# PRODUCTIVITY IN THE CONSTRUCTION INDUSTRY IN THE REPUBLIC OF SOUTH AFRICA - A HOLISTIC APPROACH TO RESOURCES UTILIZATION

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A thesis submitted to the Faculty of Architecture,
University of the Witwatersrand, Johannesburg,
in fulfillment of the requirements for the degree of Doctor of Philosophy.

JOHANNESBURG 1990

## DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Harry Lampert

3rd day of August 1990

## ABSTRACT

The productivity of the construction industry is recognised internationally as being of a low order, and the productivity of the South African construction industry rates below that of the first world countries.

The purpose of the research reported in this thesis was to identify the major causes of the low productivity; the reasons for the industry's intractability; and to develop proposals for the improvement of productivity through improved utilization of the industry's resources.

An extensive review of site practices revealed that a major factor responsible for the lack of productivity is the inadequate awareness on the part of management and supervisory staff of the need for and the techniques of effective resource utilization. Contributing to this failure by management are inadequate procedures for the measurement of productivity; for the planning of labour requirements; for the control of labour and materials; and for maintaining communication with, and motivation of the workforce.

The author's thesis is that improvement in productivity can only be achieved through the analysis of the problems and the synthesis of a solution on the basis of a holistic approach. It is fundamental to this thesis that a piecemeal approach to productivity cannot lead to overall improvement in productivity. On the basis of an analysis of the construction process the author has developed an interactive model illustrating the role of the many components, including the management functions, and their influence on productivity.

This model was tested by application to operations on actual building sites.

Once the analysis of the process and its constraints had been completed, innovative procedures, designed to overcome some of the main obstacles that had been identified, were developed, tried on site and evaluated.

These procedures include systems for the evaluation of management performance; for the recording of lost time; for improved communication and participation; for the implementation of motivational gain-sharing; and for the better handling of materials on site.

To evaluate the success of these measures it was necessary to develop appropriate measuring techniques; and a method based on a productivity ratio, for determining overall productivity has been proposed and demonstrated.

Application of this measurement method to construction contracts allowed the author to confirm both that his analysis of the construction process was accurate and that the innovations he proposed would have the predicted results.

Using the information gained from this research, he was able to establish a Klein-type econometric model relating the various inputs to the construction process to the outputs, quantitatively.

This model was tested against actual construction contracts and it will be shown that the model is applicable and provides valuable guidelines for the improvement of overall productivity. Further refinement of the model led to the development of a hierarchical rating of the contribution of the various management function inputs to the productivity process. This allows the model to be applied by the contractor to a wide variety of contracts since it can accommodate different priority ratings according to the demands of individual contracts.

It is therefore the author's contention that he has confirmed his thesis namely:

- that the productivity of the construction industry is inherently low;
- that the South African building industry has peculiar problems;
- that it is possible to improve the productivity of the industry;
- that it is only possible to improve productivity by improving the exercise of all the management functions, and applying them in a holistic manner
- that it is possible to quantify the relationship between the various inputs and the eventual output;
- that the author's proposed model will allow the building contractor to manage the productivity of the construction process more effectively.

TO

PETIE

In appreciation of her constant love, devotion and encouragement

## PREFACE

Knowledge is compounded through inquiry and search; and knowledge shared is knowledge gained. Ideas cannot survive in isolation. They require interaction and interpretation in order to grow and develop. The ultimate test of ideas is their practical application and their contribution to beneficial progress. They are the building blocks upon which development survives and prospers.

The effective utilization of resources is a subject to which I have devoted many years of study during the course of my professional practice as engineer and management consultant. Entree into the construction industry afforded me the opportunity to study site practices, identify shortcomings, and hence develop and implement solutions which resulted in better productivity. In this 'instant' age there is a tendency to apply a fragmented approach to achieving improvements - the application of the "quick fix". There appears to be insufficient time to put it all together and get it right the first time. But there is enough time to do the inevitable rework.

These observations prompted me to develop a holistic approach to productivity improvement - an approach that includes the effective practice of all the main management functions and the application of innovative materials handling methods.

The research associated with this thesis, and the interchange of thoughts and ideas with friends and teachers in academe, has been an instructive and rewarding experience.

