by:	**Recommended by:**	**Approved by:**
Quantity Surveyor	Project Manager	Client

Nom. Sub Order No. ____________________

Variation Order No. ____________________ ____________________

Project Manager

Issued on : / / Date : / /

+ Copy of completed Form to : Supervising Officer / Building Services Engineer / Structural Engineer / Quantity Surveyor

* Delete as necessary

CONTRACT COST CONTROL	Form 'X' CONSTRUCTION X | C | |
CONTRACT TITLE _______________	Date ___/___/___
PROPOSAL	**Estimated Cost** HK$

Raised by:	**Costed by:**	**Endorsed by:**	**Principle Accepted**
Supervising Officer	Quantity Surveyor	Project Manager	Client

SUPERVISING OFFICER'S INSTRUCTION

+ Instruction No. ______________ Issued	______________ Supervising Officer Date : / /

VARIATION ORDER

By : Supervising Officer	
Indicated significant programme or other contractual effects which may arise	Draft Variation Order attached Cost - HK$ ______________ ______________ Supervising Officer Date / /

Commercial Aspect Checked	**Signed:**	Project Manager / /

Costed by:	**Recommended by:**	**Approved by:**
Quantity Surveyor	Project Manager	Client
+ Variation Order No. Issued	______________	______________ Project Manager Date : / /

\+ Copy of completed Form to : Supervising Officer / Building Services Engineer / Structural Engineer / Quantity Surveyor

CONTRACT COST CONTROL			Form 'X'
			CLAIMS
			X | CL | |
CONTRACT TITLE ________________________________			Date ___/___/___
CLAIM			Contractor's Claim HK$
Raised by:	**Costed by:**	**Endorsed by:**	**Principle Accepted**
Supervising Officer	Quantity Surveyor	Project Manager	Client
Supervising Officer's Initial Comments (copy attached) Signed: ____________________ Project Manager Date : / /			

Supervising Officer's Preliminary Assessment Received & Attached Signed: ____________________ Supervising Officer Date : / /			
Comments Attached:	**Commented by:**	**Endorsed by:**	**Comments Noted by:**
Supervising Officer	Quantity Surveyor	Project Manager	Client
Project Manager's Comments (copy attached) Signed: ____________________ Project Manager Date : / /			

Supervising Officer Confirms Assessment (copy attached) Signed: ____________________ Supervising Officer Date : / /			
Comments Attached:	**Costed by:**	**Endorsed by:**	**Comments Noted by:**
Supervising Officer	Quantity Surveyor	Project Manager	Client
Project Manager's Comments (copy attached) Signed: ____________________ Project Manager Date : / /			

Copy of Certified Settlement Received from Project Manager	Amount Certified	____________________
Variation Order No.	HK$________________	Project Manager
Associated Claim No(s).		Date : / /

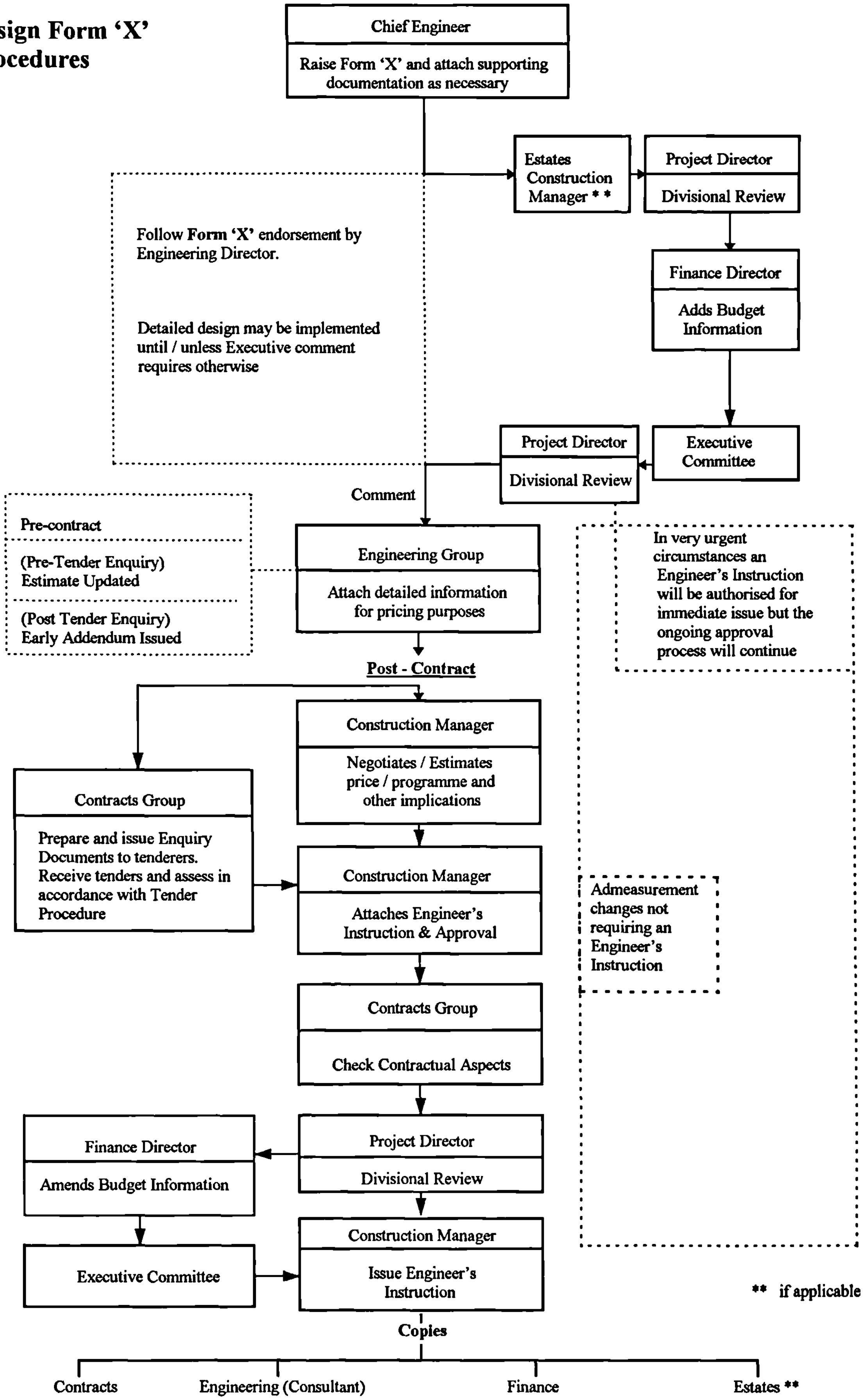
* Delete as necessary

APPENDIX 'C'

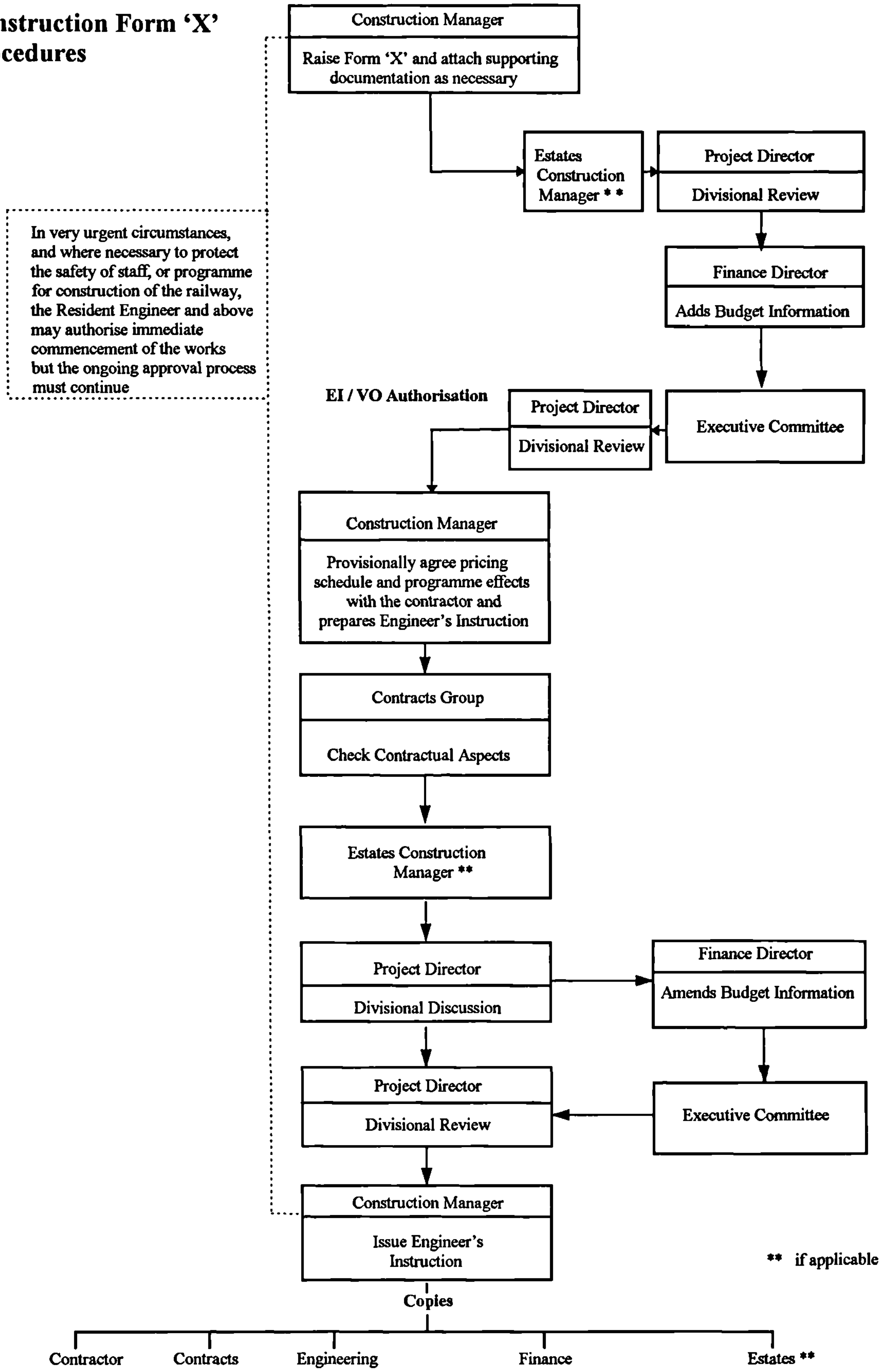
Appendix 'C' : Mass Transit Railway Corporation Form 'X' Procedures

This Appendix details the Mass Transit Railway Corporation Form 'X' procedures:

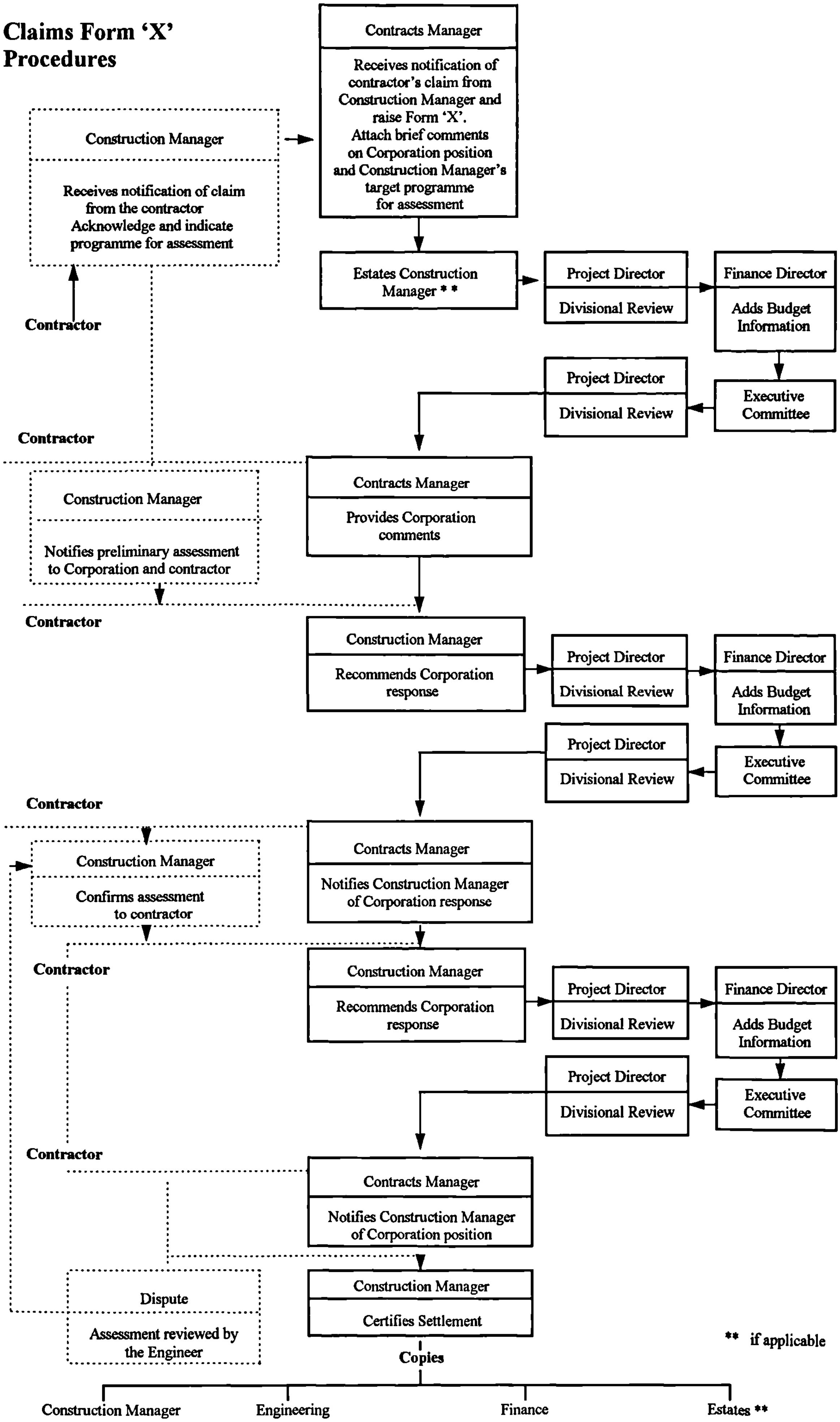
Design Form 'X' Procedures



Construction Form 'X' Procedures



Claims Form 'X' Procedures



MASS TRANSIT RAILWAY CORPORATION CONTRACT COST CONTROL PROPOSAL FOR A FORM 'X' SUBMISSION	* Design Construction Claims

To:____________________________________ Date ___/___/____

* Design Manager / Senior Resident Engineer / Resident Engineer / Senior Contracts Engineer

Copy:____________________________________

Administration Services Manager / Estates Construction Manager #

CONTRACT NO (s) : ____________________

I recommend that a Form 'X' be raised in respect of the attached.

Proposer: ______________

Title / Location: ______________

To:____________________________________ Date ___/___/____

* Chief Engineer / Construction Manager / Contracts Manager

Copy:____________________________________

Administration Services Manager / Estates Construction Manager #

My Draft Form 'X' in respect of the above are attached.

@ Input Obtained From				

Signed: ______________

Design Manager / Senior Resident Engineer / Resident Engineer / Senior Contracts Engineer

---

To:____________________________________ Date ___/___/____

Engineering Director / Project Director

* Form 'X' Numbers: ______________________) Raised and
______________________) Attached

* Application Rejected / Referred Back (see attached)

Copy :

Proposer / Administration
* Design Manager / Senior Resident Engineer /
Senior Contracts Engineer / Construction Manager
Estates Construction Manager

Signed: ______________

* Construction Manager / Contracts Manager

---

* Delete as necessary. # Where applicable.

@ Enter "initials" of the Corporation Departments / Consultants consulted.
Where recommendations are contrary to input then an appropriate explanation should be attached.

MASS TRANSIT RAILWAY CORPORATION CONTRACT COST CONTROL	Form 'X' DESIGN X | D | |
CONTRACT No______________	Date ___/___/___
PROPOSAL	**Cost** HK$

Raised by:	**Costed by:**	**Endorsed by:**	**Recorded by:**	**Principle Accepted**
Chief Engineer	Engineering Director	Project Director	Finance Director	Executive Committee

ENGINEER'S INSTRUCTION

+ No.______________________	______________________ Construction Manager
Issued	Date ___/___/___

NOMINATED SUB-CONTRACT OR SUPPLY ORDER

Pricing Information Attached	Comprising:
Chief Engineer	
Date: / /	

* By Contracts Manager ( ) or	* By Construction Manager ( )
Recommended Sub-contractor / Supplier	Cost - HK$__________________
Prime Cost Sum in BQ HK$ Recommended Sum HK$	Indicate any significant programme or other contractual effects:
Difference HK$	
______________ Construction Manager Date / /	

Engineer's Instruction attached	Signed:	Construction Manager
Commercial Aspects Checked	Signed:	Contracts Manager

Recommended by:	**Endorsed by:**	**Recorded by:**	**Approved by:**
Engineering Director	Projects Director	Finance Director	Executive Committee

Nom. Sub-contract Order No. ______________	
Variation Order No. ______________	______________________ Construction Manager
Issued on : / /	Date : / /

+ Copy of Form to : Design Manager / Finance Director / Projects Director / Contracts Manager.

* Delete as necessary

MASS TRANSIT RAILWAY CORPORATION CONTRACT COST CONTROL				Form 'X' CONSTRUCTION X | C | |
CONTRACT No______________				Date ___/___/____
PROPOSAL				**Cost** HK$
Raised by:	**Endorsed by:**	**Endorsed by:**	**Recorded by:**	**Principle Accepted**
Construction Manager	Engineering Director	Project Director	Finance Director	Executive Committee

*** ENGINEER'S INSTRUCTION**

+ Instruction No. ____________________ Issued	______________________________ Construction Manager Date : / /

VARIATION ORDER

By : Construction Manager	
Indicate any significant programme or other contractual effect	Draft Engineer's Instruction attached Cost - HK$ ________________________ ______________________________ Construction Manager Date / /

Commercial Aspect Checked	Signed:	Contracts Manager / /

Recommended by:	**Endorsed by:**	**Noted by:**	**Approved by:**
Contracts Manager	Projects Director	Finance Director	Executive Committee
+ Supplementary Engineer's Instruction No. __________ Issued		______________________ Construction Manager Date : / /	

+ Copy of Form to : Design Manager / Finance Director / Projects Director / Contracts Manager.

* Delete as necessary

MASS TRANSIT RAILWAY CORPORATION CONTRACT COST CONTROL			Form 'X' **CLAIMS** X | CL | |
CONTRACT No____________			Date ___/___/___
CLAIM			**Contractor's Claim** HK$
Raised by: Contracts Manager	**Endorsed by:** Projects Director	**Noted by:** Finance Director	**Claim Noted:** Executive Committee
Corporation's Comments to Construction Manager (copy attached) Signed: ____________ Contracts Manager Date : / /			

Construction Manager's Preliminary Assessment Received & Attached Signed: ____________ Construction Manager Date : / /			
Comments Attached: Contracts Manager	**Endorsed by:** Projects Director	**Noted by:** Finance Director	**Noted by:** Executive Committee
Corporation Comments to Construction Manager (copy attached) Signed: ____________ Contracts Manager Date : / /			

Construction Manager Confirms Assessment (copy attached) Signed: ____________ Construction Manager Date : / /			
Comments Attached: Contracts Manager	**Endorsed by:** Projects Director	**Noted by:** Finance Director	**Noted by:** Executive Committee
Corporation Comments to Construction Manager (copy attached) Signed: ____________ Contracts Manager Date : / /			

Copy of Certified Settlement Received from Construction Manager	Amount Certified HK$__________	Extension of Time Days________
Engineer's Instruction No.	Signed:________________ Contracts Manager Date : / /	
Associated Claim No(s).		

* Delete as necessary

APPENDIX 'D'

Appendix 'D' : Cost Centre Control Totals

This Appendix details the individual Cost Centres figures which make up the Contract Sum and their adjusted Cost Control Values:

CONTRACT 401 : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	77,803,876
Sheung Wan East Concourse Structure	'B'	163,243,624
Completion Works to Des Voeux Road	'C'	3,860,000
Architectural Works and Finishes to Station	'D'	14,484,576
CONTRACT 401 BILL OF QUANTITIES	TOTAL	**259,392,076**

CONTRACT 401 : COST CONTROL VALUES

Cost Centres 'A' to 'D' had Provisional Sums but owing to an error on the part of the Hong Kong Mass Transit Railway Corporation, the original Cost Control Values were calculated based on the Contract Summary.

CONTRACT 402 : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	155,673,573
Over-Run Tunnels	'B'	111,424,322
Cross-Over Box and Development Substructure	'C'	70,703,127
Sheung Wan Station Tunnels and Running Tunnels to Crossover Box	'D'	231,442,200
Sheung Wan Centre Station Concourse Structure	'E'	135,351,998
Architectural Works and Finishes to Station	'F'	14,755,000
Additional Architectural Works to Station	'G'	13,901,986
CONTRACT 402 BILL OF QUANTITIES	TOTAL	**733,252,206**

CONTRACT 402 : COST CONTROL VALUES

Original Contract Total for Cost Centre 'A'				**HK$155,673,573**
Deduct Provisional Sums:				
(i)	Monitoring	1,000,000		
(ii)	Special Attendances	7,600,000		
(iii)	Utilities Connections	100,000		
(iv)	Dayworks	10,968,750		
			Ddt.	19,668,750
COST CENTRE 'A'		**CONTROL VALUE**		**HK$136,004,823**

Cost Centres 'B' to 'G' had no Provisional Sums, therefore the Cost Control Values were the Bill of Quantities figures.

CONTRACT 406 : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	41,392,700
Fortress Hill Station Tunnels and Adits	'B'	50,603,026
Tin Hau to Fortress Hill Running Tunnels	'C'	35,187,103
Fortress Hill to North Point Running Tunnels	'D'	51,908,008
Fortress Hill Station Concourse Structure	'E'	67,342,541
Architectural Works and Finishes to Station	'F'	7,476,558
Dangerous Goods Store	'G'	1,650,648
Additional Architectural Finishes to Station	'H'	8,336,694
CONTRACT 406 BILL OF QUANTITIES	TOTAL	**263,897,278**

CONTRACT 406 : COST CONTROL VALUES

Original Contract Total for Cost Centre 'A'				**HK$41,392,700**
Deduct Provisional Sums:				
(i)	Dewatering	50,000		
(ii)	Vent Shaft Structure	750,000		
(iii)	Special Attendances	3,450,000		
(iv)	Utilities Connections	200,000		
(v)	Dayworks	3,142,500		
			Ddt.	7,592,500
COST CENTRE 'A'		**CONTROL VALUE**		**HK$33,800,200**

Original Contract Total for Cost Centre 'G'			**HK$1,650,648**
Deduct Provisional Sums:			
(i) Drainage	50,000		
		Ddt.	50,000
COST CENTRE 'G'	**CONTROL VALUE**		**HK$1,600,648**

Cost Centres 'B', 'C', 'D', 'E', 'F', and 'H' had no Provisional Sums therefore the Cost Control Values were Bill of Quantities figures.

CONTRACT 427 : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	27,460,704
Wanchai Concourse Structure	'B'	109,117,280
O'Brien Road Subway	'C'	12,647,803
Architectural Works and Finishes to Station	'D'	21,321,845
CONTRACT 427 BILL OF QUANTITIES	TOTAL	**166,378,839**

CONTRACT 427 : CONTROL VALUES

Original Contract Total for Cost Centre 'A'				**HK$27,460,704**
Deduct Provisional Sums:				
(i)	Bentonite Supply	200,000		
(ii)	Ground Treatment	150,000		
(iii)	Special Attendances	1,050,000		
(iv)	Compressed Air Working	500,000		
(v)	Dayworks	1,362,500		
			Ddt.	3,262,500
	COST CENTRE 'A'	**CONTROL VALUE**		**HK$24,198,204**

Original Contract Total for Cost Centre 'B'			**HK$123,968,155**
Deduct Provisional Sums:			
(i) Ground Treatment	14,726,075		
(ii) Core Drilling	124,800		
		Ddt.	14,850,875
COST CENTRE 'B'	**CONTROL VALUE**		**$109,117,280**

Original Contract Total for Cost Centre 'C'			**HK$12,647,803**
Deduct Provisional Sums:			
(i) Rock Excavation	66,506		
(ii) Service Pipework	982		
(iii) Ground Treatment	4,460,135		
		Ddt.	4,527,623
COST CENTRE 'C'	**CONTROL VALUE**		**HK$8,120,180**

Cost Centre 'D' had no Provisional Sums therefore the Cost Control Value was the Bill of Quantities figure.

It should be appreciated that the contract sum for Contract 427 was stated by the Corporation as being **£166,378,839** and this sum appeared in all of the contract award documentation. This sum was incorrect as Cost Centre 'B' should have been **£123,968,155** and not the **£109,117,280** stated.

The error occurred at contract award stage and although brought to the Corporation's attention by the Contractor the Corporation chose to use this figure as the contract sum.

In practical terms it made little difference as the Cost Centre value was used for payment and control purposes.

However, the use of the lower figure gives the appearance of a larger contract overspend than actually occurred.

CONTRACT 431 : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	20,550,978
Tin Hau Concourse Structure and Ventilation Shafts X and Y	'B'	130,911,401
Entrance 'B'	'C'	3,364,418
Ground Water Control and Instrumentation	'D'	5,173,202
Architectural Works and Finishes to Station	'E'	15,150,937
CONTRACT 431 BILL OF QUANTITIES	TOTAL	**175,150,936**

CONTRACT 431 : COST CONTROL VALUES

Original Contract Total for Cost Centre 'A'				**HK$20,550,978**
Deduct Provisional Sums:				
(i)	Utilities Connections	900,000		
(ii)	Special Attendances	1,025,000		
(iii)	Waterproofing	50,000		
(iv)	Dayworks	2,448,750		
			Ddt.	4,423,750
COST CENTRE 'A'		**CONTROL VALUE**		**HK$16,127,228**

Cost Centres 'B' to 'E' had no Provisional Sums therefore the Cost Control Values were the Bill of Quantities figures.

CONTRACT 403A (A) : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	4,373,038
Admiralty East Structure	'B'	9,497,075
Admiralty Lot 2 Structure	'C'	17,232,981
Flyover Substructures	'D'	1,433,692
CONTRACT 403A (A) BILL OF QUANTITIES	TOTAL	**32,536,786**

CONTRACT 403A (B) : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'E1'	10,932,213
Earthworks	'E2'	5,755,100
Concrete	'E3'	4,933,400
Concrete Ancillaries	'E4'	6,320,983
Caissons	'E5'	1,963,980
Caisson Ancillaries	'E6'	2,403,217
Waterproofing	'E7'	371,111
CONTRACT 403A (B) BILL OF QUANTITIES	TOTAL	**32,680,004**

CONTRACT 406A : CONTRACT SUMMARY

Description of Works	Cost Centre	Value (HK$)
Preliminaries	'A'	5,288,800
Site Formation	'B'	16,917,940
Fortress Hillside Access Shaft	'C'	1,184,150
121 King's Road Access Shaft	'D'	2,109,110
CONTRACT 406A BILL OF QUANTITIES	TOTAL	**25,500,000**

APPENDIX 'E'

Appendix 'E' : Cost Centre Revisions

This Appendix illustrates how the original Cost Centre totals have been revised during the course of the contract:

CONTRACT 401

COST CENTRE REVISIONS

Cost Centre 'A'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**77,803,876**
001	Demolition of toilet block in Area 'A'	15,000
003	Installation of temporary columns	92,285
004	Traffic diversion at Des Voeux Road Central	25,363
006	Additional strutting to diaphragm wall	101,343
007	Revision of temporary strut	180,323
008	Additional strut at Vent Shaft 'X'	7,756
012	Revised dewatering requirements	(400,000)
017	Revised preloading requirement to temporary propping	11,771
022	Temporary steel sheet piling at south diaphragm wall	149,891
030	Upgrade temporary loading capacity	100,000
031	Revise recharge system adjacent to Li Po Chun Chambers	359,511
-	Adjustment of Bill A1 due to remeasurement	(192,152)
-	Adjustment of Bill A4 due to remeasurement	297,515
	FINAL COST CENTRE 'A' TOTAL	**HK$78,552,482**

CONTRACT 401 (Cont'd)

Cost Centre 'B'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**163,243,624**
010	Additional site investigation to diaphragm wall	11,360
011	Additional site investigation to diaphragm wall	20,295
023	Addition of entrance structures on the Marine Cinema site	2,957,090
024	Addition of entrance structures on the Triangular site	943,222
005	Deletion of dovetail anchor slots and anchors	(116,400)
009	Movement joint between south diaphragm wall and the basement slab	59,116
015	Dowel bars for revised reinforcement at basement slab	64,240
013	Basement slab excavation	201,637
014	Revised recess for Island Line slab	38,707
018	Varied beam reinforcement detail at basement slab	16,749
019	Revised diaphragm wall cut off levels	349,928
020	Deletion of bored pile at Vent Shaft 'X'	(257,520)
021	Sheet steel piling at Vent Shaft 'X'	199,429
023	Provision of leakage collection system	16,900
024	Waterproofing to temporary columns passing through slab	26,208
025	Recesses in diaphragm wall	35,028
026	Cable and pipe brackets	27,511
027	Provision of movement joint to columns	50,995
028	Provision of suspended duct under slab	653,529
029	Provision of escalator machine plinth	122,000
	Carried Forward	**$168,663,648**

CONTRACT 401 : Cost Centre 'B' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**$168,663,648**
032	Provision of fire service and sewage tanks	162,500
033	Provision of additional slabs at platform level	1,220,543
-	Adjustment of Bill B3.1 due to remeasurement	(6,222,334)
-	Adjustment of Bill B3.2 due to remeasurement	165,130
-	Adjustment of Bill B4.1 due to remeasurement	(410,577)
-	Adjustment of Bill B5.1 due to remeasurement	(2,847,153)
-	Adjustment of Bill B5.2 due to remeasurement	501,960
	FINAL COST CENTRE 'B' TOTAL	**HK$161,233,717**

Cost Centre 'C'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**3,860,000**
034 & 035	Construction of Bus Terminus & Refuse Collection Point	1,888,000
-	Adjustment of Bill C2 due to remeasurement	(1,620,000)
	FINAL COST CENTRE 'C 'TOTAL	**HK$4,128,000**

Cost Centre 'D'

Instruction No.	Description	Valuation (HK$)
No Variations	**ORIGINAL TOTAL**	**14,484,576**
	FINAL COST CENTRE 'D' TOTAL	**HK$14,484,576**

CONTRACT 402

COST CENTRE REVISIONS

Cost Centre 'A'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**136,004,823**
001	Adoption of bored piles option for Centre Concourse	(3,725,000)
001	Support to arch in Western Market	21,000
002	Realignment of power cable in Area 'A'	11,500
003	Relocation of fire hydrant at corner of Telephone Exchange	3,274
004	Realignment of 150mm water pipe	3,362
005	Alterations to footpath in Tung Loi Lane	39,950
006	Electrical installation and connection to site offices	19,300
007	Temporary water supply to 30-32 New Market Street	25,485
008	Formation of car park for site office	32,500
012	Provision of 600mm drainage pipe in Des Voeux Road	70,387
013	Provision of 225mm drainage pipe in Des Voeux Road	10,500
014	Provision of temporary utilities diversion	9,093
015	Provision of 100mm salt water pipe in Des Voeux Road	33,000
016	Location, protection and reinstatement of 250mm gas main at Centre Concourse	1,533
017	Temporary diversion of 100 mm fresh water main at Centre Concourse	30,845
018	Revision to Temporary Steel columns in Centre Concourse	742,901
023	Temporary Access openings at Crossover Box	49,944
025	Recharge well system at the Telephone Exchange Building	322,206
	Carried Forward	**133,706,603**

CONTRACT 402 : Cost Centre 'A' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**133,706,603**
026	Recharge well system at the Western Market	502,276
029	Temporary diversion of cables at Centre Concourse	(14,000)
030	Removal of a 450mm diameter sewer at Centre Concourse	(45,000)
031	Removal of a 450mm diameter sewer at Hillier Street South	(105,000)
034	Temporary diversion of a 75mm diameter fresh water main	56,789
035	Deletion of lump sums for dewatering	(1,879,000)
036	Site Investigation associated with Station Centre Concourse and tunnel including cross-over box	557,943
037	Ground treatment associated with basement structures and stations other than stations in tunnels	(287,132)
038	Deletion of gas main	(24,000)
039	Deletion of Provisional items for dewatering	(671,000)
-	Additional site utility services	472,227
-	Adjustment of Bill A1 due to remeasurement	(817,250)
	FINAL COST CENTRE 'A' TOTAL	**HK$131,453,456**

CONTRACT 402 (Cont'd)

Cost Centre 'B'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**111,424,322**
005	Revisions to Vent Shaft 'A'	(170,000)
005	Revisions to Vent Shaft 'B'	(3,010,000)
006	Revisions to Westbound Vent Adit	(1,225,838)
009	Ground treatment from fact of excavation	(817,000)
009	Ground treatment for construction of vent shafts	(2,404,000)
010	Additional overrun vent shaft	12,945,595
020	Ground treatment at 229-231 Wing Lok Street	227,748
021	Ground treatment beneath 46-48 New Market Street	436,634
022	Ground treatment outside the Crossover Box	872,569
027	Protective coating to tunnel segments	103,334
028	Excavation of rock in tunnel	762,246
-	Adjustment of Bill B.3 due to remeasurement	3,424,197
-	Adjustment of Bill B.4 due to remeasurement	(7,109,566)
	FINAL COST CENTRE 'B' TOTAL	**HK$115,460,241**

CONTRACT 402 (Cont'd)

Cost Centre 'C'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**70,703,127**
011	Raising of guide walls, additional backfilling and subsequent removal	146,600
019	Sonic coring test on bored piles at Crossover box	212,863
024	Provision of permanent water supply system to 30-32 New Market Street	30,943
027	Testing of bored pile	(31,855)
063	Revised number of piles	1,517,107
-	Adjustment of Bill C.1 due to remeasurement	(4,208,154)
-	Adjustment of Bill C.2 due to remeasurement	(908,551)
	FINAL COST CENTRE 'C' TOTAL	**HK$67,462,080**

Cost Centre 'D'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**231,442,200**
032	Ground treatment to Adits	(1,043,324)
036	Excavation of rock in tunnel	(795,419)
038	Break through end walls	(756,000)
-	Adjustment of Bill D.1 due to remeasurement	(7,635,269)
-	Adjustment of Bill D.2 due to remeasurement	(4,366,951)
	FINAL COST CENTRE 'D' TOTAL	**HK$216,845,237**

CONTRACT 402 (Cont'd)

Cost Centre 'E'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**135,351,998**
001	Adoption of bored pile option at Centre Concourse	(3,275,000)
008	Sacrificial "I" beams to diaphragm Walls	20,751,670
010	Construction of barrettes at Centre Concourse	5,148,529
033	Demolition of part of diaphragm wall	94,080
034	Rock excavation at Centre Concourse	550,454
-	Adjustment due to remeasurement of Bill E.1	(4,205,515)
-	Adjustment due to remeasurement of Bill E.2	2,303,876
	FINAL COST CENTRE 'E' TOTAL	**HK$156,720,092**

Cost Centre 'F'

Instruction No.	Description	Valuation (HK$)
No Variations	**ORIGINAL TOTAL**	**14,755,000**
	FINAL COST CENTRE 'F' TOTAL	**HK$14,755,000**

Cost Centre 'G'

Instruction No.	Description	Valuation (HK$)
No Variations	**ORIGINAL TOTAL**	**13,901,986**
	FINAL COST CENTRE 'G' TOTAL	**HK$13,901,986**

CONTRACT 402 (Cont'd)

Cost Centre 'H'

Instruction No.	Description	Valuation (HK$)
	ORIGINAL TOTAL	**17,892,375**
040	Provision of floor finishes	217,891
041	Adjustment of extent of vitreous enamel panels	1,122,549
-	Adjustment of Bill H due to remeasurement	649,018
	FINAL COST CENTRE 'H' TOTAL	**HK$19,881,833**

CONTRACT 406

COST CENTRE REVISIONS

Cost Centre 'A'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**33,800,200**
007	Protective works to West Vent Shaft	400,000
016	Additional site utility services	50,000
021	Site reinstatement works	1,256,809
-	Dayworks	596,991
	FINAL COST CENTRE 'A' TOTAL	**HK$36,104,000**

Cost Centre 'B'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**50,603,026**
003	Deletion of temporary support system	(492,190)
010	Water ingress collection system	8,600
017	Provision of cast-in conduits	11,800
021	Provision of brackets for advertising panels	59,106
-	Remeasurement of Bills of Quantities	10,579,164
	FINAL COST CENTRE 'B' TOTAL	**HK$60,769,506**

CONTRACT 406 (Cont'd)

Cost Centre 'C'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**35,187,103**
003	Deletion of temporary supports	(1,944,251)
010	Water ingress collection system	14,190
-	Remeasurement of Bills of Quantities	(622,853)
	FINAL COST CENTRE 'C' TOTAL	**HK$32,634,189**

Cost Centre 'D'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**51,908,008**
002	Construction of surface water connection chamber	(50,000)
003	Deletion of temporary supports	(2,125,890)
005	Additional site investigation	31,160
010	Leakage collection system	20,210
-	Remeasurement of Bills of Quantities	(197,118)
	FINAL COST CENTRE 'D' TOTAL	**HK$49,586,370**

CONTRACT 406 (Cont'd)

Cost Centre 'E'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**67,342,541**
003	Deletion of temporary supports	(219,299)
004	Deletion of ground anchors & rock bolts	(3,500,000)
017	Provision of cast-in conduits	25,000
018	Provision of utilities trench	85,000
019	Provision of water bar	24,000
020	Additional protective measures due to development above	550,000
022	Support frame for temporary chiller	180,000
023	Revisions to perimeter hoarding	70,000
-	Remeasurement of Bills of Quantities	8,704,758
	FINAL COST CENTRE 'E' TOTAL	**HK$73,262,000**

Cost Centre 'F'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**7,476,558**
024	Adjustment of extent of vitreous enamel panels	(110,000)
025	Additional acoustic treatment to walls	510,000
	FINAL COST CENTRE 'F' TOTAL	**HK$7,876,558**

CONTRACT 406 (Cont'd)

Cost Centre 'G'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**1,600,648**
001	Revised piling design	(482,850)
026	Revised fire services and air conditioning systems	363,000
	FINAL COST CENTRE 'G' TOTAL	**HK$1,480,798**

Cost Centre 'H'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**8,336,694**
006	Additional ironmongery	92,309
024	Vitreous enamel finish to ceilings	640,000
-	Remeasurement of Bills of Quantities	650,000
	FINAL COST CENTRE 'H' TOTAL	**HK$9,719,003**

Cost Centre 'J'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**1,774,763**
012	Additional site investigation	74,000
014	Additional ground treatment	297,600
	FINAL COST CENTRE 'J' TOTAL	**HK$2,146,363**

CONTRACT 427

COST CENTRE REVISIONS

Cost Centre 'A'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**24,198,204**
001	Addition of additional fencing	35,325
043	Deletion of additional fencing	(35,325)
006	Services to Engineer's Portable Offices	5,800
013	Advancement of sectional completion date	445,000
035	Additional site investigation	87,275
071	Additional expenditure on site services including electrical supply to Corporation offices	7,950
073	Monitor loads in raking struts at Lower Plant Slab Level	12,056
075	Omission of one of two levels of temporary struts to Basement	(792,751)
085	Additional power supply for Designated Contractors	5,708
097	Special attendance on Designated Contractors	57,199
124	Provision of an electric hoist and beams over the temporary opening at concourse level	7,200
142	Demolish the existing bus shelter adjacent to Entrance 'A1'	10,000
152	Testing of lifting devices	29,087
159	Site security required due to delayed development	190,000
161	Additional Reinstatement	234,984
-	Dayworks	497,783
	FINAL COST CENTRE 'A' TOTAL	**HK$24,995,495**

CONTRACT 427 (Cont'd)

Cost Centre 'B'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**109,117,280**
001	Deletion of ground water control instrumentation	(7,974,500)
001	Deletion of piling provision	(24,582,790)
001	Deletion of grout curtain	(14,726,075)
001	Deletion of diaphragm walls	(25,894,624)
002	Ground water control instrumentation	8,225,822
002	Piling provisions	24,550,467
002	Grout curtain	15,392,009
002	Diaphragm wall	25,602,365
003	Preboring for diaphragm walls	6,013
009	Preboring specified piles	220,000
003	Additional penetration into rock for pile prebores	56,612
020	Revised connection between piles, columns and structural slab	(866,860)
026	Revised structural details for lower platform slab	560,000
029	Addition of ancillary structures to the main concourse structure	966,000
030	Reduction in reinforcement in the intermediate concourse slabs	(500,000)
032	Additional 50mm bars to transfer plate	102,562
039	Provide and install hoisting brackets, hooks and beams	70,000
045	Provide additional water bars to the construction joints in ground floor slab	23,608
048	Revised detail at juncture of piles and transfer plate	805,280
052	Concreting of caisson in two stages	65,248
053	Temporary cover to staircase opening	10,000
	Carried Forward	**111,228,417**

CONTRACT 427 : Cost Centre 'B' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**111,228,417**
054	Insulation of large concrete pours	69,313
059	Concourse building services and connection to public utilities	135,400
063	Temporary access slab over lift pit	15,864
065	Protect starter bars above slab and transfer plates with grout wash	11,488
066	Change the shape and size of the transfer slab	1,823,350
068	Delete couplers in piles for longitudinal reinforcement	(990,000)
074	Revised detail of column and slab connection at lower platform slab	47,675
076	Repairs to adjacent building	633
077	Provision of concrete plinths for plant	104,699
080	Supply and fix unistrut concrete eyes and beams	40,253
083	Revised quantity of 50mm reinforcement in ground floor slab and transfer plate	(3,000)
086	Provide waterproofing to Lower Platform slab	83,743
090	Deletion of slab and diaphragm wall couplers	(626,405)
094	Expenditure of Provisional item for slab couplers	(155,550)
096	Alterations to starter bars in columns	5,000
098	Temporary reinforced concrete haunches at Lower Plant slab	20,981
095	Blackfill and grout sixteen dewatering wells	47,234
100	Remedial works to diaphragm wall	(56,000)
	Carried Forward	**111,803,095**

CONTRACT 427 : Cost Centre 'B' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**111,803,095**
102	Additional works at the ground floor slab	68,387
106	Pressure gauge to piezometer	1,332
120	Waterproofing of ground floor slab using 'Mulseal DP'	300,000
158	Close structural recess on top of transfer plate	17,200
162	Modification to diaphragm wall in Area 'A'	456,113
-	Adjustment of Bill B due to remeasurement	(595,167)
	FINAL COST CENTRE 'B' TOTAL	**HK$112,050,960**

CONTRACT 427 (Cont'd)

Cost Centre 'C'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**8,120,180**
002	Provision of ground treatment in Bill of Quantities	(4,460,135)
010	Soil investigation	2,160
015	Air freighting waterbar	3,391
016	Additional excavation and backfill	35,338
016	Additional blinding	46,625
018	Provision of a wellpoint system	211,680
021	Dewatering of Northern Entrance	231,680
022	Abortive reinforcement due to the change of design	2,385
024	Additional piezometer installation	41,572
081	Supply, fix and cast in conduits pipes and accessories	10,000
040	Design change at O'Brien Road Subway South Entrance	331,000
041	Breaking up existing pavement	11,584
042	Infill the cavity between diaphragm wall and subway with lean mix concrete	3,014
043	Provision of crushed fines to complete the backfill of the South Entrance	6,956
044	Form surface joint with 10mm Flexcell between subway and concourse column	528
047	Revised lighting recess and upstand beams	30,000
049	Re-alignment of utility services in O'Brien Road North	7,280
050	Fixing of mild steel dowel bars at the expansion joint at the North Entrance	1,132
	Carried Forward	**4,636,370**

CONTRACT 427 : Cost Centre 'C' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**4,636,370**
062	Additional drainage in Hennessy Road	14,986
079	Reinstatement of utility trench around North Entrance	1,299
078	Additional utilities services at the North Entrance	14,660
079	Grout after removal of sheet piles	204,475
087	Centre section of ground treatment to O'Brien Road Subway	1,851,415
088	Dewatering of O'Brien Road Subway	400,000
089	Gravity drainage connection to the concourse from subway	36,886
157	Increased sheet piling	136,250
165	Reinstatement of footpath due to development delay	96,000
-	Adjustment of Bill C due to remeasurement	(420,037)
	FINAL COST CENTRE 'C' TOTAL	**HK$6,972,304**

CONTRACT 427 (Cont'd)

Cost Centre 'D'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**21,321,845**
060	Supply doors and frames	8,234
072	Supply ironmongery	109,529
082	Additional screeding to perimeter drainage channel	241,069
089	Provide three additional roller shutters	51,316
058	Omit 18mm plaster to walls and columns of plant room	(451,000)
091	Reduce area of vitreous enamel panels and framework	(138,873)
092	Revised backing to vitreous enamel panels	(22,120)
093	Revision to door and door frame	(34,116)
101	Additional blockwork	26,900
103	Expanded metal strip to cable trench cover	20,000
104	Construction of parapet walls at Upper Platform level	3,000
105	Block walls to be 190mm thick	37,062
107	Additional height for parapet wall at Concourse Level	10,000
108	Alteration to width of 'Altro' safety tread	37,000
109	Alteration to steel lined column to blockwork wall junction detail	130,000
110	Apply 'Neutra Rust' paint to steel columns in Concourse	160,000
112	Mass concrete blocks at base of columns between escalators	45,000
113	Reinforced concrete plinth infill to escalators	54,000
114	Construct reinforced concrete pile cap at Concourse Level	9,000
115	Reinforced concrete capping beam at escalator	2,500
	Carried Forward	**21,620,346**