To learn and disseminate knowledge is, indeed, a special privilege, and an occasion for thanksgiving.

**ACKNOWLEDGEMENTS**

This research could not have been accomplished without the opportunities provided by my clients and friends in the construction industry. My sincere thanks to them all for the privilege of exchanged thoughts and shared ideas.

A special word of thanks to Professor John Morris, AECI, Professor of Building Science, for his guidance and advice, and the many hours of discussion which helped to bring this thesis to fruition.

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Professor L P Fatti, Head of the Department of Statistics, for his suggestions regarding mathematical relationships;

And to all my friends in Academe for their direction and stimulation.

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## GLOSSARY

| | | |
|---|---|---|
| BIFSA | - | Building Industries Federation of South Africa |
| CSIR | - | Council for Scientific and Industrial Research |
| EBT | - | Earnings before tax |
| EBIT | - | Earnings before interest and tax |
| MBA | - | Master Builder's Association |
| MFPR | - | Management function performance rating |
| MFPR(aa) | - | Actual MFPR rating after the introduction of innovation |
| MFPR(ba) | - | Actual MFPR rating before the introduction of innovation |
| MFPR(max) | - | Maximum management function performance rating |
| MFV | - | Management function value |
| MIF | - | Management input factor |
| MPI | - | Management performance index |
| MU | - | Management unit |
| NIPR | - | National Institute for Personnel Research |
| NPI | - | National Productivity Institute |
| P & G | - | Preliminary and general (costs) |
| P.Q.S. | - | Professional quantity surveyor |
| RMUS | - | Relative Management units |
| RSA | - | Republic of South Africa |
| RVR | - | Relative value rating |
| SAFCEC | - | South African Federation of Civil Engineering Contractors |
| TMPR | - | Total management performance rating |
| TMPR(max) | - | Maximum total management performance rating |

# CHAPTER 1

## INTRODUCTION

### SYNOPSIS

The construction industry and its methods are markedly different from a repetitive manufacturing type of operation. Every contract is unique in location, terrain, design, specified materials, and labour skills requirements. This presents management with numerous challenges in the areas of resources utilization; and the research will show that the industry is not using its resources effectively, and that this has resulted in low levels of productivity. It is further suggested that the industry's low productivity has contributed to inflation.

The importance of the construction industry in the national economy and as a community service, and its low productivity, prompted the author to research the reasons for the existing deficiencies; and this led to the development of the holistic approach to productivity improvement.

Productivity is defined, and the existing productivity inhibitors are identified.

The inputs and resources used in the construction industry are illustrated, and the interactions and factors affecting the construction process are discussed.

The reader's guide at the end of the chapter provides a precis of the contents of this thesis.

# 1. INTRODUCTION

Construction is an interdependent discipline that involves human conception, innovation, creativity, and the effective utilization of people, materials, machinery, energy and money, culminating in the completed structure conforming to the designer's conception, and the owner's requirements.

The successful execution of the construction process thus requires a holistic approach to the utilization of the resources involved.

Past approaches to productivity improvement have been piecemeal, with concentration on improving individual factors. But no record could be traced of a holistic approach to productivity in this industry. This becomes evident from a review of past South African research and the related literature, ref. section 2.9.

Technological advancement has resulted in the fragmentation of disciplines, and circumstances have arisen where specialities become an end in themselves, providing partial solutions. This has been characterized by the introduction of the programme evaluation and review technique (PERT), and the critical path method (CPM) of programming and planning. Whilst these are useful planning and control methods, they are not a substitute for overall effective contract management.

The purpose of this research was to investigate productivity in the construction industry, identify the inhibiting factors and develop solutions that would lead to demonstrable improvements in productivity. Some of the factors responsible for poor productivity could be identified but are not amenable to experimental manipulation to prove the postulate that their elimination would bring about improvements. Such factors are the poor education available to people who constitute the cadre of 'general workers' in the construction industry and the discriminatory legislation that has affected the entire workforce for generations.

The solutions which are proposed envisage an idealized situation in which the inhibiting factors are amended, and innovative proposals implemented in holistic fashion. The realization of this situation is, perforce, dependent on the adaptability of the entire construction community and its commitment to change; and in the case of education and training, an extended period of time.

During the course of the research it was possible to apply and test the holistic approach with regard to the management functions of planning, organization, measurement, control, co-ordination, communication, participation and motivation.

The application of the innovative concepts which were developed in these areas was tested, and proved to be economically beneficial to all concerned.

People are the most important element in the productivity equation, and it will be shown that eighty percent of site labour is mainly engaged in handling and transporting materials. These facts prompted the development of simplified working procedures and the introduction of innovative handling methods which resulted in improved labour productivity. Thus materials handling constituted an integral part of the holistic approach to resources utilization.

This research was constrained with regard to the measurement of results in some of the areas investigated. The average life span of the construction projects researched was approximately eighteen months. While it was possible to make recommendations for improvement during this period, it was not always possible to implement them fully, and hence to measure the results achieved.

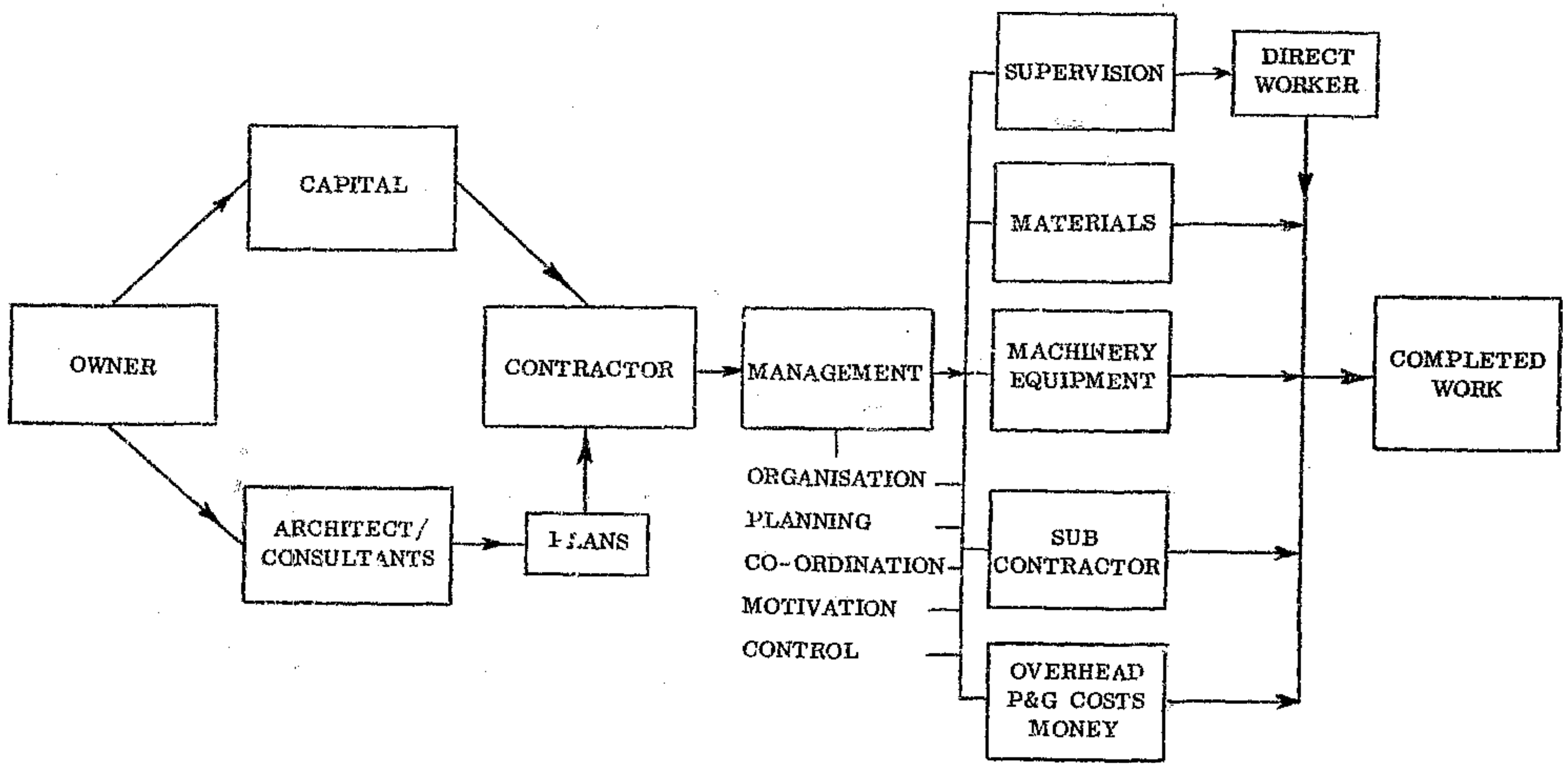


FIGURE 1.1 CONSTRUCTION PROCESS MODEL

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## 1.1 Limitations of Research