CONTRACT 427 : Cost Centre 'D' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**21,620,346**
116	Demolish blockwork around cable duct at Upper Plant level	2,000
117	Cable trenches in floor screed at Plant Room level	4,500
118	Triangular mass concrete panel in escalator area at Upper Plant Room level	850
119	Decoration of column tail at Concourse level	43,500
123	No.-fines screed at Lower Platform level	100,000
126	Stop bead to pyrok ceiling finishes	50,000
127	Metal reflector and egg-crate light diffuser	36,000
128	Screeding to escalator pits	10,366
129	Air freighting of critical door frames	14,202
130	Abortive work on blockwork at lift opening at concourse level	2,707
131	Hardwood batten to suspended ceiling	13,000
132	New door and frame for Emergency Fire Escape	12,863
133	Wire mesh to top part of column	7,000
134	Render strip around door frames in Plant Room areas	8,500
135	Abortive works carried out in rooms 2.27, 2.38, 2.39 and 2.40	14,000
136	Stainless steel strips to fix wire mesh to columns	10,000
137	Damp proof course in blockwork at Lower Platform level	3,000
138	Substitution of terrazzo tiles having a thinner facing layer	(100,000)
141	Painting to boxouts in pyrok in public areas	13,500
143	Revisions to ironmongery sets M2 and M4	(14,285)
	Carried Forward	**21,852,049**

CONTRACT 427 : Cost Centre 'D' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**21,852,049**
144	Steel bollards at lift doors	3,064
145	Revised requirement for office fitting out	(2,150)
146	Door to flood board storage recess	16,549
147	Revision to collapsible grille gate	(55,402)
148	Stainless steel drip tray at subway entrance bulkhead	6,699
149	Provide temporary lock cylinders to permanent door	4,823
150	Circular in-situ terrazzo skirting to columns	25,000
153	Concourse and adit bulkheads	250,000
155	Police visiting boxes	700
160	Painting ceiling conduits in public area	24,500
-	Adjustment of Bill D due to remeasurement	2,529,005
	FINAL COST CENTRE 'D' TOTAL	**HK$24,654,837**

CONTRACT 431

COST CENTRE REVISIONS

Cost Centre 'A'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**16,127,228**
002	Supply of fans to Magistracy Building	2,875
005	Realignment of control cable for salt water main	4,382
007	Diversion of 50mm water main pipe	8,653
011	Demolition of security wall	17,250
001	Installation of flushing water facility	35,526
013	Engineer's accommodation services	2,783
010	Backfill well	24,000
041	Public information signboard	7,590
043	Removal and disposal of existing wooden piles	(217,000)
075	Protection of starter bars	37,396
079	Chiller pipe bridge	382,656
076	Backfilling to escalator pit	4,191
080	Perimeter hoarding	75,000
119	Additional reinstatement	400,000
120	Delete electrical utility diversion work	(105,000)
	FINAL COST CENTRE 'A' TOTAL	**HK$16,807,530**

CONTRACT 431 (Cont'd)

Cost Centre 'B'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**130,911,401**
015	Interim re-measure of concourse wall	17,917,643
017	Delete provision of permanent dewatering equipment	(186,444)
018	Additional temporary column	201,963
019	Interim remeasurement of General Excavation	1,519,372
022	Waterproof construction joint roof slab	10,640
024	Additional Steel in roof slab	540,000
026	30/10 Concrete in lieu of 30/20 concrete	1,588
029	Increased reinforcement	2,748,800
030	30/10 Concrete in lieu of 30/20 concrete	365
032	Delete demolition of part of guide wall	(4,255)
033	Breakout openings in diaphragm wall	277,035
037	Modifications to plinths	7,500
042	Additional reinforcement in slabs	537,600
043	Construct roof slab nib	13,000
047	Extra Deep well near Entrance 'B'	14,000
048	Couplers in base slab	9,750
049	Core drilling	24,874
056	Breakout openings in slabs	28,000
065	Backfill inclinometer pit	8,750
074	Provision of sleeves in slabs	14,124
076	Backfill escalator pit	4,200
	Carried Forward	**154,599,906**

CONTRACT 431 : Cost Centre 'B' (Cont'd)

Instruction No.	Description	Valuation (HK$)
	Brought Forward	**154,599,906**
077	Changes to temporary works base slab strutting	(500,000)
079	Delete dewatering provisions	(1,500,000)
081	Waterproofing to roof	360,000
088	Grout up piezometers and stand pipes	6,437
121	Additional joints in base slab	240,000
120	Additional joints in roof slab	50,000
-	Adjustment of Bill B due to remeasurement	440,000
	FINAL COST CENTRE 'B' TOTAL	**HK$153,696,343**

Cost Centre 'C'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**3,364,418**
018	Structural Work to Entrances 'A1', 'A2' and 'B', Vent Shaft 'Z' and Fireman's Staircase	525,000
	FINAL COST CENTRE 'C' TOTAL	**HK$3,889,418**

CONTRACT 431 (Cont'd)

Cost Centre 'D'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**5,173,202**
Letter of 9 July 1984	Interim remeasurement	(2,373,202)
004	Excavate trial pits	14,500
045	Dewatering Entrance 'B'	14,000
065	Backfill to inclinometer pipes	8,750
	FINAL COST CENTRE 'D' TOTAL	**HK$2,837,250**

Cost Centre 'E'

Instruction No.	Description	Valuation (HK$)
-	**ORIGINAL TOTAL**	**15,150,937**
059	Additional work in Fan Chamber	79,000
-	Additional bulkhead quantities	250,000
078	Omit plasterwork	(132,000)
116	Pyrok masking to duct	931
-	Vent shaft louvres and doors	140,000
-	Pyrok to concrete soffit	250,000
-	Supply and delivery of ironmongery to site	105,607
-	Supply only of doors and frames	52,918
	FINAL COST CENTRE 'E' TOTAL	**HK$15,897,393**

APPENDIX 'F'

Appendix 'F' : Form 'X' Summary Sheets

This Appendix illustrates the various Form 'X's which were raised during the course of the contract:

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To increase the size of temporary columns 2-KA, 3-JA, 4-JA & 5-JA	83,000	Approved	003	71,000
002	To scabble the track slab under the rail plinths	5,000	Approved	-	NIL
003	To provide additional splice plates, shear studs, and bolts to steel columns 2-KA, 3-JA, 4-JA & 5-JA	27,000	Approved	003	21,285
004	To reduce the length of the bored piles under the Des Voeux Road	(507,000)	Approved	-	(507,000)
005	To reduce the length of the following bored piles to 27m: 1-X1, 2B, 3B, 3C, 2-X3, 2D, 3G, 3-JA, 5-JA	(393,000)	Approved	-	(393,000)
006	To provide additional reinforcement in the diaphragm wall alongside Li Po Chun Chambers	41,000	Approved	-	NIL
007	To delete column C1 and provide an additional column X3-2 between the Island Line floor slab and the soffit of the Basement floor slab	(34,000)	Approved	-	(34,000)
008	To provide a suspended Reinforced Concrete slab above the East Kowloon Line Platform	885,000	Approved	033	1,220,553
009	To change the width of the Developer's access ramp in the Marine/Cinema Site to comply with the Conditions of Grant	179,000	Approved	-	179,000
010	To change the columns from a square shape to a circular shape to suit the Triangular Site development	40,000	Approved	014	40,000
011	To amend the size of column J4 on the Triangular Site to suit the development	24,000	Approved	-	24,000
012	To increase the width of the subway under Des Voeux Road Central between Marine/Cinema and Triangular Sites	64,000	Approved	-	64,000

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
013	To raise the level of the Island Line floor slabs	(139,000)	Approved	-	(139,000)
014	To reduce the size of the cable duct and provide an additional cable duct in the Island Line floor slab	(86,000)	Approved	-	(86,000)
015	To provide a 1300 x 1300 mm down stand beam to the basement slab next to vent shaft 'Z' with a 1200 x 1000 mm column founded at Island Line level	130,000	Approved	-	130,000
016	To amend the core walls a ground floor and basement floor levels on the Triangular Site	26,000	Approved	-	26,000
017	To modify the capping beam and to change the top levels of the west diaphragm walls on the Triangular Site	75,000	Approved	-	75,000
018	To modify the capping beam and change the top levels of the south diaphragm walls on the Triangular Site	57,000	Approved	015	57,000
019	To amend the levels of the diaphragm walls	636,000	Approved	-	636,000
020	To increase the extent of the capping beam to the east diaphragm wall and to provide a facing wall for the diaphragm wall alongside Li Po Chun Chambers	2,200,000	Rejected	-	NIL
021	To provide an upstand kerb on the floor slab to form a perimeter drainage channel	200,000	Approved	-	241,265
022	To instruct site investigation work for the piling works	23,224	Approved	-	13,568
023	To provide lifting beams, lifting eyes, unistrut concrete inserts and cast-in conduits for Building Services purposes	97,650	Approved	-	171,867
024	To strengthen the structural members in the basement car park	130,000	Approved	-	130,000
025	To provide additional strutting to the diaphragm walls	101,700	Approved	006	103,343
026	To adopt a higher grade of concrete mix for the columns	(600,000)	Approved	-	(600,000)

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
027	To increase the quantities of reinforcement in basement slab	490,000	Approved	-	490,000
028	To revise the finishes to plant room walls	(208,000)	Approved	-	(208,000)
029	To include architectural builders work and finishes as part of the contract	13,737,421	Approved	Letter	13,737,421
030	To instruct the Main Contractor to accept the tender for the supply of doors and frames	733,252	Approved	Letter	733,252
031	To revise the ceiling finishes	271,940	Approved	-	271,940
032	To instruct the Main Contractor to accept the tender for the supply of vitreous enamel panelling	126,198	Approved	Letter	126,198
033	To provide additional starter bars at the ends of rail plinths at the Island Line and East Kowloon Line floor levels	2,400	Approved	-	2,400
034	To provide drainage facilities in the ground floor and basement floor slabs at the Marine/Cinema Site	63,000	Approved	-	53,200
035	To provide starter bars for the track plinths at Island Line floor level	19,600	Approved	018	19,600
036	To omit general attendance on the Architectural finishes	(10,000)	Approved	-	(10,000)
037	To provide a terminal manhole for the concourse drainage systems	40,000	Approved	-	85,374
038	To instruct the Main Contractor to accept the tender for the supply of ironmongery	149,425	Approved	Letter	149,425
039	To increase the quantities of reinforced concrete for the Vent Shaft 'X' substructure	192,000	Approved	-	301,080
040	To remeasure the reinforcement and concrete quantities in the floor slabs, walls, columns and stairs	(446,500)	Approved	-	(446,500)
041	To alter the design of the ground floor slab in the Triangular Site	5,000	Approved	-	5,000

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
042	To provide an additional duct for the Automatic Fare Collection System	3,310	Approved	-	3,310
043	To complete the drainage system for the basic concourse structure	100,000	Approved	031	303,390
044	To delete the dovetail anchor slots	(116,400)	Approved	005	(116,400)
045	To provide concrete plinths for Building Services plant	93,000	Approved	029	122,000
046	To revise the access panels	1,000	Approved	-	1,000
047	To delete the driven cast in-situ concrete piles for vent shaft 'X'	NIL	Approved	-	NIL
048	To provide air ducts above Island Line Platform Level	600,000	Approved	028	653,529
049	To provide additional temporary props to the basement slab	5,000	Approved	008	7,756
050	To provide a water tank for fire services at basement level and a sewage tank at East Kowloon Line level	130,000	Approved	032	162,500
051	To measure the doors and frames	145,266	Approved	-	34,014
052	To revise Vitreous enamel panel schedules and layouts and issue working drawings and measure quantities	4,325	Approved	-	4,325
053	To revise the Vitreous enamel panels in Concourses	(9,800)	Approved	-	(9,800)
054	To provide additional drainage facilities within Vent Shaft 'X' structure at the Triangular Site	35,000	Approved	-	35,000
055	To remeasure the suspended ceilings in public areas and over stairs and escalators	(97,500)	Approved	-	(97,500)
056	To form recesses in the diaphragm walls for connecting the walls of Vent Shafts and Air Plenums	19,280	Approved	025	35,028
057	To revise the vitreous enamel panels	17,120	Rejected	-	NIL
058	To omit the shear studs from the steel columns at Island Line floor slab level	(26,000)	Approved	-	NIL

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
059	To install drilled-in shear reinforcement in the diaphragm wall	71,000	Approved	-	64,240
060	To reduce the number of reinforcement couplers	(1,600,000)	Approved	-	(1,950,222)
061	To omit the requirement to maintain dewatering after the Island Line Platform slab is cast, and substitute a pressure relief system	(777,000)	Approved	012	(777,000)
062	To provide a lightning Earth System for the Marine/Cinema site development	17,500	Approved	-	11,608
063	To provide a Leakage Current Collection System in the Island Line track slab	18,000	Approved	023	16,900
064	To revise the reinforcement quantities	1,912,000	Approved	-	1,799,044
065	To revise the joint detail between blockwork infill panels and slab soffit and provide horizontal joint reinforcement	131,500	Approved	-	230,495
066	To supply and fix light reflectors and diffusers in staff areas	38,250	Approved	-	38,250
067	To revise the reinforcement quantities	580,000	Approved	-	580,000
068	To provide uni-struts and fix brackets to the walls alongside the Island Line tracks to support the Building Services cables	29,000	Approved	026	29,000
069	To provide hairline finish to aluminium signs	31,000	Rejected	-	NIL
070	To provide stainless steel police visiting book boxes	(1,930)	Approved	-	(1,930)
071	To revise the diaphragm wall slab recess at Island Line	35,000	Approved	-	38,707
072	To change the arrangement of staircases S4, S14 and connection to the footbridge on the Marine/Cinema Site	79,000	Approved	-	NIL
073	To revise staircase S14 configuration to suit the development proposals	17,000	Rejected	-	NIL

CONTRACT 401

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
074	To provide temporary barriers and steel staircases for the East Kowloon Line platform	177,000	Approved	-	177,000
075	To provide platform edge fascias	273,000	Approved	-	273,000
076	To provide a new Refuse Collection Point in the Rumsey Street bus terminus	470,000	Approved	035	470,000
077	To revise the design of the Excess Fare and Booking Offices	135,500	Approved	-	210,000
078	To covert office accommodation into kiosks	95,000	Approved	-	369,000
079	To provide additional cat ladders, handrails and access panels to the vent shaft and lift shaft	60,000	Approved	-	60,000
080	To revise the Rumsey Street Bus Terminus Refuse Collection Point	1,596,000	Approved	035	1,509,823
081	To revise the Rumsey Street Bus Terminus to cater for modifications to traffic arrangements in Rumsey Street	90,000	Approved	034	90,000
082	To revise the Rumsey Street Bus Station to cater for the replacement of precast concrete strips covering the existing pipe chamber at the Refuse Collection Point	7,080	Approved	034	7,080

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To authorise site investigation for piling works at Sheung Wan East Concourse	58,000	Approved	010	34,706
002	To authorise additional site investigation for piling works at Sheung Wan East Concourse	27,327	Approved	011	16,305
003	To instruct the Contractor to demolish the toilet block in works area A	15,000	Approved	001	15,000
004	To install monitoring equipment for Sheung Wan East Concourse	461,614	Approved	-	155,900
005	To approve Dayworks Orders	1,784	Approved	Various	1,784
006	To approve Dayworks Orders	11,620	Approved	Various	11,620
007	To expend the provisional items for ground treatment	7,624,205	Approved	-	6,931,500
008	To instruct the contractor to carry out three additional boreholes	30,000	Rejected	-	NIL
009	To instruct the contractor to carry out two additional boreholes	20,000	Rejected	-	NIL
010	To approve site investigation for stage 4 piling work at Sheung Wan East Concourse	35,048	Approved	-	30,756
011	To provide additional monitoring equipment at Stage 4 of Sheung Wan East Concourse	51,200	Rejected	-	NIL
012	To approve an instruction for an additional site investigation borehole and permeability tests and sampling in site investigation holes	80,600	Approved	-	80,600
013	To approve Dayworks Orders	6,058	Approved	Various	6,058
014	To approve Dayworks Orders	21,212	Approved	Various	21,212
015	To approve the works carried out for traffic diversion at Des Voeux Road Central	27,500	Approved	004	25,363
016	To instruct the contractor to carry out additional site investigation boreholes	15,000	Approved	-	15,000

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
017	To instruct the provision of additional equipment for ground treatment to diaphragm walls	63,200	Approved	-	NIL
018	To approve Dayworks Orders	12,632	Approved	Various	12,632
019	To approve Dayworks Orders	16,680	Approved	Various	16,680
020	To approve Dayworks Orders	3,842	Approved	Various	3,842
021	To provide funds for the extraction of timber piles at Sheung Wan East Concourse	575,904	Approved	Letter	605,472
022	To instruct the provision of additional equipment for ground treatment works	80,800	Rejected	-	NIL
023	To approve Dayworks Orders	1,946	Approved	Various	1,946
024	To instruct civil contractors to provide power supply arrangements which match the requirements of the Building Services contractors	79,000	Approved	-	NIL
025	To approve the reimbursement to the Main Contractor of miscellaneous costs	21,320	Rejected	-	NIL
026	To approve the reimbursement to the Main Contractor of additional costs arising from the revisions in specified levels of temporary struts	180,324	Approved	007	180,324
027	To approve Dayworks Orders	41,271	Approved	-	41,271
028	To approve the final measurement of Activity Bill B5	(2,029,397)	Approved	-	(1,890,731)
029	To approve the final measurement of Activity Bill B4	(1,033,670)	Approved	-	(583,849)
030	To approve the deletion of the supply of Ironmongery	(12,500)	Approved	-	(12,500)
031	To approve revisions to the vitreous enamel panels	(11,000)	Approved	-	(11,000)
032	To provide funds for the construction of a movement joint between slabs, columns and south diaphragm wall	170,000	Approved	027	59,115

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
033	To approve Dayworks Orders	3,619	Approved	Various	3,619
034	To authorise additional works associated with the delayed start of the Marine/Cinema development	3,316,000	Approved	023	2,297,375
035	To authorise additional works associated with the delayed development of the Triangular Site	1,087,000	Approved	024	888,206
036	To approve additional costs resulting from revisions to the specified cut-off levels of the diaphragm walls	300,000	Approved	019	349,928
037	To approve additional costs resulting from revisions to the soffit level of the basement slab	225,000	Approved	013	201,637
038	To approve the final measurement of Activity B3.1	(6,564,738)	Approved	-	(6,659,238)
039	To approve the final measurement of Activity Bill A1	6,739,348	Approved	-	6,739,348
040	To instruct the Main Contractor to upgrade capacity of hoisting gear to allow use by designated Contractors	120,000	Approved	030	100,000
041	To approve the deletion of the Provisional Items billed for the operation, maintenance and handover of the dewatering system for the concourse structure	NIL	Approved	-	NIL
042	To revise the dewatering and pressure relief requirement within the concourse structure	(400,000)	Approved	012	(400,000)
043	To approve Dayworks Orders	12,484	Approved	Various	12,484
044	To approve Dayworks Orders	54,401	Approved	Various	125,117
045	To revise diaphragm wall recesses for revised slab levels	50,000	Approved	-	13,557
046	To revise beam reinforcement at basement slab	16,749	Approved	-	16,749
047	To provide additional preloading to S3 temporary propping	11,771	Approved	017	11,771

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
048	To approve the contractors revised propping arrangements	162,000	Rejected	-	NIL
049	To approve the final measurement of Activity Bill B3.2.	165,130	Approved	-	165,130
050	To provide funds for the construction of movement joints at columns to slabs at the south diaphragm wall	90,000	Approved	009	50,995
051	To delete the billed provision for bored piling at Vent Shaft 'X'	(257,520)	Approved	020	(257,520)
052	To approve the incorporation of temporary sheet piling works at Vent Shaft 'X' into the permanent foundation works for the structure	199,429	Approved	021	199,429
053	To install temporary sheet piling at the south diaphragm wall	149,891	Approved	022	149,891
054	To modify capping beam to diaphragm walls	164,500	Approved	-	164,500
055	To approve Dayworks Orders	14,580	Approved	Various	14,580
056	To provide waterproofing to temporary columns	26,564	Approved	024	26,208
057	To provide additional fire and fresh water mains	52,000	Approved	-	30,352
058	To approve Dayworks Orders	27,702	Approved	Various	27,702
059	To approve final measurement of Activity Bill A4	115,000	Approved	-	115,000
060	To approve the blocking of building services openings and air ducts for the East Kowloon Line	72,000	Approved	-	53,616
061	To approve the covering of the ventilation openings in the East Kowloon Line platform slabs	58,000	Approved	-	38,268
062	To provide pressure relief valves	21,000	Rejected	-	NIL
063	To reinstate the footpaths and carriageway	115,000	Approved	-	224,837

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
064	To transfer all billed provision for instrumentation and monitoring to Activity Bill A5	NIL	Approved	-	NIL
065	To provide infill panels to wall openings at Escalators E11/E12	25,000	Approved	-	25,000
066	To approve miscellaneous works carried out under Activity Bill B4	61,476	Approved	-	61,476
067	To provide protective measures against leakage from the development area at the Marine/Cinema Site	60,000	Approved	023	56,197
068	To provide funds for the additional column strut interface at struts S6 & S7	10,000	Approved	-	10,000
069	To provide funds for minor works	14,800	Rejected	-	NIL
070	To obtain approval of the admeasurement of Activity Bill B3	(119,385)	Approved	-	(119,385)
071	To provide general attendance on Contract 413	10,000	Approved	-	10,000
072	To approve the admeasurement to Activity Bill B12.2	(32,269)	Approved	-	(32,269)
073	To obtain approval of the deletion of the billed provision for the preparation of rock in Activity Bill B3.1	NIL	Approved	-	NIL
074	To approve the admeasurement adjustment to Activity Bill 8.1	42,114	Approved	-	42,114
075	To approve the admeasurement adjustment to Activity Bill B9.1	37,035	Approved	-	37,035
076	To approve the admeasurement adjustment to Activity Bill B7.1	177,031	Approved	-	177,031
077	To approve Dayworks Orders	17,388	Approved	Various	17,388
078	To approve Dayworks Orders	8,230	Approved	Various	8,230
079	To raise funds for the sealing of pressure relief pipes at the Sheung Wan East Concourse Island Line Slab	160,000	Approved	031	115,000
080	To approve the admeasurement adjustment to Activity Bill A5	181,768	Approved	-	181,768