This study has been limited to the formal sector of the construction industry which is responsible for most of South Africa's construction activities.

Black workers constitute approximately 85% of the labour force, and their main task is materials handling. Their productivity is therefore fundamental to the productivity of the industry. The research with regard to manpower productivity has therefore been mainly concentrated on the black labour component.

## 1.2 The Importance of Productivity

The wealth of a country is dependent upon how effectively the country's resources are being utilized - the extent to which they are productively employed. This point is emphasized by Sir John Hedley Greenborough, deputy chairman, Shell U.K. Ltd. in his introduction to "*Productivity Measurement*", Baily and Hubert (1980: xxxii).

"*Productivity is, in practice, the essential link in the chain between investment and the growth of economic prosperity. Its continuous improvement is vital to justify the former and bring about the latter, and it is therefore an essential task of management to monitor and control it.*"

The observations of Frederick Winslow Taylor (1917) are equally applicable today, viz:

"*The greatest prosperity can exist only as the result of the greatest possible productivity of the men and machines of the establishment*"

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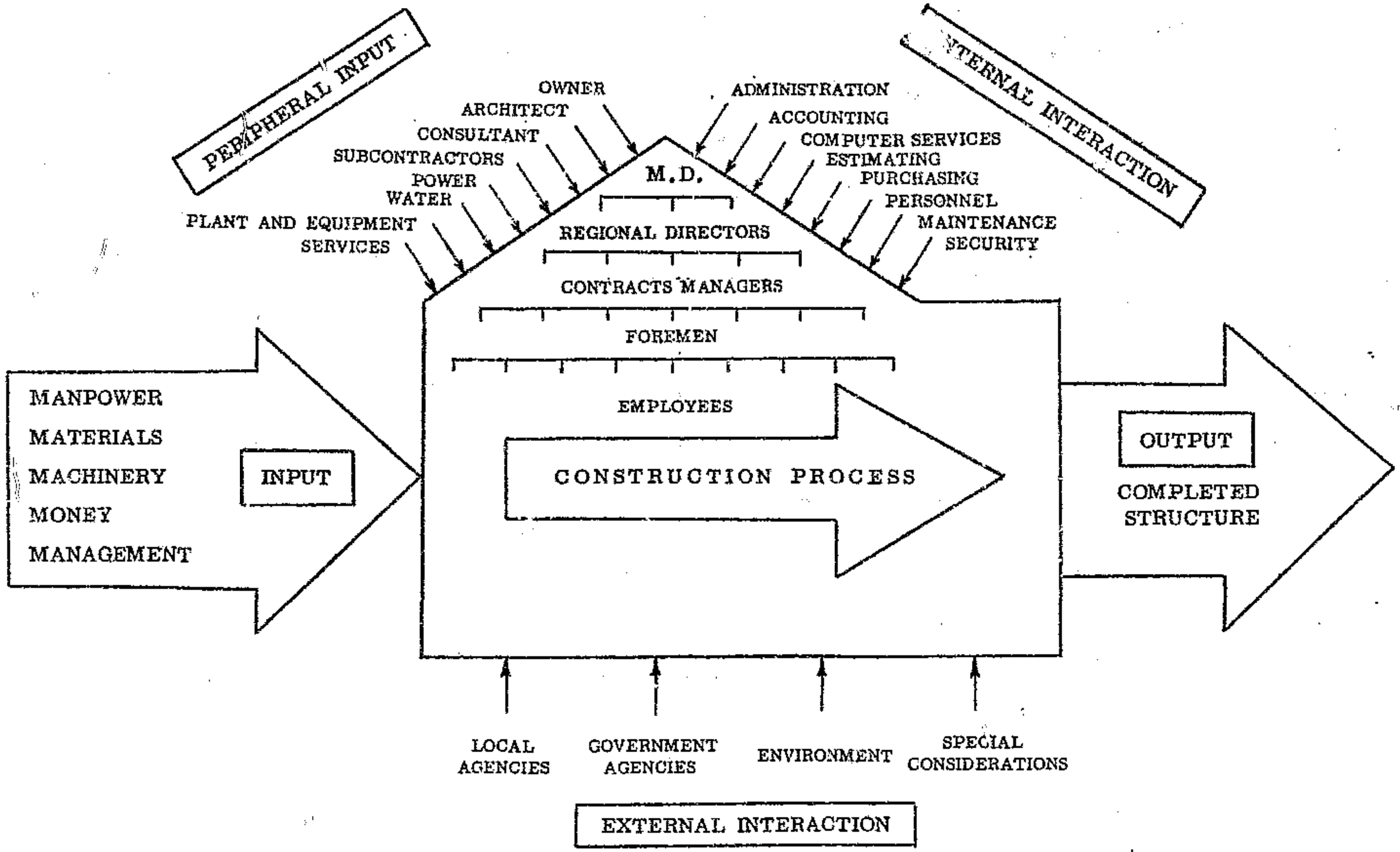