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
081	To approve the admeasurement adjustment to Activity Bill B7.2	(76,143)	Approved	Various	(76,143)
082	To approve admeasurement adjustment to Activity Bill B8.2	(39,433)	Approved	-	(39,433)
083	To approve the admeasurement adjustment to Activity Bill B8.3	8,225	Approved	-	8,225
084	To approve the admeasurement adjustment to Activity Bill B9.2	(200,375)	Approved	-	(200,375)
085	To approve the admeasurement adjustment to Activity Bill B9.3	33,442	Approved	-	33,442
086	To approve the admeasurement adjustment to Activity Bill B10.1	(103,739)	Approved	-	(103,739)
087	To approve the admeasurement adjustment to Activity Bill B10.2	173,396	Approved	-	173,396
088	To approve the admeasurement adjustment to Activity Bill B11	124,599	Approved	-	124,599
089	To approve additional works arising from changes in pile cut off levels as a result of revision to Island Line slab levels	48,634	Approved	-	48,634
090	To raise funds for miscellaneous minor works carried out by the Main Contractor	15,955	Approved	-	15,955
091	To obtain additional funds for works involved in revising the movement joint detail	30,725	Approved	-	30,725
092	To approve Dayworks Orders	73,436	Approved	Various	73,436
093	To approve Dayworks Orders	35,307	Approved	Various	35,307
094	To approve miscellaneous minor works to be carried out by the Main Contractor	44,128	Approved	-	44,128
095	To obtain funds for additional waterproofing works within the station box	89,551	Approved	-	89,551
096	To approve Dayworks Orders	68,710	Approved	Various	68,710
097	To provide special attendance on designated Contractors	360,994	Approved	-	360,994

CONTRACT 401

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
098	To delete the provisions for Engineer's Site Services	NIL	Approved	-	NIL
099	To provide monitoring equipment	800	Approved	031	800
100	To approve the admeasurement adjustment to Activity Bill B6	(111,764)	Approved	-	(111,764)

CONTRACT 401

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	Additional costs due to relocation of one pile from stage 2 to stage 1	Unknown	Approved	-	NIL
002	Extension of time due to unforeseen ground conditions	Unknown	Approved	-	NIL
003	Additional costs associated with an Extension of time due to unforeseen ground conditions	Unknown	Approved	012	7,835,965
004	Additional costs incurred due to changes to temporary columns	Unknown	Approved	-	NIL
005	Additional costs due to additional Utilities Works	Unknown	Approved	-	NIL
006	Reimbursement of loss and expense due to varied working conditions	Unknown	Approved	-	NIL
007	Extension of time due to instruction of additional ground treatment works	Unknown	Approved	-	NIL
008	Extension of time due to unforeseen physical conditions	Unknown	Approved	-	NIL
009	Reimbursement of loss and expense due to unforeseen physical conditions	Unknown	Approved	-	NIL
010	Extension of time due to re-alignment of unforeseen 100 mm gas main	Unknown	Approved	-	NIL
011	Additional costs due to unforeseen rise in piezometric pressure	Unknown	Approved	-	NIL
012	Extension of time due to unforeseen rise in piezometric pressure	Unknown	Approved	-	NIL
013	Additional costs due to revisions to the founding levels of the diaphragm walling	Unknown	Approved	017	992,896
014	Extension of time due to revisions to the founding levels of the diaphragm walling	Unknown	Approved	-	NIL
015	Additional costs due to the presence of unforeseen artificial obstructions in the foundation to the Marine Building	Unknown	Approved	-	NIL

CONTRACT 401

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
016	Extension of time due to the presence of unforeseen artificial obstructions in the foundation to the Marine Building	Unknown	Approved	-	NIL
017	Extension of time arising from the withdrawal of consent to undertake diaphragm walling works adjacent to the Li Po Chun Chambers	Unknown	Approved	-	NIL
018	Additional costs arising from the withdrawal of consent to diaphragm walling works adjacent to Li Po Chun Chambers	Unknown	Approved	-	NIL
019	Extension of time due to the collapse of Diaphragm Wall Trench Panel	Unknown	Approved	-	NIL
020	Additional costs due to the collapse of Diaphragm Wall Trench Panel	Unknown	Approved	-	NIL
021	Extension of time to the collapse of Diaphragm Wall Panel	Unknown	Approved	-	NIL
022	Additional costs due to the collapse of Diaphragm Wall Panel	Unknown	Approved	-	NIL
023	Extension of time due to additional temporary strutting to diaphragm walls	Unknown	Approved	-	NIL
024	Additional costs due to additional temporary strutting to diaphragm walls	Unknown	Approved	-	NIL
025	Extension of time due to delay in commencing work on Barrette 1C	Unknown	Approved	-	NIL
026	Additional costs due to delay in commencing work on Barrette 1C	Unknown	Approved	-	NIL
027	Extension of time arising from Typhoons "Ellen" and "Joe"	Unknown	Approved	-	NIL
028	Extension of time arising from withdrawal of consent and unforeseen physical conditions associated with excavation and strutting works	Unknown	Approved	-	NIL
029	Additional costs arising from withdrawal of consent and unforeseen physical conditions associated with excavation and strutting works	Unknown	Approved	-	NIL

<u>CONTRACT 401</u>

<u>FORM 'X' SUMMARY SHEET : CLAIMS</u>

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
030	Extension of time arising from unforeseen ground conditions and the effect on Diaphragm Walling and Bored Piling	Unknown	Approved	-	NIL
031	Additional costs due to delay arising from unforeseen ground conditions and the effect on Diaphragm Walling and Bored Piling	Unknown	Approved	024	4,367,392
032	On account payment for claims on Contract 401	9,650,000	Approved	Letter	5,995,000
033	Application for re-assessment of Extension of time awarded against Milestones B4 and B5	Unknown	Approved	-	NIL
034	Extension of time due to revisions to Ground Water Control System	Unknown	Approved	-	NIL
035	Additional costs arising from revisions to Ground Water Control System	Unknown	Approved	-	NIL
036	Extensions of Time related to Contract Completion Dates	Unknown	Approved	-	NIL
037	Reimbursement of costs for the construction of a hand dug caisson at Panel No. 47	3,903,304	Approved	047	2,245,435
038	Extension of time arising from Deepening of Slab recess at Island Line level	Unknown	Approved	-	NIL
039	Extension of time arising from the revised recess levels for slabs	Unknown	Approved	-	NIL
040	Extension of time arising from Typhoon "Hal"	Unknown	Approved	-	NIL
041	Extension of time due to the changes in architectural finishes to concrete walls and columns	Unknown	Rejected	-	NIL
042	Additional costs due to the changes in architectural finishes to concrete walls and columns	Unknown	Approved	050	1,598,992
043	Extension of time arising from the redesign of machine plinth at Grid Line 1-3/E at Island Line level	Unknown	Approved	-	NIL
044	Additional costs arising from the redesign of machine plinth at Grid Line 1-3/E at Island Line level	Unknown	Approved	-	NIL

CONTRACT 401

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
045	Extension of time due to revision of blockwork	Unknown	Approved	-	NIL
046	Additional costs due to revision of blockwork	Unknown	Approved	-	NIL
047	Extension of time due to the rejection of reinforcement	Unknown	Approved	-	NIL
048	Additional costs due to the rejection of reinforcement	Unknown	Approved	-	NIL
049	Extension of time arising from revised Fan Room design details	Unknown	Approved	-	NIL
050	Additional costs arising from revised Fan Room details	Unknown	Approved	-	NIL
051	Extension of time arising from discovery of unforeseen utilities in the Bus Terminus area	Unknown	Approved	-	NIL
052	Additional costs arising from discovery of unforeseen utilities in the Bus Terminus area	Unknown	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To adopt the alternative vertical alignment of Sheung Wan Overrun Tunnel Cost Centre 'B'	(2,675,000)	Approved	Letter	(2,675,000)
002	To adopt the 7 segment tunnel rings system as opposed to the 9 segment system	(974,780)	Approved	Letter	(974,780)
003	To relocate or reduce the size of the temporary access openings in the roof slab and mechanical level slabs of the Crossover Box	50,000	Approved	023	49,944
004	To adopt alternative bored pile foundations for the Centre Concourse	(7,000,000)	Approved	001	(7,000,000)
005	To revise the trackbed concrete in the Island Line Platform Tunnels to reduce the height of plinths to be cast under Contract 413	(136,986)	Approved	-	(136,986)
006	To include additional ground treatment beneath 46-48 New Market Street	1,539,234	Rejected	-	NIL
007	To increase the guide wall height for the Crossover Box diaphragm walls	67,000	Approval	005	146,600
008	To provide an additional 'T' panel between grid lines 4 & 5 and revisions to the 'T' panels at grid lines 12 & 13 including widening the beam between grid lines 3 & 4 for inclusion of a 1000 x 1500 mm utilities trench	50,000	Approved	-	50,000
009	To increase the size of steel columns to accommodate a flood load to level of +5.2m Port Datum	1,315,000	Approved	018	742,901
010	To provide for the additional costs of treating the ground beneath 46-48 New Market Street through which the West Bound Tunnel is to be driven	100,000	Approved	021	436,634
011	To revise tunnel invert reinforcement to comply with revised electrical requirements for the earthing of leakage and fault current	9,000	Approved	014	9,000
012	To omit shear walls	(500,000)	Approved	006	(500,000)
013	To increase both concrete and reinforcement quantities in diaphragm walls	3,500,000	Approved	Letter	3,500,000
014	To change the shape of the vent shafts from rectangular to circular	200,000	Approved	005	200,000

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
015	To omit staircase finishes and dry linings	(1,000,000)	Approved	-	(1,000,000)
016	To omit suspended ceilings in certain areas	(41,000)	Rejected	-	NIL
017	To install uni-strut concrete inserts in slabs of Centre Concourse	80,000	Approved	-	80,000
018	To omit selected finishes in plant rooms	(17,000)	Rejected	-	NIL
019	To provide a concrete upstand on which to construct internal walls at the Centre Concourse and Crossover Box	150,000	Approved	-	150,000
020	To provide additional rock stabilisation works, ground treatment and construction of internal wall in lieu of under-pinning	1,615,000	Approved	-	568,988
021	To relocate sump for use as temporary mucking out pit	NIL	Approved	-	NIL
022	To revise the lining at the end of the westbound overrun tunnel	3,500,000	Approved	-	3,500,000
023	To provide a durasteel box and frame over the staircase passageway of stair no. 1	39,000	Approved	-	39,000
024	To approve minor amendments to walls and slabs during detailing for working drawings	32,000	Approved	-	32,000
025	To approve minor amendments to signage	16,000	Rejected	-	NIL
026	To construct a permanent vent shaft and fan chamber at the end of the westbound overrun tunnel	10,050,000	Approved	009 & 010	10,050,000
027	To approve minor amendments to signage	9,000	Rejected	-	NIL
028	To provide long bolts in circle joints of 600mm long steel rings for building services brackets and overhead line equipment	12,000	Approved	-	12,000
029	To provide starter bars for points and crossing slab and rail plinths at Crossover Box	36,000	Approved	-	36,000
030	To alter the layout in the plant rooms to suit revised plant dimensions	162,000	Rejected	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
031	To amend the ground treatment at 229-231 Wing Lok Street on the line of the westbound overrun tunnel	340,000	Approved	020	227,748
032	To caulk the station tunnel linings	2,750,000	Rejected	-	NIL
033	To change the grade of concrete from 30/20 to 45/21 in columns	(165,600)	Approved	-	(165,600)
034	To make provision for building services in the Centre Concourse South development	25,000	Approved	-	25,000
035	To caulk the station tunnel linings	1,450,000	Approved	-	1,267,092
036	To provide precast concrete covers to seal the building services openings at the Upper and Lower Mechanical Slabs	50,000	Approved	-	50,000
037	To delete the in-situ concrete extension beneath the diaphragm walls	(1,803,191)	Approved	-	(1,803,191)
038	To reduce the overall area of vitreous enamel panelling in station platforms and adits	(187,000)	Approved	041	(187,000)
039	To caulk running tunnel linings	4,120,000	Rejected	-	NIL
040	To provide additional signage	86,000	Rejected	-	NIL
041	To revise cat ladders and access panels	57,000	Rejected	-	NIL
042	To incorporate architectural builders work and finishes	13,001,102	Approved	Letter	13,001,102
043	To provide concrete air ducts at slab soffits within the Centre Concourse	280,000	Approved	-	280,000
044	To modify the proposed wall finishes	36,000	Rejected	-	NIL
045	To provide temporary slab infills and strutting at Centre Concourse	866,000	Approved	-	189,000
046	To instruct the Main Contractor to accept the tender for the supply of doors and frames	460,062	Approved	Letter	460,062
047	To revise the ceiling finishes	262,692	Approved	-	262,292
048	To instruct the Main Contractor to accept the tender for the supply of vitreous enamel panelling	556,384	Approved	041	556,384

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
049	To install unistruts above track at platforms to allow future installation of acoustic panels if required	52,520	Approved	-	52,520
050	To install additional cat ladder	7,600	Rejected	-	NIL
051	To provide additional starter bars at the ends of rail plinths and turnout slabs	8,250	Approved	-	8,250
052	To replace the dividing wall between staircase S5 and escalator DE1 with a parapet	(19,800)	Approved	-	(19,800)
053	To omit General Attendance on the Architectural Work and Finishes	(45,000)	Approved	-	(45,000)
054	To revise the earthing mat design at the Sheung Wan Crossover	65,000	Approved	-	87,344
055	To provide cast-in fixings for Building Services equipment	80,000	Approved	-	80,000
056	To provide drainage in the Centre Concourse in excess of the BQ provision	270,000	Approved	-	270,000
057	To provide drainage in the Crossover Box in excess of the BQ provision	202,000	Approved	-	144,713
058	To instruct the contractor to accept the tender for the supply of ironmongery	90,084	Approved	Letter	90,084
059	To provide concrete plinths for Building Services plant	30,000	Approved	-	30,000
060	To delete the Shield access opening in the roof, upper and lower mechanical floor slabs	(170,800)	Approved	-	(170,800)
061	To omit the scabbling of the surface of the concrete invert beneath the track plinth from the main contract	(56,370)	Approved	-	(56,370)
062	To provide additional downstand beams around Escalator EE1	45,000	Approved	-	45,000
063	To provide an additional duct for the Automatic Fare Collection system	3,128	Approved	-	3,128
064	To provide acoustic treatment to the platform areas	510,000	Approved	-	510,000

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
065	To delete the dovetail anchor slots in the vertical joints between the reinforced concrete and blockwork walls	(536,270)	Approved	-	(536,270)
066	To replace the reinforced concrete partition wall with a blockwork wall	82,000	Approved	-	82,000
067	To increase the quantity of reinforcement in slabs in order to carry temporary concrete struts	NIL	Approved	-	NIL
068	To revise the cat ladders and access panels	26,000	Approved	-	26,000
069	To provide fire water tank, fresh water tank and sewage tank	150,000	Approved	-	150,000
070	To undertake a remeasurement of doors and frames	107,547	Approved	-	(8,015)
071	To issue revised working drawings and adjust the bill of quantities	(50,308)	Approved	-	(50,308)
072	To provide Platform Edge Barriers	420,000	Rejected	-	NIL
073	To erect internal warning signs	10,000	Approved	-	10,000
074	To revise the vitreous enamel panel backing sheets	(41,230)	Approved	041	(41,230)
075	To approve additional ironmongery	72,788	Approved	-	72,788
076	To instruct the remeasurement of doors and door frames	105,863	Approved	-	105,863
077	To instruct the remeasurement of suspended ceilings in public areas and over stairs and escalators	227,000	Approved	-	227,000
078	To cut recesses in I beam stop ends at connection between Slabs and Diaphragm Walls	32,000	Approved	-	23,940
079	To provide Platform Edge Barriers	120,000	Approved	-	120,000
080	To construct temporary in-situ cover slabs to escalator pits	670,000	Approved	-	670,000
081	To fix angles and brackets for advertising panels	47,181	Approved	-	47,181

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
082	To revise the bill of quantities for station names and supergraphics	(18,197)	Approved	-	(18,197)
083	To revise the platform edge fascia	(45,923)	Approved	-	(45,923)
084	To provide precast concrete cable troughs for the protection of electrical cables	16,000	Approved	-	16,000
085	To form recesses in the diaphragm walls to provide horizontal restraint to the reinforced concrete walls of vent shafts, plenums and stairs	22,400	Approved	-	22,400
086	To revise the top level of diaphragm wall W4	25,000	Approved	-	25,000
087	To install light reflectors and diffusers in staff areas	40,500	Approved	-	40,500
088	To provide surface mounted covers to platform emergency plungers	5,000	Approved	-	5,000
089	To revise the bill of quantities for reinforcement and couplers	2,486,535	Approved	-	2,332,555
090	To revise blockwork infill panel details to reinforced concrete structural walls and overhead air ducts	120,000	Approved	-	120,000
091	To provide holding-down bolts for future steel-framed building	15,000	Approved	-	15,000
092	To revise architectural finishes	26,000	Rejected	-	NIL
093	To provide negatives for supergraphics	5,000	Approved	-	5,000
094	To revise reinforcement and coupler quantities	(900,000)	Approved	-	NIL
095	To provide stainless steel police visiting book boxes	(4,800)	Approved	-	(4,800)
096	To install cat ladders to signalling equipment room roofs	3,000	Approved	-	3,000
097	To amend the width of stair SA5	15,000	Approved	-	15,000
098	To revise architectural finishes	18,000	Rejected	-	NIL
099	To revise the bored pile cut-off level	100,000	Approved	-	108,500

CONTRACT 402

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
100	To instruct the delivery of building services plant	60,000	Approved	-	18,469
101	To provide a two hour rated roller shutter	25,000	Approved	-	25,000
102	To revise the station signage	8,200	Rejected	-	NIL
103	To take groundwater samples at regular intervals throughout the length of the tunnels where precast segments have been used and to take concrete cores for analysis	23,895	Approved	-	23,895
104	To provide architectural finishes required for the early installation of Escalators E8 & E9	1,300,000	Approved	-	1,300,000
105	To omit the finishes specified for the chiller plant rooms.	(130,000)	Approved	-	(130,000)
106	To provide a cat ladder to the expansion tank on the roof of the chiller room at podium level	20,000	Approved	-	20,000
107	To provide additional notice boards	16,000	Rejected	-	NIL
108	To provide additional advertising panels	198,000	Rejected	-	NIL
109	To repaint the Macau Ferry Subway ceiling soffit	32,000	Approved	-	12,000

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To expend the Provisional Sums for constructing and maintaining barge loading facilities	4,364,000	Approved	Letter	4,462,000
002	To provide monitoring equipment	464,860	Approved	Letter	243,110
003	To provide additional monitoring equipment	979,850	Approved	Letter	304,730
004	To carry out site investigation at the Centre Concourse and Crossover Box	294,611	Approved	-	NIL
005	To carry out electrical installation connections to the site office	29,030	Approved	006	19,300
006	To approve the diversion of a 100mm diameter gas pipe	19,000	Approved	038	19,000
007	To approve the removal of existing obstructions near the existing granite arch at the southern entrance of Western Market	21,000	Approved	001	21,000
008	To realign two 11KV cables	11,500	Approved	002	11,500
009	To approve the provision of a concrete footpath in Tung Loi Lane	44,450	Approved	005	39,950
010	To approve the provision of an additional salt water pipe	6,250	Approved	004	3,363
011	To approve the relocation of a fire hydrant	5,400	Approved	003	3,274
012	To approve Dayworks Orders	4,777	Approved	Various	4,777
013	To cancel Construction Form 'X' 004 and to instruct the Contractor to carry out additional site investigation	536,534	Approved	036	536,534
014	To expend the Provisional items for ground treatment works	2,664,038	Approved	035,037,039	3,050,038
015	To carry out site investigation for bored pile construction	378,141	Approved	Letter	378,141
016	To instruct the contractor to carry out utility division works	879	Approved	-	879
017	To authorise the change from large diameter bored piles to barrettes	2,400,000	Approved	010	5,148,529

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
018	To divert a large diameter sewer pipe at the junction of Hillier Street and Des Voeux Road Central	70,000	Approved	012	25,000
019	To divert two electrical cables	63,000	Approved	029	49,000
020	To divert a large diameter sewer pipe in Hillier Street	150,000	Approved	030	45,000
021	To provide a temporary flush water supply system to 30-32 New Market Street	26,985	Approved	007	26,985
022	To authorise additional site investigation below the toe of the diaphragm wall	175,000	Approved	036	258,270
023	To authorise the purchase of monitoring equipment	99,600	Approved	Letter	99,600
024	To investigate rock foundation level for the development foundations	155,000	Approved	036	155,000
025	To obtain approval to construct a car parking area adjacent to the Marine Department car park	53,960	Approved	008	53,960
026	To instruct the contractor to carry out temporary diversion of a sewer pipe	12,630	Approved	013	10,500
027	To approve Dayworks Orders	10,527	Approved	Various	10,527
028	To authorise sonic testing to be carried out on bored piles	234,000	Approved	019	212,864
029	To approve the installation of I beams in diaphragm walling	18,000,000	Rejected	-	NIL
030	To carry out site investigation to verify the existence of sound rock 6m below crossover box bored pile foundations	87,000	Approved	036	87,000
031	To purchase additional monitoring equipment	37,000	Rejected	-	NIL
032	To instruct the installation and maintenance of a recharge well system	724,000	Approved	025 & 026	824,482
033	To approve the installation of I beams in diaphragm walling	20,751,670	Approved	008	20,751,670

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
034	To break out a section of tunnel lining	13,500	Rejected	-	NIL
035	To provide temporary station signage	6,300	Rejected	-	NIL
036	To authorise the provision of a permanent flush water supply system to 30-32 New Market Street	23,000	Approved	024	23,000
037	To approve additional ground treatment in the area of the tunnel shield	1,063,000	Approved	022	872,569
038	To approve Dayworks Orders	24,081	Approved	Various	24,081
039	To instruct the contractor to undertake the temporary diversion of a water pipe	44,000	Approved	015, 017	44,000
040	To instruct the contractor to undertake the temporary diversion of a fresh water main	56,800	Approved	034	56,800
041	To approve Dayworks Orders	51,281	Approved	Various	51,281
042	To provide additional site services	6,200	Rejected	-	NIL
043	To break out portion of tunnel lining	39,750	Rejected	-	NIL
044	To instruct the Contractor to undertake additional site investigation works	41,000	Approved	036	26,555
045	To instruct installation of monitoring devices	40,000	Approved	-	NIL
046	To instruct the Contractor to undertake additional ground treatment work	270,000	Approved	Letter	67,953
047	To instruct the contractor to provide a power supply to meet the requirements of the Building Services Sub-contractors	100,000	Approved	Letter	NIL
048	To provide temporary direction signs	62,000	Rejected	-	NIL
049	To provide a protective coating to the precast concrete tunnel linings	103,334	Approved	027	103,334
050	To approve the construction of tunnel segments in compressed air	1,390,760	Approved	Letter	3,430,007
051	To carry out consolidation grouting from the platform tunnels within the Concourse structure	950,000	Approved	009	709,731

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
052	To approve coring through three pile shafts	22,200	Approved	027	33,814
053	To authorise the final measurement of the site investigation works	82,999	Approved	-	82,999
054	To delete the provisional items for core proving in the diaphragm walls	(242,380)	Approved	-	(242,380)
055	To authorise the final measurement of ground treatments associated with the diaphragm walls	162,830	Approved	-	162,830
056	To approve Dayworks Orders	16,398	Approved	Various	16,398
057	To delete the provisional items for coring internal diaphragm walls	NIL	Approved	-	NIL
058	To approve the admeasurement of diaphragm walls at the Centre Concourse	(5,433,929)	Approved	Letter	(3,343,893)
059	To approve the admeasurement of diaphragm walls at the Crossover Box	(3,297,245)	Approved	Letter	(3,297,245)
060	To approve the deletion of all "extra over" items in the Bill of Quantities for ground treatment from the tunnel face	(15,433,000)	Approved	Letter	(15,433,000)
061	To delete the lump sum items for ground treatment works	1,600,000	Approved	032	(1,043,324)
062	To authorise rock excavation	1,929,949	Approved	028,034,036	1,929,949
063	To delete the provisional item for the gas main temporary diversion	NIL	Approved	-	NIL
064	To approve the sealing of all piezometers	57,546	Approved	-	57,546
065	To approve additional consolidation in the ground treatment	36,178	Approved	009	36,178
066	To approve additional Ironmongery	19,900	Approved	-	19,900
067	To approve the purchase of monitoring equipment	89,500	Rejected	-	NIL
068	To approve the construction of built-in temporary support at adit openings	344,984	Approved	-	280,391
069	To instruct the upgrading of the hoisting equipment for use by Sub-Contractors	86,500	Approved	Letter	86,500

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
070	To carry out site investigation works for the proposed subway connection between the Macau Ferry Terminal and the Centre Concourse	200,000	Approved	Letter	148,553
071	To provide bored piles for the commercial development	1,800,000	Approved	-	4,268,832
072	To authorise the coring of bored piles	96,120	Approved	-	40,990
073	To authorise the construction of a canopy for Entrance 'D1'	235,000	Approved	Letter	235,000
074	To authorise the construction of a canopy for Entrance 'D2' together with the first floor slab of the development at 255-257 Des Voeux Road Central	470,000	Approved	Letter	470,000
075	To approve the preparation of rock surfaces	1,182,200	Approved	-	1,182,200
076	To approve a revision in the excavation quantities for the overrun tunnel due to an under-measurement in the Bill of Quantities	645,900	Approved	-	645,900
077	To approve the admeasurement of earth work at the Centre Concourse excluding filling and compaction and provisional items	(1,791,001)	Approved	-	(1,791,001)
078	To approve the chasing of walls for conduit	66,000	Rejected	-	NIL
079	To delete the Provisional Items for the maintenance, operation, overhaul and hand-over of the dewatering system	NIL	Approved	-	NIL
080	To delete the lump sum items for dewatering the Crossover Box and Centre Concourse	(1,879,000)	Approved	-	(1,879,000)
081	To delete the Provisional Sums for monitoring equipment and tunnel instrumentation	NIL	Approved	-	NIL
082	To approve the chasing of walls for conduit	11,000	Rejected	-	NIL
083	To delete the Provisional Sums for breaking through the diaphragm wall end walls	NIL	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
084	To approve Dayworks Orders	12,362	Approved	Various	12,362
085	To authorise the inclusion of Architectural and Builders Work items within vent shafts 'V' and 'W'	127,000	Approved	-	127,000
086	To approve the admeasurement of structural supports to 30-33 New Market Street	(21,566)	Approved	-	(21,566)
087	To revise propping designs	18,000	Rejected	-	NIL
088	To approve altered requirements for water-proofing of slabs	173,000	Approved	011	148,318
089	To cut back all redundant starter bars originally designed for railway plinths and screed the surface to drainage falls	22,300	Approved	-	22,300
090	To approve the construction of the Macau Ferry Subway	15,050,000	Approved	Letter	15,050,000
091	To provide monies for water mains and connections between the existing water mains and the Centre Concourse	20,000	Approved	-	19,688
092	To approve the reinstatement of Tung Loi Lane	30,000	Approved	-	50,965
093	To approve the admeasurement of Activity Bill C11 Part 11.3 Earthing Mat	8,043	Approved	-	8,043
094	To approve the admeasurement of Activity Bill C3 - Earthworks	(959,813)	Approved	-	(959,813)
095	To delete the provisional items for trimming the diaphragm wall to allow for construction of the tunnel	NIL	Approved	-	NIL
096	To approve the admeasurement of Activity Bill C10, Part 10.1 - Completion of slab access holes	(909,551)	Approved	-	(909,551)
097	To delete the provisional sums for soil bearing capacity tests	NIL	Approved	-	NIL
098	To approve the costs relating to the diaphragm walling for Centre Concourse	1,482,536	Approved	-	1,482,536
099	To approve the admeasurement of Activity Bill A4.1 - Works Areas	309,758	Approved	-	309,758

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
100	To approve the admeasurement of Activity Bill E3 - Earthworks to Concourse Box Excluding Diaphragm Walls	(377,520)	Approved	-	(377,520)
101	To expend provisional sum for bored piles	1,257,594	Approved	-	1,257,594
102	To approve the admeasurement of Activity Bill E5 - Bored Piles	NIL	Approved	-	NIL
103	To approve the admeasurement of Activity Bill B1.1 - Specialised Plant	(196,200)	Approved	-	(196,200)
104	To revise the wall finish in plant rooms	16,000	Rejected	-	NIL
105	To approve the admeasurement of Activity Bill B1.3 - Ground Treatment	(921,000)	Approved	-	(921,000)
106	To approve the reconstruction of Des Voeux Road Central	817,250	Approved	-	817,250
107	To approve the admeasurement of Activity Bill D1.1 - Specialised Plant	(223,180)	Approved	-	(223,180)
108	To approve the admeasurement of Activity Bill C6 - Roof/Basement Slab	(640,261)	Approved	-	(640,261)
109	To approve the admeasurement of Activity Bill C7 - Upper Mechanical Slab	523,188	Approved	-	523,188
110	To approve the admeasurement of Activity Bill C8 - Lower Mechanical Slab	840,922	Approved	-	840,922
111	To approve the admeasurement of Activity Bill E7.1 - Basement Slab	31,733	Approved	-	31,733
112	To approve the admeasurement of Activity Bill E8.1 - Concourse Slab	102,887	Approved	-	102,887
113	To approve the admeasurement of Activity Bill E9.1 - Interchange Slab	(254,394)	Approved	-	(254,394)
114	To approve the admeasurement of Activity Bill E10.2 Mechanical Slab	(24,915)	Approved	-	(24,915)
115	To approve the admeasurement of Activity Bill D4.1 - Eastbound Station Passenger Adits	18,929	Approved	-	18,929
116	To approve the admeasurement of Activity Bill D4.2 - Westbound Station Passenger Adits	(274,814)	Approved	-	(274,814)

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
117	To approve the admeasurement of Activity Bill D5.1 - Ventilation Connection and Fireman's Access Adit	(47,790)	Approved	-	(47,790)
118	To approve the admeasurement of Activity Bill D5.2 - Ventilation Connection and Fireman's Access Adit	35,282	Approved	-	35,282
119	To approve the supply of galvanised iron tunnel segments	252,630	Approved	Letter	252,630
120	To approve the admeasurement of Activity Bill C9 - Track Slab	331,020	Approved	-	331,020
121	To expend the Provisional Items for site investigation, excavation and toe chiselling	1,179,104	Approved	-	1,179,104
122	To chase walls for conduit	82,000	Rejected	-	NIL
123	To approve the diversion of a water main	131,147	Approved	016 & 031	131,147
124	To approve the admeasurement of Activity Bill C2 - Monitoring	336,165	Approved	-	336,165
125	To chase walls for conduit	16,000	Rejected	-	NIL
126	To approve the admeasurement of Activity Bill E2 - Monitoring	341,865	Approved	-	341,865
127	To expend the Provisional Items for rock stabilisation	19,056	Approved	-	19,056
128	To approve the admeasurement of Activity Bill C5 - Piling for Crossover Box and Development Foundations	(1,220,475)	Approved	-	(1,220,475)
129	To approve the admeasurement of Activity Bill E11.2 - Waterproofing	(17,474)	Approved	-	(17,474)
130	To approve the admeasurement of Activity Bill 11.1 - Platform Slab and Sumps	(89,748)	Approved	-	(89,748)
131	To approve the admeasurement adjustment to Activity Bill E12 Part 12.2 - Waterproofing	(161,534)	Approved	-	(161,534)
132	To approve Dayworks Orders	36,778	Approved	Various	36,778

CONTRACT 402

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
133	To approve the admeasurement of Activity Bill C10.3 - Filling to Roof Slab	(63,956)	Approved	-	(63,956)
134	To provide additional funds for providing and fixing a cover to the roller shutter motor	6,120	Approved	-	6,120
135	To approve and provide funds for the supply and installation of concrete temperature devices	10,408	Approved	Letter	10,408
136	To approve funds for the construction of the above Ground Structure at the South Box of the Centre Concourse	169,987	Approved	Letter	169,987
137	To approve the admeasurement adjustment of Activity Bill D6 Part 6.4 - Westbound Tunnel	(496,248)	Approved	-	(496,248)
138	To approve the admeasurement adjustment of Activity Bill D6 Part 6.2 - Eastbound Tunnel	(454,899)	Approved	-	(454,899)
139	To modify the edge of the loading platform at track slab level	8,778	Approved	-	8,778
140	To modify plant room finishes	4,120	Rejected	-	NIL
141	To approve the admeasurement adjustment of Activity Bill C10, Part 10.2 Vent Shafts, Walls and Stairs	(1,153,947)	Approved	-	(1,153,947)

CONTRACT 402

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	Extension of time due to delayed commencement of work at crossover.	Unknown	Approved	-	NIL
002	Additional costs due to delayed commencement of work at crossover	Unknown	Approved	-	NIL
003	Extension of time due to delayed commencement of work at centre concourse	Unknown	Approved	-	NIL
004	Additional costs due to delayed commencement of work at centre concourse	Unknown	Approved	-	NIL
005	Extension of time due to delay in issue of working drawings for the crossover and tunnel	Unknown	Approved	-	NIL
006	Additional costs due to delay in issue of working drawings for the crossover and tunnel	Unknown	Approved	-	NIL
007	Extension of time due to delay in issue of working drawings for the centre concourse	Unknown	Approved	-	NIL
008	Additional costs due to delay in issue of working drawings for the centre concourse	Unknown	Approved	074	128,634
009	Additional costs due to the realignment of storm water drains in Works Area 'A'	Unknown	Approved	-	NIL
010	Extension of time due to the need to provide temporary works for the concourse and crossover box	Unknown	Approved	-	NIL
011	Additional costs due to the need to design temporary works for the concourse and crossover box	Unknown	Approved	-	NIL
012	Extension of time due to unforeseen artificial obstructions in the excavation	Unknown	Approved	-	NIL
013	Additional costs due to unforeseen artificial obstructions in the excavation	Unknown	Approved	003	914,071
014	Extension of time due to an unscheduled length of water pipe beyond valve W41	Unknown	Approved	-	NIL
015	Additional costs due to an unscheduled length of water pipe beyond valve W41	Unknown	Approved	-	NIL
016	Additional costs due to presence of demolition Contractor in Area 'D'	Unknown	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
017	Extension of time due to ground treatment in Area 3	Unknown	Approved	-	NIL
018	Additional costs due to ground treatment in Area 3	Unknown	Approved	075	1,577,411
019	Extension of time due to ground treatment in Area 2	Unknown	Approved	-	NIL
020	Additional costs due to ground treatment in Area 2	Unknown	Approved	-	NIL
021	Extension of time due to the presence of unscheduled utilities	Unknown	Approved	-	NIL
022	Reimbursement of loss and expense due to the unscheduled utilities	Unknown	Approved	-	NIL
023	Extension of time due to the presence of an unscheduled 250mm gas main	Unknown	Approved	-	NIL
024	Additional costs due to the presence of an unscheduled 250mm gas main	Unknown	Approved	-	NIL
025	Extension of time due to the existence of an unscheduled sewer pipe in Des Voeux Road	Unknown	Approved	-	NIL
026	Additional costs due to the existence of an unscheduled sewer pipe in Des Voeux Road	Unknown	Approved	-	NIL
027	Extension of time due to the existence of unscheduled electric cables in the footpath	Unknown	Approved	-	NIL
028	Additional costs due to the existence of unscheduled electric cables in the footpath	Unknown	Approved	-	NIL
029	Extension of time due to the presence of artificial obstructions	Unknown	Approved	-	NIL
030	Additional costs due to the presence of artificial obstructions	Unknown	Approved	076	1,950,344
031	Extension of time due to the loss of bentonite	Unknown	Approved	-	NIL
032	Additional costs due to the loss of bentonite	Unknown	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
033	Extension of time due to existence of four way telephone cable	Unknown	Approved	-	NIL
034	Additional costs due to existence of four way telephone cable	Unknown	Approved	-	NIL
035	Additional costs due to site investigation below toe of diaphragm wall	Unknown	Approved	041	61,035
036	Extension of time due to diversion of unforeseen drainage pipe in Des Voeux Road	Unknown	Approved	-	NIL
037	Extension of time due to late possession of works areas	Unknown	Approved	-	NIL
038	Additional costs due to late possession of works areas	Unknown	Approved	015	63,812
039	Extension of time due to the presence of an old sea wall encountered during diaphragm wall excavation	Unknown	Approved	-	NIL
040	Additional costs due to the presence of an old sea wall encountered during diaphragm wall excavation	Unknown	Approved	-	NIL
041	Additional costs due to ground treatment at Area 4	Unknown	Approved	061	2,081,050
042	Additional costs due to the inflow of water into utilities trench	Unknown	Approved	-	NIL
043	Extension of time due to delayed consent to excavate	Unknown	Approved	-	NIL
044	Extension of time due to delayed consent to excavate	Unknown	Approved	-	NIL
045	Extension of time due to diaphragm wall chiselling	Unknown	Approved	-	NIL
046	Extension of time due to additional toe chiselling requirements	Unknown	Approved	-	NIL
047	Extension of time due to settlement at Western Market	Unknown	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
048	Additional costs due to settlement at Western Market	Unknown	Approved	-	NIL
049	Extension of time due to delayed consent for excavation below roof slab	Unknown	Approved	-	NIL
050	Additional costs due to delayed consent for excavation below roof slab	Unknown	Approved	-	NIL
051	Extension of time due to delay in Engineer granting consent to alternative proposed method	Unknown	Approved	-	NIL
052	Additional costs due to delay in Engineer granting consent to alternative method	Unknown	Approved	-	NIL
053	Extension of time due to need for temporary strutting at slab openings	Unknown	Approved	-	NIL
054	Additional costs due to re-grouting in Area 5	Unknown	Approved	-	NIL
055	Additional costs for bored "cast in place" concrete piles	Unknown	Approved	-	NIL
056	Extension of time due to the high rock profile	Unknown	Approved	-	NIL
057	Additional costs due to the high rock profile	Unknown	Approved	-	NIL
058	Extension of time due to the presence of unforeseen physical obstructions	Unknown	Approved	-	NIL
059	Additional costs due to presence of unforeseen physical obstructions	Unknown	Approved	-	NIL
060	Extension of time arising from Typhoons "Ellen" and "Joe"	Unknown	Approved	-	NIL
061	Additional costs due to unforeseen H-piles at Ground Treatment Area 2	335,095	Approved	068	191,093
062	Additional costs for the treatment of voids below the centre pile cap in Area 4	Unknown	Approved	-	NIL
063	Additional costs due to delay arising from additional site investigation	61,035	Approved	-	NIL
064	Extension of time due to rescheduling of the specified sequence of construction for the overrun tunnel	Unknown	Approved	-	NIL

CONTRACT 402

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
065	Additional costs due to rescheduling of the specified sequence of construction for the overrun tunnel	Unknown	Approved	-	NIL
066	Extension of time due to Engineer's failure to issue consent	Unknown	Approved	-	NIL
067	Additional costs due to the Engineer's failure to issue consent	Unknown	Approved	-	NIL
068	Extension of time due to the issue of a suspension of works order for the overrun tunnel	Unknown	Approved	-	NIL
069	Additional costs due to the issue of a Suspension of Works Order for the overrun tunnel	Unknown	Approved	-	NIL
070	Extension of time due to the Engineer's refusal to give consent to the Contractor's proposed method of work for the Station Tunnel Shield Chamber Construction	Unknown	Approved	-	NIL
071	Additional costs due to the Engineer's refusal to give consent to the Contractor's proposed method of work for the Station Tunnel Shield Chamber Construction	Unknown	Approved	-	NIL
072	Extension of time arising from unforeseen ground condition	Unknown	Approved	-	NIL
073	Additional costs arising from unforeseen ground conditions	Unknown	Approved	-	NIL
074	Extension of time arising from Typhoon "Hal"	Unknown	Approved	-	NIL
075	Extension of time arising from other un-named Typhoons during the year	Unknown	Approved	-	NIL

CONTRACT 406

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To replace piled foundations by spread footings and incorporate additional Building Services elements	(200,000)	Approved	002,003	(200,000)
002	To increase the thickness of tunnel lining at Fortress Hill Station to support development foundation loads	12,200,000	Approved	006	12,200,000
003	To re-align Fortress Hill Station Westbound tunnel to avoid an interaction with the Fortress Hill Concourse Escalator Box	619,000	Approved	004	619,000
004	To modify the station tunnels	3,684,000	Approved	004	3,684,028
005	To increase various slab thicknesses	80,000	Rejected	-	NIL
006	To approve North Point boreholes	31,160	Approved	005	31,160
007	To revise the adit layout	316,000	Rejected	-	NIL
008	To revise the earth leakage system	8,600	Approved	010	8,600
009	To revise the concourse layout	612,000	Rejected	-	NIL
010	To revise the plantroom layout	70,000	Rejected	-	NIL
011	To revise the escalator configuration	46,000	Rejected	-	NIL
012	To approve the provision of a utility trench	86,317	Approved	016	86,317
013	To reduce the overall area of vitreous enamel panelling in station platforms and adits	(111,000)	Approved	-	(111,000)
014	To approve the incorporation of architectural builders work and finishes into the contract	7,754,366	Approved	Letter	7,754,366
015	To revise the concourse layout to accommodate a changed development superstructure proposal	3,300,000	Approved	Letter	3,300,000
016	To revise finishes to plant room walls	(93,000)	Approved	-	(93,000)
017	To revise the ceiling finishes	46,000	Rejected	-	NIL
018	To revise the ceiling finishes	640,000	Approved	Letter	640,000
019	To instruct the contractor to accept the tender for the supply of vitreous enamel panelling	47,257	Approved	Letter	47,257

CONTRACT 406

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
020	To provide additional rock bolts	62,000	Approved	-	62,000
021	To revise North Point vent system	(250,000)	Approved	008	(250,000)
022	To revise floor finishes	70,000	Approved	-	70,000
023	To revise the platform edge fascia	(28,000)	Approved	-	(28,000)
024	To omit general attendance on the architectural finishes works	(150,000)	Approved	-	(150,000)
025	To revise ceiling finishes	170,000	Rejected	-	NIL
026	To revise cast in conduit	11,800	Approved	017	11,800
027	To increase the quantity of steel reinforcement in the concourse structure	2,376,052	Approved	-	2,376,052
028	To revise AFC trunking routes	46,000	Rejected	-	NIL
029	To revise the drainage installation	43,000	Rejected	-	NIL
030	To revise the supply of ironmongery	92,309	Approved	Letter	92,309
031	To approve the construction of service manholes and making connections to existing services	155,470	Approved	016	155,470
032	To revising the concourse drainage system	166,500	Approved	-	166,500
033	To revise the layout of the line-sump and drainage cross-section	(67,000)	Approved	-	(67,000)
034	To change drawings from tender to working level	(227,000)	Approved	-	(227,000)
035	To delete lightning conductor provision	(46,528)	Approved	-	(46,528)
036	To revise the number of rock bolts and rock anchors	(969,530)	Approved	-	(969,530)
037	To delete the Provisional Items for rock bolts and rock anchors	(1,402,930)	Approved	Letter	(1,402,930)
038	To provide cable troughs	171,000	Rejected	-	NIL
039	To increase the size of the escalator adit	334,000	Approved	-	334,000

CONTRACT 406

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
040	To approve the modification of the Automatic Fare Collection ducting	1,210	Approved	-	1,210
041	To increase the thickness of structural slabs	107,000	Approved	-	107,000
042	To increase various column sizes	414,000	Approved	Letter	414,000
043	To approve the inclusion of acoustic treatment to station platform areas	510,000	Approved	Letter	510,000
044	To approve an increase quantity of steel reinforcement	236,381	Approved	Letter	236,381
045	To approve increased steel reinforcement in entrances	378,400	Approved	Letter	378,400
046	To approve a core-wall height reduction	(460,500)	Approved	Letter	(460,500)
047	To approve the remeasurement of doors and frames	(5,019)	Approved	-	(5,019)
048	To approve the issue of revised vitreous enamel panel	398	Approved	-	398
049	To revise station signage	8,600	Rejected	-	NIL
050	To approve the supply of ironmongery	2,710	Approved	-	2,710
051	To revise the vitreous enamel panel design	(3,290)	Approved	-	(3,290)
052	To revise the design of Entrance 'B'	15,000	Approved	-	15,000
053	To approve the remeasurement of doors and frames	41,694	Approved	-	41,694
054	To approve the installation of water bar at concourse/development interface	24,000	Approved	-	24,000
055	To approve the remeasurement of suspended ceilings in public areas and over stairs and escalators	(473,000)	Approved	-	(473,000)
056	To provide a steelwork frame for dampers in fan chamber	96,000	Approved	-	96,000
057	To provide cable troughs	113,000	Approved	-	113,000

CONTRACT 406

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
058	To undertake protection works required by delayed development activities	550,000	Approved	-	550,000
059	To approve the construction of temporary vent towers due to delayed development activities	100,000	Approved	-	100,000
060	To revise the angle and bracket design for the advertising panels	59,106	Approved	021	59,106
061	To revise the design of the North Point West Fan chamber	1,167,500	Approved	-	1,167,500
062	To revise wall finishes	82,000	Rejected	-	NIL
063	To construct support frames for temporary chillers	180,000	Approved	-	180,000
064	To approve the revised quantities of station names and supergraphics	(23,400)	Approved	-	(23,400)
065	To revise the platform edge fascia	(209,944)	Approved	Letter	(209,944)
066	To revise the suspended ceiling design	82,000	Rejected	-	NIL
067	To provide additional hoarding and construct the entrance pavement due to delayed development activities	70,000	Approved	-	70,000
068	To provide aluminium angle frames to openings	53,200	Approved	-	53,200
069	To erect light reflectors and diffusers in staff areas	39,000	Approved	-	39,000
070	To provide surface mounted covers to platform emergency plungers	5,000	Approved	-	5,000
071	To provide a dust proof seal to BMT door frames	4,800	Approved	-	4,800
072	To carry out protection work to adjacent rock slope	60,000	Approved	-	60,000
073	To approve revisions to ironmongery sets M2 and M4	(4,439)	Approved	-	(4,439)
074	To instruct the provision of negatives for supergraphics	6,000	Approved	-	6,000

CONTRACT 406

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
075	To approve the remeasurement of metal bulkheads and provide access panels and walk-on panels	360,000	Approved	-	360,000
076	To provide stainless steel police visiting book boxes	(1,350)	Approved	-	(1,350)
077	To provide cat ladders to signalling equipment room roofs	3,000	Approved	-	3,000
078	To authorise the reconstruction of Ming Yuen Street	80,000	Approved	-	80,000
079	To authorise the reinstatement of Works Area C at 121 King's Road	110,000	Approved	Letter	110,000
080	To authorise minor design revisions to mosaic tiles	5,000	Approved	-	5,000