FIGURE 1.2 INTERACTIONS AND FACTORS AFFECTING THE CONSTRUCTION PROCESS

To this must be added total resources, i.e. capital, materials, energy and management.

Productivity is a commonly used phrase which is often not understood in its economic context, and is confused with production. Productivity and production are often regarded as synonymous.

Production can be increased by merely applying more resources i.e. man power, materials and machinery. However productivity can, and often is, adversely affected by the application of additional resources.

## 1.3 Definition of Productivity

Economic productivity is the relationship between output achieved and the resources applied to achieve this output, within a given time and to a given quality standard. Hence productivity can be stated as :

$$\text{Productivity} = \frac{\text{Output}}{\text{Resources Input}}$$

Production, on the other hand, is the aggregate units produced, irrespective of the resources input.

In order to measure productivity it is necessary to define further the resources being applied, and the resultant output, i.e., the end product.

Figure 1.1 was developed to illustrate inputs in the construction process, and the resultant output in the form of completed work. Five main resources are used. These are :

- Manpower
- Materials
- Machinery and equipment
- Money (Capital)
- Management

Subcontract work also requires the above resources, but is shown as a separate activity.

The effective utilization and control of resources is dependent on the management functions of organization, planning, co-ordination, motivation and control. The effect of these functions on productivity improvement is discussed in chapters 12, 13 and 14.

## 1.4 Interactions and Factors affecting the Construction Process

Figure 1.2 illustrates the interactions and factors which affect the construction process. All the inputs and internal and external interactions affect productivity and resources utilization.

These inputs and interactions require a high degree of management planning, co-ordination and control, and the practical aspects of these management functions are discussed in chapters 12, 13 and 14.

The successful and timeous start to a contract is largely dependent on management's successful interaction with the external local and governmental agencies, and taking cognisance of the environment and any special site and local considerations.

Co-ordination and productive relationships with the owners, consultants and sub-contractors are vital to the economic success of the project. Similar, site personnel cannot work effectively without positive interaction and a productive in-house relationship with the service divisions of the company, i.e. administration, personnel, purchasing, et al.

It must be appreciated that every construction/building enterprise is unique by virtue of the fact that it consists of an association of people who are individually unique. Thus as Katzell (1975:36) states :

*"A cookbook approach will not solve the complex problems of productivity."*

The multiplicity of inputs and interactions further stresses the importance of attention to detail and a caring and concern for the people involved, and the resources employed. In practice, a multitude of small improvements, which in themselves may not appear to be significant, add up to a lot, and can make a significant financial contribution to the overall results of a construction project.

Productivity is thus dependent on multifaceted inputs and interactions, and in these circumstances there is no single simplistic riposte to the challenge of productivity improvement. The practical answer to productivity improvement must thus be sought in a holistic systems approach such as is presented in the interactive model in figure 2.2.