CONTRACT 406

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To approve additional rock excavation in Works Area 406A	1,200,000	Approved	002	1,400,625
002	To approve the removal of a rock berm	460,000	Approved	Letter	516,120
003	To approve the installation of temporary supports in tunnel, adit and concourse	834,000	Approved	Letter	834,000
004	To approve Dayworks Orders	150,000	Approved	Various	150,000
005	To approve the installation of temporary ground anchors	915,000	Approved	Letter	915,000
006	To approve the installation of additional temporary ground anchors	4,614,030	Approved	Letter	4,614,030
007	To approve the installation of additional temporary supports in tunnels, adits and concourse area	1,538,000	Approved	Letter	2,179,728
008	To approve additional works in connection with the West Vent Shaft surface structure	350,000	Approved	007	645,466
009	To approve the installation of additional temporary supports in tunnels, adits and concourse area	825,000	Approved	Letter	428,074
010	To approve Dayworks Order	100,000	Approved	Various	100,000
011	To approve deletion of temporary supports	(100,000)	Rejected	-	NIL
012	To approve additional site investigation	374,000	Approved	012,014	374,000
013	To revise wall finishes in plant rooms	(31,000)	Rejected	-	NIL
014	To approve deletion of temporary supports	(2,000,000)	Approved	003,010,011	(2,000,000)
015	To approve Dayworks Orders	150,000	Approved	Various	150,000
016	To approve Dayworks Orders	90,000	Approved	Various	90,000
017	To approve Special Attendance on designated Contractors	60,000	Approved	-	60,000
018	To authorise the provision of Site Services for the Engineer	21,000	Approved	-	21,000
019	To approve Dayworks Orders	110,000	Approved	Various	110,000
020	To approve Dayworks Orders	100,000	Approved	Various	100,000

CONTRACT 406

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	Extension of time due to lack of drawings for Fortress Hill Concourse	Unknown	Approved	-	NIL
002	Additional costs arising from delays due to lack of drawings for Fortress Hill Concourse	Unknown	Approved	-	NIL
003	Extension of time due to additional work in revised station tunnels	Unknown	Approved	-	NIL
004	Extension of time due to delay and disruption of concourse excavation caused by revised requirement for rock anchors	Unknown	Approved	009	33,001
005	Additional costs due to delay and disruption of concourse excavation caused by revised requirement for rock anchors	Unknown	Approved	-	NIL
006	Extension of time due to additional escalator and adit work in connection with the proposed Shell Redevelopment connection to Fortress Hill Station	Unknown	Approved	-	NIL
007	Extension of time due to the clearing of loose rock and concrete infilling to over-break at the bottom of Access Shaft D	Unknown	Approved	001 & 037	1,367,624
008	Extension of time due to the late amendment of rock anchor positions	Unknown	Approved	-	NIL
009	Additional costs due to late amendment of rock anchor positions	Unknown	Approved	-	NIL
010	Extension of time due to revised rock anchor type	Unknown	Rejected	-	NIL
011	Extension of time due to unforeseen ground conditions, amended adit layout and the addition of a chamber	Unknown	Approved	-	NIL
012	Extension of time due to revised rock anchor type	Unknown	Rejected	-	NIL
013	Additional costs due to non-release of Retention Money arising from alleged late issue of Certificate of Completion for Cost Centre E	Unknown	Approved	-	NIL
014	Additional costs arising from the admeasurement of load cells	Unknown	Approved	-	NIL

CONTRACT 427

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To revise geotechnical instrumentation	(66,800)	Rejected	-	NIL
002	To delete the inclinator torpedo	(75,500)	Approved	-	NIL
003	To revise the shape and sizes of the transfer slab due to changes in the superstructure design	1,220,000	Rejected	-	NIL
004	To authorise an increase in quantities of excavation and reinforced concrete due to revised structural requirements	560,000	Approved	029	560,000
005	To revise the concourse basic structure in order to satisfy station functional requirements	1,000,000	Approved	030	1,000,000
006	To authorise a reduction in the quantity of concourse column reinforcement	(1,710,000)	Approved	068	(1,909,750)
007	To authorise an increase in the quantity of reinforced concrete due to a measurement error when computing the quantities required for the Southern Entrance structure	331,000	Approved	040	331,000
008	To authorise the design of the Northern Entrance and the section under Hennessy Road	30,000	Approved	047	30,000
009	To revise position of monitoring devices	16,000	Rejected	-	NIL
010	To authorise a reduction in the quantity of reinforcement in the intermediate slabs	(500,000)	Approved	032	(500,000)
011	To cast in items required for Building Services Installations	131,000	Approved	080,081	131,000
012	To omit one of the two levels of temporary struts for the top-down construction of the basement.	(500,000)	Approved	075	(792,751)
013	To authorise the addition of architectural finishes and builders works into the contract	20,192,124	Approved	Letter	20,192,124
014	To instruct the main Contractor to order vitreous enamel panelling	535,346	Approved	Letter	535,346
015	To revise the plant room wall finishes	(451,000)	Approved	058,082	(451,000)
016	To authorise the inclusion of waterbars in the ground floor slab construction joints	65,000	Approved	045	23,608

CONTRACT 427

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
017	To alter the building services and provide a connection to the public utilities	135,400	Approved	059	135,400
018	To instruct the Main Contractor to accept the tender for doors and frames	602,609	Approved	060	602,609
019	To revise the ceiling finishes	612,745	Approved	061	612,745
020	To revise the shape and sizes of the transfer slab due to changes in the superstructure design thereby cancelling Design Form 'X' No. 003	2,010,000	Approved	066,102	2,010,000
021	To authorise additional cast-in items for Building Services Installations	115,000	Approved	039	115,000
022	To instruct the Main Contractor to accept the tender for the supply of ironmongery	109,529	Approved	072	109,529
023	To provide concrete plinths for building services plant	124,000	Approved	077	124,000
024	To revise the duct layout	29,800	Rejected	-	NIL
025	To authorise the remeasurement of doors and frames	(34,116)	Approved	093	(34,116)
026	To revise the water proofing system at the Lower Platform slab	101,000	Approved	085	83,743
027	To approve the issue of working drawings in respect of the vitreous enamel panels	(138,873)	Approved	091	(138,873)
028	To revise the above ground railway structures due to delayed development activities	540,000	Approved	111,121, 122,161	540,000
029	To revise the design of the vitreous enamel panels	(22,120)	Approved	092	(22,120)
030	To authorise the remeasurement of ceilings	(427,000)	Rejected	-	NIL
031	To provide a waterproofing membrane at the ground floor slab and make provision for site security	490,000	Approved	159,120	490,000
032	To authorise the remeasurement of wall and floor finishes	(46,000)	Rejected	-	NIL

CONTRACT 427

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
033	To revise the suspended ceiling layout	41,000	Rejected	-	NIL
034	To revise ironmongery sets M2 and M4	(14,285)	Approved	143	(14,285)
035	To provide additional signage	26,000	Rejected	-	NIL
036	To provide stainless steel police visiting book boxes	739	Approved	155	739
037	To authorise minor revisions to mosaic wall tiles	2,000	Approved	-	2,000

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To provide 70m of additional type C fencing	36,400	Approved	001	NIL
002	To provide an additional inclinometer to record the effect of ground movement	25,000	Approved	-	23,500
003	To provide guide walls to improve diaphragm wall trench stability	62,400	Approved	-	NIL
004	To authorise the use of 32/20 concrete for diaphragm walls in lieu of the 40/20 concrete specified	NIL	Approved	-	NIL
005	To authorise solid stabilisation measures	14,726,075	Approved	Letter	14,726,075
006	To authorise expenditure on site services	5,800	Approved	006	5,800
007	To drill and grout inclined holes at the North Wall of the Concourse	58,000	Approved	Letter	NIL
008	To remove the dewatering wells and grout in the boreholes	120,000	Approved	Letter	112,028
009	To authorise the use of compressed air within the running tunnels	500,000	Approved	013	445,000
010	To authorise site investigation for column foundations	50,000	Approved	-	50,000
011	To authorise additional site investigation for column foundation	220,000	Approved	009	220,000
012	To authorise additional drilling in diaphragm wall pre-bores below the designed founding level	7,500	Approved	003	7,500
013	To authorise grouting of bored piles A1, A2, A3	350,250	Approved	Letter	310,877
014	To authorise ground treatment works in the O'Brien Road subway	925,000	Approved	-	NIL
015	To authorise additional temporary works in the O'Brien Road subway	1,396,000	Rejected	-	NIL
016	To approve Dayworks Orders	29,550	Approved	Various	29,550
017	To approve minor sundry item revisions	26,500	Approved	010,015	26,500

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
018	To approve main contractor's alternative proposal to use hand dug caissons in lieu of steel casings and cement/bentonite grout	NIL	Approved	-	NIL
019	To authorise additional penetration into rock	56,612	Approved	003	50,000
020	To approve a revision of the Interim Payment Schedules	NIL	Approved	-	NIL
021	To provide additional security fencing	47,704	Approved	035	87,276
022	To concrete the caissons in two stages	750,000	Rejected	-	NIL
023	To provide additional reinforcement to the ground floor slab and transfer plate	80,000	Approved	-	80,000
024	To approve Dayworks Orders	6,700	Approved	Various	6,700
025	To provide couplers for substructure reinforcement	NIL	Approved	Letter	NIL
026	To revise the connection between the columns and the slabs below ground level	(866,860)	Approved	026	(866,860)
027	To provide additional security fencing to the northern entrance of O'Brien Road subway	NIL	Approved	-	NIL
028	To provide ground water control instrumentation	99,604	Approved	Letter	99,604
029	To authorise core drilling through piles	78,000	Approved	Letter	106,320
030	To authorise pumping and dewatering tests	150,000	Approved	-	150,000
031	To approve revised transfer plate design	805,280	Approved	048	805,280
032	To approve concreting of caissons in two stages as opposed to one	77,216	Approved	052	65,248
033	To approve sundry minor works items	28,200	Approved	022,041,042 043 & 044	24,466
034	To approve Dayworks Orders	122,700	Approved	Various	122,700
035	To approve additional sundry minor works items	23,500	Approved	049,050,053	22,533
036	To provide insulation to cure concrete in Transfer Plate	70,000	Approved	054	69,313

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
037	To authorise additional reinforcement in piles due to the difficulty of fixing	535,000	Approved	Letter	534,924
038	To pump out the basement and construct bund walls	50,000	Approved	-	50,000
039	To authorise the admeasurement of the grout curtain	619,322	Approved	-	665,934
040	To authorise the protection of column and wall starter bars protruding above the slab and transfer plate	244,280	Rejected	-	NIL
041	To approve additional sundry minor works items	41,000	Approved	062,063	39,133
042	To provide Engineer's site services	7,280	Approved	071	7,950
043	To approve additional sundry minor works items	28,500	Approved	065	28,500
044	To authorise the admeasurement of concrete piles	641,630	Approved	-	641,308
045	To reinstate defective road surfacing and protect the utilities in Hennessy Road	40,000	Rejected	-	NIL
046	To authorise additional subway ground treatment	1,018,060	Approved	Letter	1,018,060
047	To authorise additional temporary works in the O'Brien Road Subway	565,000	Approved	Letter	565,000
048	To approve additional sundry minor works items	63,650	Approved	073,074, 076	60,365
049	To authorise additional ground treatment works in the vicinity of the O'Brien Road and replacing Construction Form 'X' 014	2,066,116	Approved	019,087	2,066,116
050	To authorise additional temporary works on O'Brien Road Subway and replacing Construction Form 'X' 015	965,364	Approved	016,018, 021,024, 088	965,364
051	To add screeding to the perimeter drainage channel	310,082	Approved	082	310,082
052	To vary the diameter of steel grouting tubes in the diaphragm wall	181,500	Approved	-	181,500
053	To authorise the use of Bentonite	NIL	Approved	Letter	NIL

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
054	To authorise the addition of two fire resisting roller shutters	51,316	Approved	089	51,316
055	To authorise the deletion of screwed couplers in the diaphragm wall	(626,405)	Approved	090	(626,405)
056	To alter width of 'Altro' safety tread width from 75mm to 100mm in the concourse and O'Brien Road Subway	38,000	Approved	108	38,000
057	To authorise sundry variations	39,158	Approved	078,079,083,084 085,100 & 101	39,158
058	To provide infill couplers	25,000	Approved	094	25,000
059	To alter the steel lined column to blockwork wall junction detail	134,000	Approved	109	134,000
060	To apply 'Neutra Rust' paint to steel columns	160,000	Approved	110	160,000
061	To approve sundry minor variations	76,000	Approved	095,096,098,106	76,000
062	To approve of sundry architectural variations	75,500	Approved	103,104,105,107	75,500
063	To approve the addition of mass concrete around and between columns at escalators	102,000	Approved	112,113	102,000
064	To close the structural recess on top of transfer plate	31,000	Approved	-	31,000
065	To provide waterproofing, drains, screeds and non-fines concrete at lower platform level	101,000	Approved	123	101,000
066	To approve sundry architectural variations	10,800	Approved	116,117,118	10,800
067	To authorise the remeasurement of the Diaphragm Walls	(292,259)	Approved	161	(292,259)
068	To authorise the remeasurement of the concrete pile reinforcement	283,922	Approved	-	283,998
069	To provide a stop bead to pyrok finishes and also provide painting to steel columns at plant room level	115,000	Approved	126	115,000
070	To approve Dayworks Orders	64,000	Approved	Various	64,000

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
071	To approve sundry architectural variations	55,800	Approved	114,115,119	55,800
072	To approve additional architectural variations	44,000	Approved	130,131,132,133	14,000
073	To authorise the payment of air freight charges for critical door frames	14,200	Approved	134	14,200
074	To approve Dayworks Orders	70,000	Approved	Various	70,000
075	To approve items for special attendance	22,600	Approved	097	22,600
076	To approve sundry variations	50,200	Approved	124,127,128,129 136 & 137	50,200
077	To paint building service conduit in public areas	25,000	Approved	160	25,000
078	To approve Dayworks Orders	126,000	Approved	Various	126,000
079	To authorise the construction of Concourse and Adit bulkheads	250,000	Approved	153	250,000
080	To approve the admeasurement of Activity Bill No. B6 - Earthing Mat	NIL	Rejected	-	NIL
081	To authorise sundry minor works variations	28,500	Approved	144,145,146,147 148,149,150,152	28,500
082	To approve special attendance on designated contractors	37,200	Approved	-	37,200
083	To increase the length of sheetpiles	497,000	Approved	157	136,253
084	To approve sundry minor works variations	40,700	Approved	141,142	40,700
085	To approve the artworks for station graphics	18,555	Approved	-	18,555
086	To reinstate the footpath due to delayed development activities	96,000	Approved	165	96,000
087	To approve the admeasurement of Activity Bill B4 - Slabs, Staircases and Walls	(595,000)	Approved	Letter	(595,000)

CONTRACT 427

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
088	To approve sundry minor works variations	147,950	Rejected	-	NIL
089	To approve sundry minor works variations	67,950	Approved	-	67,950
090	To approve sundry architectural variations	131,600	Rejected	-	NIL
091	To approve sundry architectural variations	47,600	Rejected	-	NIL
092	To modify existing signs	16,000	Rejected	-	NIL
093	To approve the admeasurement of Activity Bill No. C2 - Roadway Construction	(217,446)	Approved	Letter	(217,446)

CONTRACT 427

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	Additional costs due to unforeseen ground conditions encountered on the south side of the concourse	Unknown	Approved	-	NIL
002	Additional costs due to delays caused by an increase in quantity of reinforcing steel	Unknown	Approved	-	NIL
003	Extension of time due to delays caused by an increase in quantity of reinforcement	Unknown	Approved	-	NIL
004	Extension of time due to delays caused by the installation of a dewatering system at the O'Brien Road Subway	Unknown	Approved	-	NIL
005	Extension of time due to a delay in the issue of reinforcement drawings for the Southern Entrance of the O'Brien Road Subway	Unknown	Approved	-	NIL
006	Additional costs due to a delay in the issue of reinforcement drawings for the Southern Entrance of the O'Brien Road Subway	Unknown	Approved	007	75,001
007	Additional costs due to the reduction of site access and facilities caused by the presence of starter bars	Unknown	Approved	-	NIL
008	Extension of time due to revised reinforcement details considered to be a variation to the Contract	Unknown	Approved	-	NIL
009	Additional costs due to revised reinforcement details considered to be a variation to the Contract	3,020,000	Approved	-	NIL
010	Extension of time due to the change from one stage to two stage concreting of caisson piles	Unknown	Approved	-	NIL
011	Additional costs arising from the change from one stage to two stage concreting of caisson piles	9,830,000	Approved	-	NIL
012	Extension of time due to variations in the works for the ground floor slab and transfer plate	Unknown	Approved	-	NIL
013	Additional costs due to variations in the works for the ground floor slab and transfer plate	Unknown	Approved	-	NIL

CONTRACT 427

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
014	Extension of time due to a reassessment of all claims	Unknown	Approved	-	NIL
015	Extension of time arising from Typhoons "Ellen" and "Joe"	Unknown	Approved	-	NIL
016	Extension of time due to additional site investigation	Unknown	Approved	-	NIL
017	Additional costs arising from delays due to additional site investigation	Unknown	Approved	-	NIL
018	Additional costs due to difficulties in extracting sheet piling, due to grouting	Unknown	Approved	-	NIL
019	Additional costs due to installation of dewatering system and cancellation of ground treatment	Unknown	Approved	-	NIL
020	Additional costs due to changes in the specification of painting to steel columns in plant rooms	235,428	Approved	-	NIL

CONTRACT 431

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To delete the provision of an inclinometer torpedo	(84,750)	Approved	-	(84,750)
002	To provide buttress support to diaphragm walls at adit connection	130,000	Approved	Letter	130,000
003	To redesign the roof slab	(800,000)	Rejected	-	NIL
004	To redesign various columns and beams	415,000	Rejected	-	NIL
005	To provide an additional temporary steel column to support the floor slab during construction	202,000	Approved	018	201,964
006	To incorporate architectural finishes and builders work into the contract	14,365,676	Approved	Letter	14,365,676
007	To authorise an increase in excavation quantities due to the modification of design	101,000	Rejected	-	NIL
008	To instruct the Main Contractor to place the order for the supply of vitreous enamel panelling	279,761	Approved	-	279,761
009	To authorise an increase in excavation quantities due to a modification in design and superseding Design Form 'X' 007	440,000	Approved	019	440,000
010	To revise the concrete and formwork requirements at lower plant room slab level	(28,400)	Approved	-	(28,400)
011	To revise the concrete and formwork requirements at upper platform slab level	117,000	Approved	Letter	117,000
012	To revise the concrete and formwork requirements at lower platform slab level	160,000	Approved	Letter	160,000
013	To revise the concrete and formwork requirements for upper plantroom slab	5,000	Approved	-	5,000
014	To authorise revised reinforcement quantities for lower plant room slab, upper platform slab, upper plant room slab and concourse slab	2,748,000	Approved	029	2,748,000
015	To revise the concrete and formwork requirements at concourse slab level	51,000	Approved	Letter	51,000
016	To revise the ceiling finishes	(132,000)	Approved	-	(132,000)

CONTRACT 431

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
017	To instruct the Main Contractor to accept the tender for the supply of doors and frames	441,861	Approved	Letter	441,861
018	To revise the ceiling finishes	504,109	Approved	Letter	504,109
019	To omit attendance on the architectural finishes works	(50,000)	Approved	-	(50,000)
020	To instruct the Main Contractor to accept the tender for the supply ironmongery	105,607	Approved	Letter	105,607
021	To provide additional reinforcement to the base slab	556,630	Approved	042	556,630
022	To provide concrete plinths for the Building Services	6,000	Approved	037	6,000
023	To provide cat ladders and platforms to the emergency vent shaft	24,000	Approved	-	24,000
024	To provide louvres and doors to the vent shaft	140,000	Approved	Letter	140,000
025	To authorise the remeasurement of doors and frames	52,919	Approved	Letter	116,558
026	To approve the issue of revised working drawings for the vitreous enamel panels	(15,888)	Approved	Letter	(15,888)
027	To revise the vitreous enamel panel design	(18,200)	Approved	Letter	(18,200)
028	To authorise the remeasurement of the suspended ceilings in public areas and over stairs and escalators	(392,000)	Approved	-	(392,000)
029	To revise the substructure to meet additional superstructure changes	72,000	Approved	059	65,000
030	To revise the substructure to accommodate additional superstructure changes	19,200	Approved	-	19,200
031	To provide protection to the starter bars at Entrances A1, A2, B, Vent Shaft Z and Fireman's Entrance	10,000	Approved	075	10,000
032	To provide a protection system, including pipebridge and truss at ground level, plinth supports and hoarding, to the railway chillers	275,000	Approved	079	410,000

CONTRACT 431

FORM 'X' SUMMARY SHEET : DESIGN

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
033	To provide additional signage	26,410	Rejected	-	NIL
034	To provide additional signage	12,000	Rejected	-	NIL
035	To provide light reflectors and diffusers in staff areas	39,750	Approved	-	39,750
036	To revise ironmongery sets M2 and M4	(7,085)	Approved	-	(7,085)
037	To approve the provision of signs	2,600	Rejected	-	NIL
038	To approve minor modifications to the mosaic tile wall finishes	42,000	Approved	-	42,000

CONTRACT 431

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	To install flushing water system for the Magistracy	48,000	Approved	001	48,000
002	To approved miscellaneous minor items of work	16,200	Approved	002	16,200
003	To backfill well at Magistracy	50,000	Approved	010	24,000
004	To approve Dayworks Orders	29,000	Approved	Various	18,315
005	To revise the diaphragm wall quantities	23,900,000	Approved	015	17,906,258
006	To authorise the demolition of the existing fence near the Causeway Bay Magistracy	18,000	Approved	011	17,250
007	To delete the supply of a tension tape for use with monitoring points	(33,900)	Approved	-	(33,900)
008	To authorise additional drilling through rock for installation of instrumentation and to facilitate dewatering	600,000	Approved	019	600,000
009	To remeasure the quantity of rock excavation	1,450,000	Approved	019	1,450,000
010	To approve Dayworks Orders	35,400	Approved	Various	31,505
011	To vary the roof slab construction method	543,409	Approved	024	543,409
012	To approve minor works revisions	59,600	Approved	022 & 026	59,600
013	To approve Dayworks Orders	4,620	Approved	Various	4,530
014	To break out the diaphragm wall at concourse level	280,000	Approved	033	280,000
015	To provide couplers in the base slab	220,000	Approved	019	220,000
016	To provide additional couplers	247,500	Approved	019	247,500
017	To approve additional minor works	14,611	Approved	030 & 032	14,611
018	To approve Dayworks Orders	38,992	Approved	Various	37,534
019	To approve minor works variations	59,100	Approved	041 & 045	59,100
020	To approve the deletion of wooden piles	217,000	Approved	043	(217,000)
021	To delete the provision of permanent dewatering equipment	(186,444)	Approved	017	(186,444)