## 1.5 The Construction Industry as a Community Service

The material wellbeing of a community is dependent upon its capacity to produce the basic necessities for sustaining life i.e. food, clothing and shelter.

The Construction industry provides shelter and employment; but its contributions to the community are far wider, ranging through the construction of manufacturing premises, industrial plants, commercial buildings, educational, civil and governmental institutions, hotels, domestic dwellings, et al. Thus the industry makes a major contribution towards providing the community with the essential infrastructure required for community sustenance and development.

The cost of construction has a major impact on the overall cost of living. Excessive construction costs add to the user cost of the facility in perpetuity. For example :

- The cost of building a hotel will be reflected in the daily rental of each room, and any excess construction cost will be borne by the hotel guest.

- The cost of building a manufacturing plant will be partly borne by the end user of the manufacturer's products.

- The cost of a commercial building will have to be borne by the clients using the company's services.

- The houseowner, because of high building costs, ends up with a smaller disposable income.

- Taxpayers have to carry the burden of the cost of public buildings.

Thus the cost of construction directly affects every member of the community; and it is therefore in everyone's interest to improve the utilization of the resources employed in the industry. This will result in increases in economic productivity; lower construction costs, and ultimately, a better quality of life.

## 1.6 Productivity and Inflation

The low levels of productivity in the Republic of South Africa, and the construction industry in particular, are a matter of grave national concern. Construction statistics published by the National Productivity Institute (1988) indicate an average annual multifactor productivity growth rate of 0.6 for the period 1970 - 1986. Increases in construction costs during this period have exceeded the increase in consumer price index, indicating that the industry has been contributing to inflation.

This serious situation presents a challenge to both the state and private enterprise to commit themselves to change and innovation. It is essential that the established premises be questioned; that better methods be developed and implemented; and hence a better result obtained. Improved results cannot be expected whilst maintaining the same input in method, practice and philosophy.

## 1.7 Productivity Inhibitors

During the course of the research it was found that most loss making construction contracts were badly managed, and that contributory factors to poor productivity (resources utilization) included :

- inadequate site and general planning;
- poor supervision;
- inadequate materials and equipment scheduling;
- excessive labour on site;
- ineffective worker motivation and application;
- lack of awareness regarding work simplification;
- lack of appreciation that construction is a materials handling exercise;

- unimaginative materials handling;
- inadequate measurement procedures;
- poor management of innovative technology;
- an overall lack of commitment;
- the need for rework;
- lack of labour skills.

Low productivity is thus the product of poor management. This is in concert with the philosophy that there is no such thing as a bad business, but only bad management.

The construction scene is generally beset with an urgency to complete contracts in accordance with a committed programme, and to produce short term results and to maximize profits. Completion of contracts is often achieved at excessive costs in overtime; and short term results are achieved at a sacrifice in both long term development of manpower resources, and overall economic growth and stability.

Thus the lack of commitment to the development of manpower resources has contributed to poor workmanship and excessive working costs.

The losses recorded by some of the largest construction groups in recent years are testimony to their inability to meet the challenges of achieving higher productivity in an increasingly competitive market.

This situation is not unique to South Africa. Arnold Judson (1982: 93) who studied 236 top executives representing 195 U.S. industrial companies commented :

*"Only recently have managers in the private sector begun to acknowledge openly that much of the responsibility for their companies' poor productivity lies at their own door. True, they*

*have not ignored the issue of productivity improvement, as some critics claim; they have, instead, defined their efforts too narrowly, administered them in too disjoint a fashion, controlled them with too short a time horizon in mind, organized them with too little attention to how well they fit with the overall business strategy, and implemented them without the wholehearted involvement of top management."*

Management is, indeed, responsible for improvements in productivity. It is their responsibility to make things happen - for the better, and this can only be achieved by optimising the utilization of the resources at their disposal.

**READER'S GUIDE**

Chapter 2 outlines the problem to be researched and postulates a hypothesis regarding the factors contributing to low productivity. An interactive systems model is described which represents the construction process. The methodology employed in this research is described, and past South African research and related literature are discussed.

Chapter 3 discusses the position of the construction industry within the South African economy. The industry's productivity is compared with that of other industries, and South Africa's national productivity is compared with that of other countries.