CONTRACT 431

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
022	To approve minor variations to the architectural finishes	39,750	Approved	043,047, 048,049	39,750
023	To approve the breaking out of reinforced concrete slabs	166,500	Approved	056	166,500
024	to provide an electricity supply for Nominated Sub-Contractors	200,000	Approved	-	200,000
025	To approve the deletion of Cost Centre B - Dewatering	(1,231,034)	Approved	079	(1,231,034)
026	To approve dewatering during caisson excavation	NIL	Approved	-	NIL
027	To revise the base slab temporary strutting arrangement	(500,000)	Approved	077	(500,000)
028	To authorise the remeasurement of Cost Centre E - Ground Water Control and Instrumentation	(2,373,202)	Approved	Letter	(2,373,202)
029	To approve Dayworks Orders	29,000	Approved	Various	29,000
030	To approve minor variations	62,000	Approved	055,074,076	62,000
031	To waterproof the roof slabs due to the delays in development activities	650,000	Approved	081	650,000
032	To erect perimeter hoarding and protect the starter bars	112,000	Approved	080	112,000
033	To authorise the remeasurement of Bill B3 - Ground Level to Formation Level	(370,000)	Approved	Letter	(370,000)
034	To revise the routing of the utilities	(105,000)	Approved	120	(105,000)
035	To authorise the remeasurement of the lower platform slab	(300,000)	Approved	019	(300,000)
036	To authorise a remeasurement of slab reinforcement	480,000	Approved	019	480,000
037	To authorise minor variations to finishes	62,000	Rejected	-	NIL
038	To authorise the reinstatement of the footpath	450,000	Approved	119	550,000
039	To authorise the revision of bulkheads	250,000	Rejected	059	NIL
040	To approve additional dewatering provisions	NIL	Rejected	-	NIL

CONTRACT 431

FORM 'X' SUMMARY SHEET : CONSTRUCTION

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
041	To provide additional waterproof joints in the roof slab	64,000	Approved	Letter	64,000
042	To approve artworks for station graphics	18,000	Approved	-	18,000
043	To approve revised ceiling finishes	80,000	Rejected	-	NIL
044	To approve revised wall finishes	106,000	Rejected	-	NIL
045	To approve revised finishes in plant rooms	19,000	Rejected	-	NIL
046	To authorise the remeasurement of the upper platform slab	250,000	Approved	-	250,000
047	To authorise the provision of additional joints in the base slab	288,600	Approved	120 & 121	288,600
048	To revise existing station signs	175,000	Rejected	-	NIL
049	To approve Dayworks Orders	38,400	Approved	Various	38,400
050	To approve minor revision to finishes	72,352	Approved	116	72,352
051	To undertake various remedial works to adjacent Government works	100,000	Approved	-	100,000
052	To approve special attendance on Nominated Sub-contractors	119,700	Approved	-	119,700
053	To approve Dayworks Orders	15,997	Approved	Various	15,997

CONTRACT 431

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
001	Extension of time due to delayed possession of the site	Unknown	Approved	-	NIL
002	Additional costs due to delayed possession of the site	Unknown	Approved	-	NIL
003	Extension of time due to unforeseen ground conditions along the line of the East Diagram Wall	Unknown	Approved	-	NIL
004	Additional costs due to unforeseen ground conditions along the line of the East Diagram Wall	Unknown	Approved	-	NIL
005	Extension of time due to unforeseen ground conditions in vicinity of concourse retaining wall	Unknown	Approved	-	NIL
006	Extension of time due to unforeseen ground conditions in vicinity of concourse retaining wall	Unknown	Approved	-	NIL
007	Extension of time due to a delay in the diversion of sewers by Government contractors	Unknown	Approved	-	NIL
008	Additional costs due to a delay in the diversion of sewers by Government contractors	Unknown	Approved	-	NIL
009	Extension of time due to increase in bulk excavation inside concourse wall due to unforeseen ground conditions	Unknown	Approved	-	NIL
010	Additional costs due to increase in bulk excavation inside concourse wall due to unforeseen ground conditions	Unknown	Approved	-	NIL
011	Extension of time due to unforeseen physical conditions	Unknown	Approved	-	NIL
012	Additional costs due to unforeseen physical conditions	Unknown	Approved	-	NIL
013	Extension of time due to increased quantity and complexity of steel	Unknown	Approved	-	NIL
014	Additional costs due to unforeseen physical conditions	Unknown	Approved	-	NIL
015	Extension of time due to need to break out and form diaphragm opening	Unknown	Approved	-	NIL

CONTRACT 431

FORM 'X' SUMMARY SHEET : CLAIMS

Form 'X' No.	Description	Estimated Cost (HK$)	Approved or Rejected	Instruction No.	Final Cost (HK$)
016	Additional costs due to need to break out and form opening through diagram wall	Unknown	Approved	-	NIL
017	Extension of time arising from typhoons "Ellen" and "Joe"	Unknown	Approved	-	NIL
018	Extension of time due to revised work content at Entrance 'B' caused by non-completion of work by Government contractors	Unknown	Approved	-	NIL
019	Additional costs due to revised work content at Entrance 'B' caused by non-completion of work by Government contractors	Unknown	Approved	-	NIL

APPENDIX 'G'

Appendix 'G' : List of Engineer's Instructions

This Appendix illustrates the various Engineer's Instructions which were issued on the three contracts using site-based control:

CONTRACT 403A (A)

LIST OF ENGINEER'S INSTRUCTIONS

Type of Instruction	Description	Instruction No.	Final Cost (HK$)
Design	To instruct the deletion of permanent ground anchors	001	(708,000)
Design	To instruct the revision of the roof transfer beams	003	28,000
Design	To instruct the revision of the cash siding platforms	004	95,000
Design	To instruct the revision of the retaining wall, roof, vent shaft walls, staircases and columns	005	685,000
Design	To instruct the increasing of the thickness of the shield shaft walls	006	205,000
Design	To instruct the increasing of the thickness of the concourse roof	007	(80,000)
Design	To instruct the increasing of the wall thickness of the cash siding	008	820,000
Design	To instruct revisions to the drainage layout	009	30,000
Design	To instruct the revision to the basement	016	(2,000,000)
Design	To instruct the revision of various structural elements	017	2,114,000
Design	To instruct the provision of development column starter bar couplers	019	7,500
Construction	To instruct the provision of a covered walkway round the site	020	200,000
Construction	To instruct the remeasurement of the cash siding caisson due to errors in the Bill of Quantities	023	350,000
Construction	To instruct the provision of additional development related caissons	024	150,000
Construction	To instruct the remeasurement of the rock excavation in the cash siding due to errors in the Bill of Quantities	030	925,000
Construction	To authorise the remeasurement of the cut and cover tunnel	031	1,155,000
Construction	To authorise the remeasurement of the sheet steel piling	032	55,000

CONTRACT 403A (A) (Cont)

LIST OF ENGINEER'S INSTRUCTIONS

Type of Instruction	Description	Instruction No.	Final Cost (HK$)
Construction	To authorise the remeasurement of reinforcement	033 & 034	219,100
Construction	To authorise the remeasurement of the caissons	035	70,000
Construction	To authorise the remeasurement of the access shafts	036	210,000
Claims	To agree claims	Letter	5,350,000

CONTRACT 403A (B)

LIST OF ENGINEER'S INSTRUCTIONS

Type of Instruction	Description	Instruction No.	Final Cost (HK$)
Design	To instruct the revision of the vent shaft	002	40,000
Design	To instruct revisions to the drainage layout	010	10,000
Design	To instruct provision of temporary openings in the concourse roof slab	011	70,000
Design	To instruct the lowering of the lower track slab	012	124,500
Design	To instruct revisions to the vent shaft walls	013	20,000
Design	To instruct the revision of the reinforcement design	014	600,000
Design	To instruct the incorporation of additional reinforcement	015	2,000,000
Design	To instruct the revision of the base slab	018	15,000
Construction	To instruct the installation of three additional piezometers	021	19,280
Construction	To instruct the revision of the flyover foundations	022	40,000
Construction	To instruct further revisions to the flyover foundations	025	171,000
Construction	To instruct additional rock excavation	026	602,000
Construction	To instruct the protection of the flyover foundations	027	3,500
Construction	To instruct the modification of the vent shaft	028	120,000
Construction	To instruct the provision of special backfill material	029	50,000
Claims	To agree claims	Letter	7,359,000

CONTRACT 406A

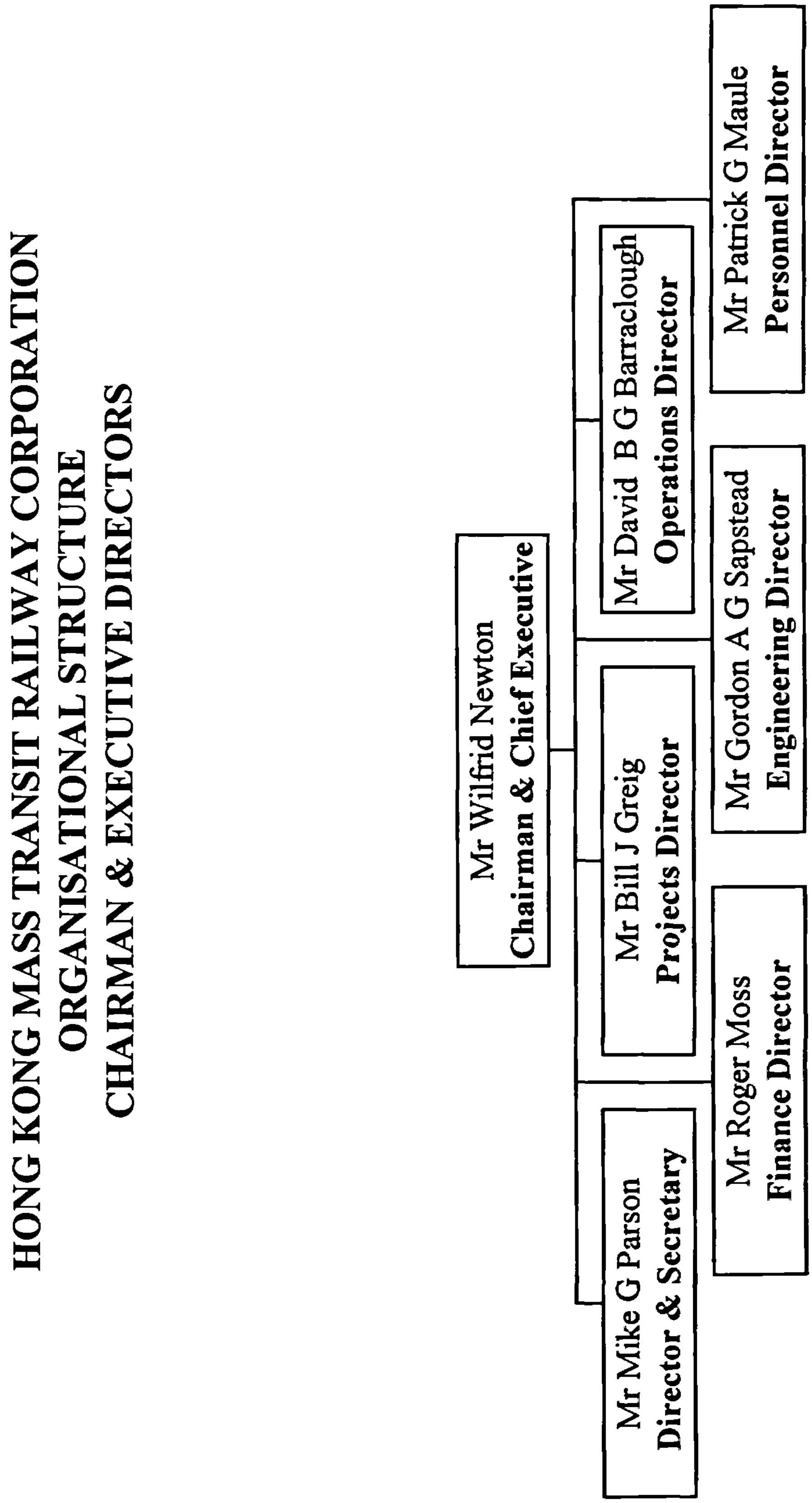
LIST OF ENGINEER'S INSTRUCTIONS

Type of Instruction	Description	Instruction No.	Final Cost (HK$)
Design	To instruct lift off tests on existing rock anchors	001	5,500
Design	To instruct soil sampling and testing	002	41,500
Design	To revise design of additional caissons in North West corner of the site	003	1,000,000
Construction	To instruct demolition and removal from site of squatter huts	004	6,000
Construction	To instruct provision of additional rock bolts and wire mesh supports to stabilise adjacent rock faces	005	54,000
Construction	To instruct demolition of existing caissons outside the site boundary	006	155,000
Construction	To instruct erection of the contract signboard	007	455
Construction	To instruct erection of the contract signboard	008	12,000
Construction	To instruct additional works in site area 'D'	009	60,000
Construction	To instruct works in lieu of sheet steel piling	010	1,000,000
Construction	To instruct the deletion of rock excavation in works area 'D'	011	(500,000)
Construction	To instruct the revision of anchor load cell requirements	012	204,000
Construction	To instruct revised working method to rock berm surface	013	60,500
Construction	To instruct soil stabilisation measures	014	44,125
Construction	To instruct additional soil stabilisation measures	015	286,498
Construction	To instruct revised working sequence on soil stabilisation works	016	134,770
Construction	To instruct various items of work to be executed on a Daywork basis	017	79,641
Construction	To instruct provision of site services for Engineer	018	8,000
Construction	To instruct the revision of load cell provisions	019	89,780
Claims	To agree claim for additional costs arising from various additional work	020	1,250,000
Claims	To resolve various contractual disputes	021	173,280

APPENDIX 'H'

Appendix 'H' : Organisational Structures

This Appendix illustrates the organisational structures applicable to the various contracts being studied:



HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
PROJECTS DIRECTORATE CONSTRUCTION MANAGERS

Mr Bill J Greig
Projects Director

Mr George O Archer
Construction Manager (Area 10)

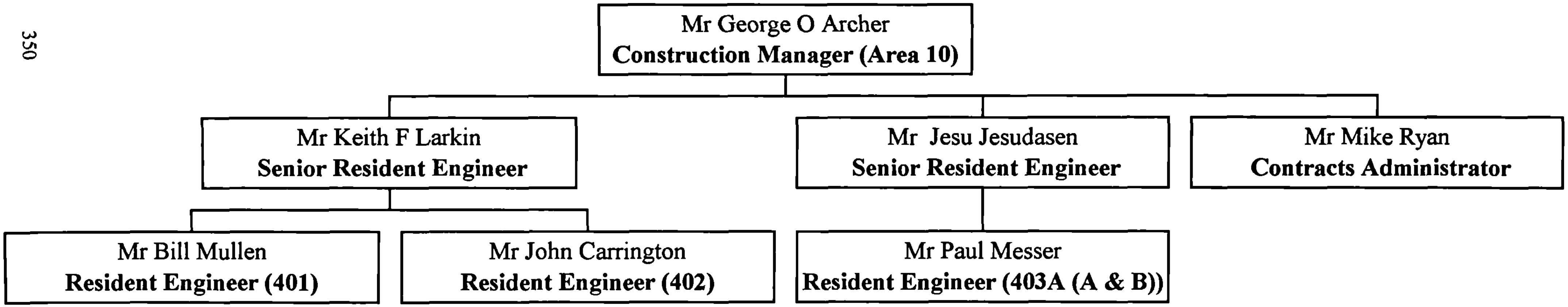
Mr Frank G Storey
Construction Manager (Area 11)

Mr Bill F M Love
Construction Manager (Area 12)

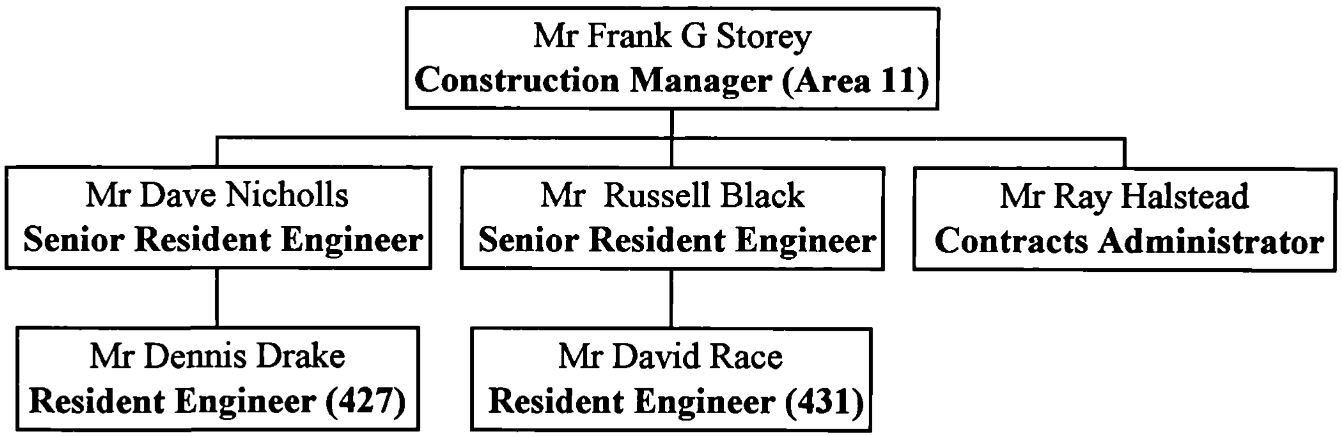
Mr Mike C F Smith
Construction Manager (Area 13)

Mr Dave J Corby
Construction Manager (Area 14)

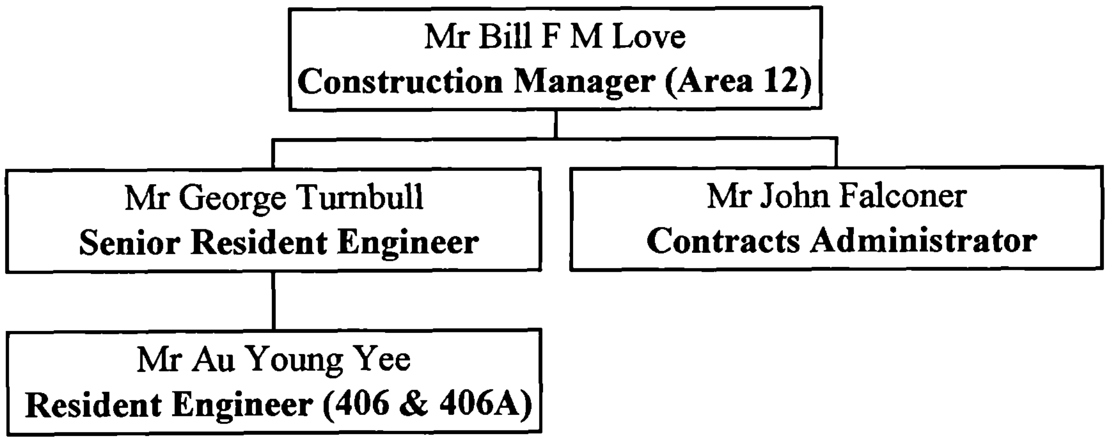
HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
PROJECTS DIRECTORATE AREA 10



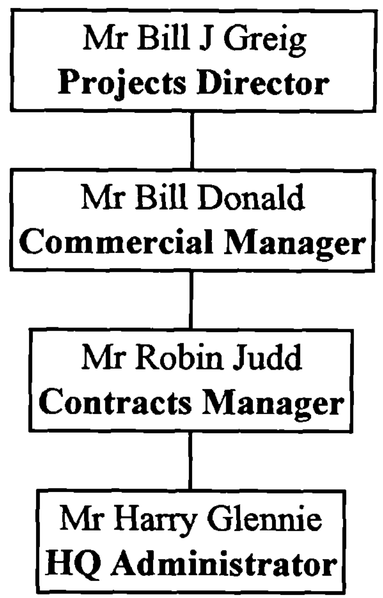
HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
PROJECTS DIRECTORATE AREA 11



HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
PROJECTS DIRECTORATE AREA 12



HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
PROJECTS DIRECTORATE COMMERCIAL & CONTRACTS MANAGERS



HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
ENGINEERING DIRECTORATE DESIGN MANAGERS

Mr Gordon A Sapstead
Engineering Director

Mr David Sharpe
Chief Civil Engineer

Mr Roland Paoletti
Chief Architect

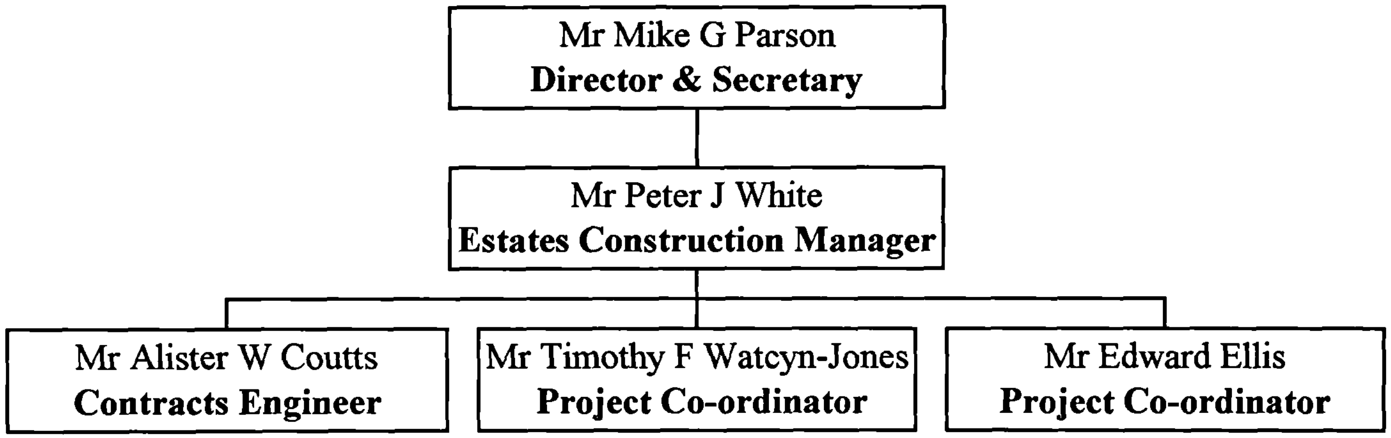
Mr Alistair Budge-Reid
Project Design Manager

Mr Alastair W P Coutts
Design Manager (Section 1)

Mr Chris Calton
Design Manager (Section 2)

Mr Wilf Ring
Design Manager (Section 3)

HONG KONG MASS TRANSIT RAILWAY CORPORATION
ORGANISATIONAL STRUCTURE
ESTATES DIRECTORATE CONSTRUCTION MANAGERS



APPENDIX 'I'

Appendix 'I' : Reaction to the New Approach

This Appendix details the interviews which were held with Corporation personnel and external consultants to ascertain their reaction to the new approach to contract control.