Chapter 4 sets out the background and characteristics of the labour force employed in the construction industry.

Chapter 5 provides historical data regarding the restrictive legislation which has inhibited the development of skills amongst black workers. Past and present training schemes are discussed, and recommendations are made regarding the improved and accelerated training of black workers.

Black education and its effect on the development of cognitive skills is reviewed in chapter 6, in the context of labour productivity. Comparisons are drawn between black and white education standards, and the level of education of employees in the South African construction industry and that existing in other countries. It is concluded that a greater emphasis should be placed on technical education at school level; and recommendations are made for technical education and skills training in black schools.

Chapters 7, 8, 9 and 10 deal with the principles and inherent difficulties in measuring the productivity of labour, materials and of the total contract. Discrete measures of productivity are discussed and an overall economic measure of contract productivity is developed. Recommendations are submitted for this measure of productivity to be adopted for measuring and comparing inter-company productivity levels for the various sectors in the construction industry.

Chapter 11 deals with materials handling and work simplification. A description is given of the methods and equipment which were developed during the course of this research, to safeguard materials and equipment, and reduce labour costs through simplified handling of materials.

Chapter 12 discusses various productivity losses which were identified during the course of the research, and the solutions which were applied to reduce these losses.

Chapter 13 deals with the management functions and their effect on productivity. These functions comprise organization, planning, motivation, communication and control.

Organization deals with the importance of clearly defining functional responsibilities on site, so that duplication and omission of functions is avoided. The section on planning discusses planning of activities, and the economic allocation of labour resources to these activities at site level. It is shown how this planning procedure is integrated with labour cost control, and a bonus incentive plan for hourly paid workers.

Chapter 14 presents the perceptions of employees of their employers and supervisors. The applications of exercises in participation and communication are discussed, and the results of applying the cybernetic discussion technique are presented in the form of a "Building and Construction Site Vade Mecum" (Appendix C).

Chapter 15 deals with motivation, and identifies the main inhibitors of site productivity and discusses their elimination. Details of a group gain-sharing plan which has been developed and based on the concept of production value, are presented, and the results of its application are discussed.

Chapter 16 discusses the principles of holism and describes how the innovations which were developed during the course of the research, were applied to provide a holistic systems approach to productivity improvement.

The place and interaction of the different elements in the productivity improvement process are illustrated in a conceptual presentation in fig. 16.1. The dynamics of the interactions between management function inputs and resultant outputs are developed by means of a Klein-type econometric model. The method of testing the hypothesis is described. The test method involved the development of a measure for assessing a MPI (management performance index) and it was found that there was a close correlation between the MPI and the productivity ratio. This confirmed the positive advantages of the holistic approach to productivity improvement.

Chapter 17 presents a discussion and conclusions.

Chapter 18 sets out the recommendations.

# CHAPTER 2

## STATEMENT OF THE PROBLEM AND THE HYPOTHESIS

### SYNOPSIS

This chapter defines the problem to be researched, and postulates a hypothesis regarding the factors contributing to low productivity.

An interactive systems model is described which represents the construction process, and this model is used to evaluate the various components of the system.

The methodology involved the study of site operations, and consultations with management and employees regarding the practice of management functions and resources utilization.

Past South African research and related literature are discussed.