The table shows the personnel who were interviewed:

Name	Position	Organisation
Bill J Greig	Projects Director	Hong Kong Mass Transit Railway Corporation
Bill R Donald	Commercial Manager	Hong Kong Mass Transit Railway Corporation
Robin Judd	Contracts Manager	Hong Kong Mass Transit Railway Corporation
Harry Glennie	HQ Administrator	Hong Kong Mass Transit Railway Corporation
George O Archer	Construction Manager (10)	Hong Kong Mass Transit Railway Corporation
Frank G Storey	Construction Manager (11)	Hong Kong Mass Transit Railway Corporation
Bill F M Love	Construction Manager (12)	Hong Kong Mass Transit Railway Corporation
Mike Ryan	Contracts Administrator (10)	Hong Kong Mass Transit Railway Corporation
Ray Halstead	Contracts Administrator (11)	Hong Kong Mass Transit Railway Corporation
John Falconer	Contracts Administrator (12)	Hong Kong Mass Transit Railway Corporation
Gordon A Sapstead	Engineering Director	Hong Kong Mass Transit Railway Corporation
David Sharpe	Chief Civil Engineer	Hong Kong Mass Transit Railway Corporation
Alistair Budge-Reid	Project Design Manager	Hong Kong Mass Transit Railway Corporation
Chris Calton	Design Manager (1)	Hong Kong Mass Transit Railway Corporation
Alastair W P Coutts	Design Manager (2)	Hong Kong Mass Transit Railway Corporation
Roland Paoletti	Chief Architect	Hong Kong Mass Transit Railway Corporation
Peter J White	Estates Construction Manager	Hong Kong Mass Transit Railway Corporation
Tim Watcyn-Jones	Project Co-ordinator	Hong Kong Mass Transit Railway Corporation

Name	Position	Organisation
Lawrence Wong	Partner	Freeman Fox & Partners, Consulting Engineers
George Gillot	Associate	Maunsell Consultants Asia, Consulting Engineers
Ray Crane	Associate	Ove Arup & Partners, Consulting Engineers
Ku Moon Lun	Partner	Langdon Every & Seah, Quantity Surveyors
Albert Cheung	Partner	Levett & Bailey, Quantity Surveyors
Bruce Humphrey	Partner	Rawlinson Russell & Partners, Quantity Surveyors

Details of the individual interviews are indicated below:

Name : **Bill J Greig**	Interview No : **01**
Position : **Projects Director**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Projects Directorate an opinion as to the usefulness of the Form 'X' control procedure from a strategic management perspective.

Main Points From Interview :

1. Mr Greig stated that he was in no doubt that the Form 'X' procedure was a major development which he had advocated for many years.
2. He stated that it was his idea to commission a control methodology and he had persuaded the Board to allow the experiment to take place.
3. Mr Greig stated that he had chaired the review meetings and had total responsibility for all project activity.
4. He stated that much of the success of the Corporation was due to his management of the construction process and paid tribute to his staff for their efforts.
5. Mr Greig argued that the procedure had been easy to implement but a number of senior project staff had complained over their lack of freedom and the bureaucracy of the system.
6. The Projects Director stressed on a number of occasions the need to complete the construction of the Island Line on time and within budget.
7. Mr Greig displayed a robust personality and had a high opinion of his ability to achieve the objectives of the organisation.
8. He stated that the Form 'X' procedure could have been used on every project he had ever worked on and was simple to operate.

Implications For The Methodology:

There is a need to speed up the process and to reduce the amount of paper within the system.

Name : **Bill R Donald**	Interview No : **02**
Position : **Commercial Manager**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Commercial and Claims Department an opinion as to whether the Form 'X' control procedure had been of assistance in negotiating with contractors over construction claims.

Main Points From Interview :

1 Mr Donald stated that he had reservations over the usefulness of the Form 'X' control methodology as it applied to construction claims. This was due to the fact that the conditions of contract allowed the contractor to give notice of his intention to claim but the contractor was not required to justify the claim at this stage.

2 He stated that, in most cases, he was able to reduce significantly the amount paid, either by proving that the claim was not justified or else by offering an immediate commercial settlement.

3 Mr Donald stated that the principal benefit of the Form 'X' system had been the fact that he had received details of any claims at an early juncture and information flow on Corporation contracts was better than in other organisations.

4 He said that the system generated a lot of paper, partly because the Projects Director insisted that all of the facts had to be presented and partly because project staff believed that the more information which was presented, the greater the chance of the proposal being accepted.

5 Mr Donald argued that the system could be improved by reducing the volume of information and by only using the system for design and construction changes.

Implications For The Methodology:

There would appear to be a need to reduce the amount of paper in the system and to consider whether claims notifications should be part of the procedure.

Name : **Robin Judd**	Interview No : **03**
Position : **Contracts Manager**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Contracts Department an opinion as to the effect of the Form 'X' control procedure on the Corporation's cost control process.

Main Points From Interview :

1 Mr Judd stated that he was thought the Form 'X' procedure had worked very well and had provided him with high quality technical and financial information.

2 He stated that the methodology had reduced the amount of changes which were notified to him.

3 Mr Judd stated that he attended the review meetings and had noted that the design and construction personnel proposing the changes appeared nervous and that they did not like the "grilling" which they received from the Projects Director.

4 He stated that good cost control was of crucial importance on construction contracts and the Form 'X' procedure had improved the control process.

5 Mr Judd stated that the procedure was very simple to follow and he had never experienced any difficulty in obtaining information from site.

6 He stated that the Contracts Administrators liked the system but the Construction Managers were less happy because they had to attend the review meetings.

7 Mr Judd stated that the Form 'X' had made his job easier as he no longer had to push site staff and consultants for information.

Implications For The Methodology:

There were no implications.

Name : **Harry Glennie**	Interview No : **04**
Position : **HQ Administrator**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the administrator responsible for processing the individual Form 'X's an opinion as to the usefulness of the procedure in keeping track of the changes proposed by the various designers.

Main Points From Interview :

1 Mr Glennie stated that the Form 'X' system was an excellent method of recording both potential and actual changes.

2 He stated that the Project Director had ensured that all potential changes were notified by Projects personnel and had left staff in no doubt as to his commitment to the new system.

3 Mr Glennie stated that the quality of information submitted had improved over time.

4 The HQ Administrator said that the amount of information which was being submitted had also increased over time and that he needed additional storage facilities to cope with all of the records/information.

5 Mr Glennie stated that the Corporation had far better information on the Form 'X' contracts than on other Corporation contracts.

Implications For The Methodology:

There would appear to be a need to reduce the amount of paper in the system.

Name : **George O Archer**	Interview No : **05**
Position : **Construction Manager (10)**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a Construction Manager an opinion as to the usefulness of the Form 'X' control procedure from a operational management perspective.

Main Points From Interview :

1 Mr Archer stated that he had nothing but praise for the Form 'X' system which he described as being long overdue.

2 He stated that the system had forced his staff to justify their need to change the design and he was able to use the system to ensure that he received information from both his staff and the contractors under his jurisdiction.

3 Mr Archer did make the comment that he felt that the need to refer all change management matters to the headquarters had reduced his authority.

4 He also stated that the process took time as there was the need to obtain and collate information and this could delay construction progress.

5 Mr Archer complained about the bureaucracy involved in the process and the fact that he needed additional clerical and secretarial support.

Implications For The Methodology:

There would appear to be a need to reduce the bureaucracy in the system and to accelerate the decision making process.

Name : **Frank G Storey**	Interview No : **06**
Position : **Construction Manager (11)**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a Construction Manager an opinion as to the usefulness of the Form 'X' control procedure from a operational management perspective.

Main Points From Interview :

1 Mr Storey stated that he had supported the Projects Director in his desire to introduce a cost control methodology as he understood the desire for greater control over the change management process.

2 He stated that the system had caused a number of difficulties as he had experienced problems in obtaining sufficient information to support his request for revisions.

3 Mr Storey stated that his staff resented the fact that they had to refer to headquarters in deciding whether a detail could be revised. He felt that his staff were usually better placed to decide on the validity of the request.

4 He also stated that the process took time and suggested that greater authority could be delegated to individual Construction Managers and their staff.

Implications For The Methodology:

There is a need to inform the Construction Manager of the reason for the introduction of the methodology.

Name : **Bill F M Love**	Interview No : **07**
Position : **Construction Manager (12)**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a Construction Manager an opinion as to the usefulness of the Form 'X' control procedure from a operational management perspective.

Main Points From Interview :

1 Mr Love stated that he believed that the Form 'X' methodology had both strengths and weaknesses.

2 He stated that the system required the production of large quantities of information to justify what was an obvious conclusion.

3 He also stated that the justification process took a huge amount of time which hindered staff undertake their site-based duties.

4 Mr Love concluded by acknowledging that there had been a need for a recording system to keep headquarters informed but stressed that the Form 'X' system was not required for his projects as he had always exercised good project control.

5 Mr Love made the point on a number of occasions that he had a track record of excellent project control but fully understood why the Projects Director had been determined to implement a cost-control procedure.

Implications For The Methodology:

There would appear to be a need to minimise the bureaucracy in the system.

Name : **Mike Ryan**	Interview No : **08**
Position : **Contracts Administrator**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a site-based quantity surveyor/contracts administrator an opinion as to the usefulness of the Form 'X' control procedure as a change management process.

Main Points From Interview :

1 Mr Ryan stated that the Form 'X' methodology was a good system but was hard work due to the need to obtain information for submission to headquarters.

2 He stated that the system could be used to persuade contractors to supply information and he used the excuse that headquarters required the information because of the Form 'X' procedure in order to get information on claims etc.

3 He also stated that the process was time-consuming and bureaucratic.

4 Mr Ryan stated that there was a need for a recording system to keep track of variations and he had no objection to the Form 'X' procedure.

5 He stated that he objected to the Projects Director's attitude to changes and felt that the system had established a blame culture and put pressure on staff not to propose changes.

6 Mr Ryan stated that all of his contracts could have been administered without using a cost control system as he was an experienced Contracts Administrator

Implications For The Methodology:

There is a need to speed up the process and to reduce the amount of paper in the system.

Name : **Ray Halstead**	Interview No : **09**
Position : **Contracts Administrator**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a site-based quantity surveyor/contracts administrator an opinion as to the usefulness of the Form 'X' control procedure as a change management process.

Main Points From Interview :

1 Mr Halstead stated that the Form 'X' methodology was only required due to the need to provide information for headquarters consumption.

2 He stated that the process was "a waste of time and effort".

3 He also stated that there was no need for a recording system on his contracts as he was a very experienced Contracts Administrator.

4 Mr Halstead stated that it was the Projects Director's attitude to change which mattered not the Form 'X' procedure.

5 Mr Halstead stated that the procedure could be improved by giving more authority to site-based staff.

6 He stated that he would not use the procedure if it was not mandatory.

Implications For The Methodology:

There is a need to simplify the process and consider the level of delegated authority.

Name : **John Falconer**	Interview No : **10**
Position : **Contracts Administrator**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a site-based quantity surveyor/contracts administrator an opinion as to the usefulness of the Form 'X' control procedure as a change management process.

Main Points From Interview :

1 Mr Falconer stated that he was a firm believer in the Form 'X' methodology.

2 He stated that the system was very logical and most of the information which was required should be held by the Contracts Administrator as a matter of course.

3 He also stated that the justification process was lengthy and that the Form 'X' submissions took a long time to circulate.

4 Mr Falconer stressed that the Form 'X' system was only required for project staff who did not have the experience to exercise good project control.

5 He stated that he used the system to persuade contractors to supply information which they had been reluctant to supply.

6 He also stated that the process relied too much on the flow of paper.

Implications For The Methodology:

There is a need to reduce bureaucracy and the amount of paper in the system.

Name : **Gordon A Sapstead**	Interview No : **11**
Position : **Engineering Director**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Engineering Directorate an opinion as to the usefulness of the Form 'X' control procedure from a strategic management perspective.

Main Points From Interview :

1 Mr Sapstead stated that the Form 'X' procedure was an excellent system for recording changes and he had encouraged all of the staff in his Directorate to support the new system.

2 He stated that it was his idea to commission a control methodology and he had persuaded the Board to allow the experiment to take place.

3 He stated that he had responsibility for all engineering activity in the Corporation.

4 The Engineering Director stressed on a number of occasions the need to complete the construction of the Island Line on time and within budget.

5 Mr Sapstead displayed a relaxed personality and said that he was happy for others in the organisation to take the credit for the success of the construction of the Island Line.

6 He stated that the Form 'X' procedure was popular with his staff and with the external consultants.

7 He stated that he would like to revise a number of the Form 'X' forms as he did not like the final design which he said was over complicated.

Implications For The Methodology:

There may be a need to simplify the forms.

Name : **David Sharpe**	Interview No : **12**
Position : **Chief Civil Engineer**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Chief Civil Engineer an opinion as to the usefulness of the Form 'X' control procedure from an operational management perspective.

Main Points From Interview :

1 Mr Sharpe stated that the Form 'X' procedure had aided communication and had resulted in the Executive team having a far clearer understanding of problem areas.

2 He stated that the procedure had ensured that Design Managers, and external consultants, properly recorded change submissions and also ensured that they had the support documentation to enable them to justify the reason for the change.

3 He stated that time was not the most important criteria in determining change and a robust recording mechanism was important.

4 Mr Sharpe said that the Form 'X' system was easy to operate and all of his staff were aware of the new procedure.

5 He added that the design consultants had complained about the procedure due to the additional paperwork involved but only because they wished additional fees.

6 Mr Sharpe said that he did not consider the paperwork to be excessive and adequate documentation was important.

7 He stated that there were a number of persons in the Corporation who did not think the Form 'X' procedure should apply to claims notifications.

8 He concluded by stating that the methodology had forced site staff to be far more thorough and this was a good thing.

Implications For The Methodology:

There is a need to reduce bureaucracy and the amount of paper in the system.

Name : **Alastair Budge-Reid**	Interview No : **13**
Position : **Project Design Manager**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Design Department an opinion as to the usefulness of the Form 'X' control procedure from an operational management perspective.

Main Points From Interview :

1 Mr Budge-Reid stated that the Form 'X' procedure had made a considerable difference to the Corporation as it had revolutionised the amount of information which was available.

2 He said that the Form 'X' system had been helpful to him as a method of ensuring that the design consultants supplied information on proposed design changes.

3 He said that the design consultants liked the system but not the amount of paperwork involved in progressing change requests.

4 Mr Budge-Reid said that any system to control design changes would be helpful to the organisation.

Implications For The Methodology:

None.

Name : **Chris Calton**	Interview No : **14**
Position : **Design Manager (1)**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a design administrator an opinion as to the usefulness of the Form 'X' control procedure as a change management process.

Main Points From Interview :

1 Mr Calton stated that the Form 'X' procedure had assisted him in recording potential cost increases.

2 He also stated that the need to submit the Form 'X's to a review committee acted as an inhibitor to change.

3 Mr Calton complained that the methodology was time-consuming and he constantly had to push engineering staff for design information.

4 He stated that the design consultants had complained about the additional paperwork which the Form 'X' demanded.

5 Mr Calton acknowledged that the Form 'X' system did require additional information and the design consultants had cause for complaint.

6 He concluded by stating that he valued the new system but it had increased his workload.

Implications For The Methodology:

There is a need to reduce the paperwork in the system.

Name : **Alastair W P Coutts**	Interview No : **15**
Position : **Design Manager (2)**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a design administrator an opinion as to the usefulness of the Form 'X' control procedure as a change management process.

Main Points From Interview :

1 Mr Coutts stated that the Form 'X' procedure was an excellent procedure which ensured that adequate information was provided for senior management.

2 He also stated that the need to submit design changes to a review committee had prevented any non-essential changes.

3 Mr Coutts advised that the methodology was time-consuming and bureaucratic.

4 He stated that the design consultants had complained about the need to comply with the requirements of the Form 'X' methodology.

5 Mr Coutts stated that he had little sympathy for the design consultants as the supply of information was the key to cost control.

6 He concluded by stating that the Form 'X' methodology had been of considerable assistance to the Corporation.

Implications For The Methodology:

None.

Name : **Roland Paoletti**	Interview No : **16**
Position : **Chief Architect**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Chief Architect an opinion as to the usefulness of the Form 'X' control procedure from an operational management perspective.

Main Points From Interview :

1 Mr Paoletti stated that he had no opinion on the Form 'X' procedure as he had little need to change the architectural design.

2 He stated that he did not have any view on the need for a recording mechanism.

3 Mr Paoletti showed a distinct lack of interest in answering questions on the methodology and merely stated that, as an experienced architect, he required little assistance to discharge his duties.

Implications For The Methodology:

None.

Name : **Peter J White**	Interview No : **17**
Position : **Estates Construction Manager**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from the Head of the Estates Construction Department an opinion as to the effect of the Form 'X' control procedure on the Corporation's design process.

Main Points From Interview :

1 Mr White stated that the Form 'X' procedure was an important methodology for the control of construction costs.

2 He stated that success of the methodology was due to the nature of the process and the high quality of Corporation personnel.

3 He also stated that the procedure had been easy to implement.

4 He stated that the Form 'X' procedure could be used on building projects and that that had been the original intention.

Implications For The Methodology:

None.

Name : **Tim F Watcyn-Jones**	Interview No : **18**
Position : **Project Co-ordinator**	
Organisation : **Hong Kong Mass Transit Railway Corporation**	

Objective of Interview:

To obtain from a member of the Estates Construction Department an opinion as to the effect of the Form 'X' control procedure on the Corporation's design process.

Main Points From Interview :

1 Mr Watcyn-Jones stated that he had little contact with the Form 'X' procedure other than to receive copies of submissions which had an effect on his builders work contracts.

2 He stated that methodology appeared to be an appropriate way to control costs.

3 He stated that he would be concerned if the methodology was introduced for all types of projects as it would result in a considerable increase in paperwork..

4 He concluded by saying that it appeared to be an excellent system "in theory" but it might be too bureaucratic in practice.

Implications For The Methodology:

None.

Name : **Lawrence Wong**	Interview No : **19**
Position : **Partner**	
Organisation : **Freeman Fox & Partners, Consulting Engineers**	

Objective of Interview:

To obtain from one of the Corporation's design consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1 Mr Wong stated that he had supported the Corporation in the introduction the Form 'X' procedure which was designed to limit project costs.

2 He stated that the Corporation intended to introduce the system on all Corporation contracts as the system had worked on a number of projects.

3 Mr Wong stated that while the procedure was easy to implement it was a very slow decision making process.

4 He also stated that the Form 'X' methodology was bureaucratic and required a great deal of administrative support.

5 He concluded by stating that the success of the Corporation was due to its consultants who were amongst the most experienced in the world.

Implications For The Methodology:

There is a need to reduce bureaucracy and the amount of paper in the system.

Name : **George Gillot**	Interview No : **20**
Position : **Associate**	
Organisation : **Maunsell Consultants Asia, Consulting Engineers**	

<u>Objective of Interview:</u>

To obtain from one of the Corporation's design consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1 Mr Gillot stated that the Form 'X' procedure was an extremely time-consuming process.

2 He complained about the need to complete Form 'X' submissions and the delay in arriving at a decision.

3 He said that the system could be improved by delegating more authority to individual Design Managers.

4 Mr Gillot stated that while the procedure was easy to implement, it tied up a great deal of resources.

5 He questioned the need for a Form 'X' to be raised for every design change

6 He concluded by stating that the new procedure ignored the fact that the design consultants were staffed by extremely experienced and well qualified engineers.

<u>Implications For The Methodology:</u>

There is a need to educate the consultants as to the real benefits of the methodology to the design consultants.

Name : **Ray Crane**	Interview No : **21**
Position : **Associate**	
Organisation : **Ove Arup & Partners, Consulting Engineers**	

Objective of Interview:

To obtain from one of the Corporation's design consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1. Mr Crane stated that the Form 'X' procedure was an important break-through as it was a means of regulating design changes.
2. He stated that the system which had been introduced by the Corporation put financial control at the top of its agenda and this had resulted in resources being channelled into the administration of design changes.
3. He stated, however, that the Corporation needed to streamline the procedure to reduce the amount of time spent on preparing submissions.
4. Mr Crane was critical of the bureaucratic nature of the procedure and the fact that his staff were required to submit detailed reports to justify their actions.

Implications For The Methodology:

There is a need to reduce bureaucracy and the amount of paper in the system.

Name : **Ku Moon Lun**	Interview No : **22**
Position : **Partner**	
Organisation : **Langdon Every & Seah, Quantity Surveyors**	

<u>*Objective of Interview:*</u>

To obtain from one of the Corporation's contracts consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1 Mr Ku stated that the Form 'X' procedure had forced contractors to submit information to justify any claims for an extension of time.

2 He also stated that procedure had forced the design consultants to submit much more information than had normally been the case in the past to justify a change application.

3 Mr Ku indicated that the Form 'X' procedure was "painfully slow" but "the end had justified the means".

4 He stated that his staff liked the system as they were able to compile accurate records of the project.

5 He stressed on a number of occasions that he enjoyed working on Corporation contracts and had an excellent working relationship with Corporation personnel.

6 He also said that the senior managers he dealt with in the Corporation were in fear of the reaction of the Projects Director to increases in project cost as a result of changes or contractual claims.

<u>**Implications For The Methodology:**</u>

There is a need to speed up the process and reduce the amount of paperwork within the system.

Name : **Albert Cheung**	Interview No : **23**
Position : **Partner**	
Organisation : **Levett & Bailey, Quantity Surveyors**	

Objective of Interview:

To obtain from one of the Corporation's contracts consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1. Mr Cheung stated that the Form 'X' procedure had been successfully used on projects under his jurisdiction.
2. He stated that he had reservations over the system as he has found it very time consuming.
3. He advised that the Form 'X' procedure had slowed up the decision making process due to the need to obtain the signatures of all of the design consultants prior to submission of the Form 'X' to the Corporation.
4. Mr Cheung stated that the procedure had forced all of the parties to provide information and to be part of the decision making process.
5. He stated that the senior managers he dealt with in the Corporation were keener on the new system than he was.

Implications For The Methodology:

There is a need to simplify the process to make it less time-consuming..

Name : **Bruce Humphrey**	Interview No : **24**
Position : **Partner**	
Organisation : **Rawlinson Russell & Partners, Quantity Surveyors**	

Objective of Interview:

To obtain from one of the Corporation's contracts consultants an opinion as to the usefulness of the Form 'X' control procedure as a management device.

Main Points From Interview :

1. Mr Humphrey stated that the Form 'X' procedure was an important innovation and his organisation would like to use it on projects for another client.
2. He stated that the Corporation should be commended for the introduction of the system which he said could be used on both building and civil engineering contracts.
3. He stated, however, that the success of the Corporation was due to its management of the construction process and it was the senior people in the organisation, and their use of modern techniques, which made the organisation so good at financial control.
4. Mr Humphrey stated that while the procedure was easy to implement it was quite slow as the Form 'X' submissions could take a long time to be seen by all of the designated parties.
5. He said that firms should be entitled to additional fees for using the system as it required consultants to devote additional resources to Form 'X' contracts.
6. He concluded by stating that he was a Chartered Quantity Surveyor who had the experience to comment objectively on the new procedure.

Implications For The Methodology:

There is a need to speed up the process.