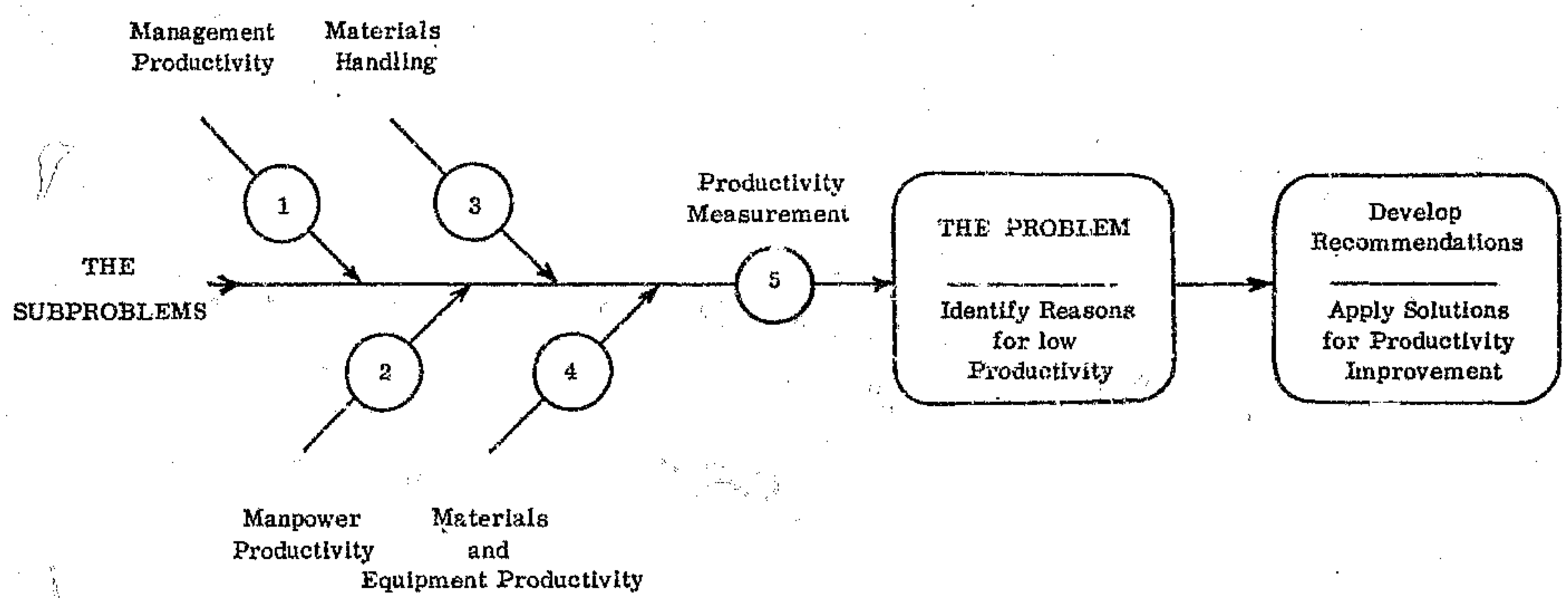


FIGURE 2.1 OUTLINE (DELIMITATION) OF RESEARCH

# 2. STATEMENT OF THE PROBLEM

According to National Productivity Institute (NPI) productivity statistics, Fig 3.5, there has been little improvement in productivity in the construction industry since 1970. The purpose of this research was to identify the reasons for the absence of productivity improvement, and hence develop recommendations and solutions to help improve resource utilization and thus increase productivity.

Fig 2.1 shows an outline of the proposed research, and the relevant subproblems which will now be defined.

## 2.1 The First Subproblem

The first subproblem is the variable effectiveness of managers and supervisors in utilizing the resources available to them - manpower, materials, machinery and capital. It is proposed to investigate their current practices in exercising their managerial and supervisory functions, and develop recommendations which will assist them in the areas of organization, planning, co-ordination, motivation and control.

## 2.2 The Second Subproblem

The second subproblem is manpower productivity. It is proposed to investigate the characteristics of the manpower employed in the industry; identify the factors which inhibit manpower productivity; and develop ways and means to reduce or remove the inhibitors.

## 2.3 The Third Subproblem

Approximately 80% of the labour employed in the construction industry is engaged in materials handling and the construction process should therefore be viewed as being largely a materials handling exercise. It is proposed to investigate the effectiveness of handling practices and hence develop recommendations for work simplification and improvements in materials handling. Any improvements in these areas of activity will, perforce, contribute to improvements in productivity.

## 2.4 The Fourth Subproblem

The fourth subproblem is the utilization of materials, machinery and equipment. It is proposed to establish the potential for increasing productivity by reducing wastage and improving utilization.

## 2.5 The Fifth Subproblem

The fifth subproblem is the measurement of productivity. It is proposed to establish a realistic method for measuring productivity which will permit the identification of changes in productivity and the effectiveness of resources utilization.

## 2.6 The Hypothesis

Low productivity is due to many factors. The most important factor is the failure of management to ensure the optimal utilization of the resources at its disposal: materials, plant, capital, energy and, most important of all, manpower. Important factors contributing to managements' failure are :

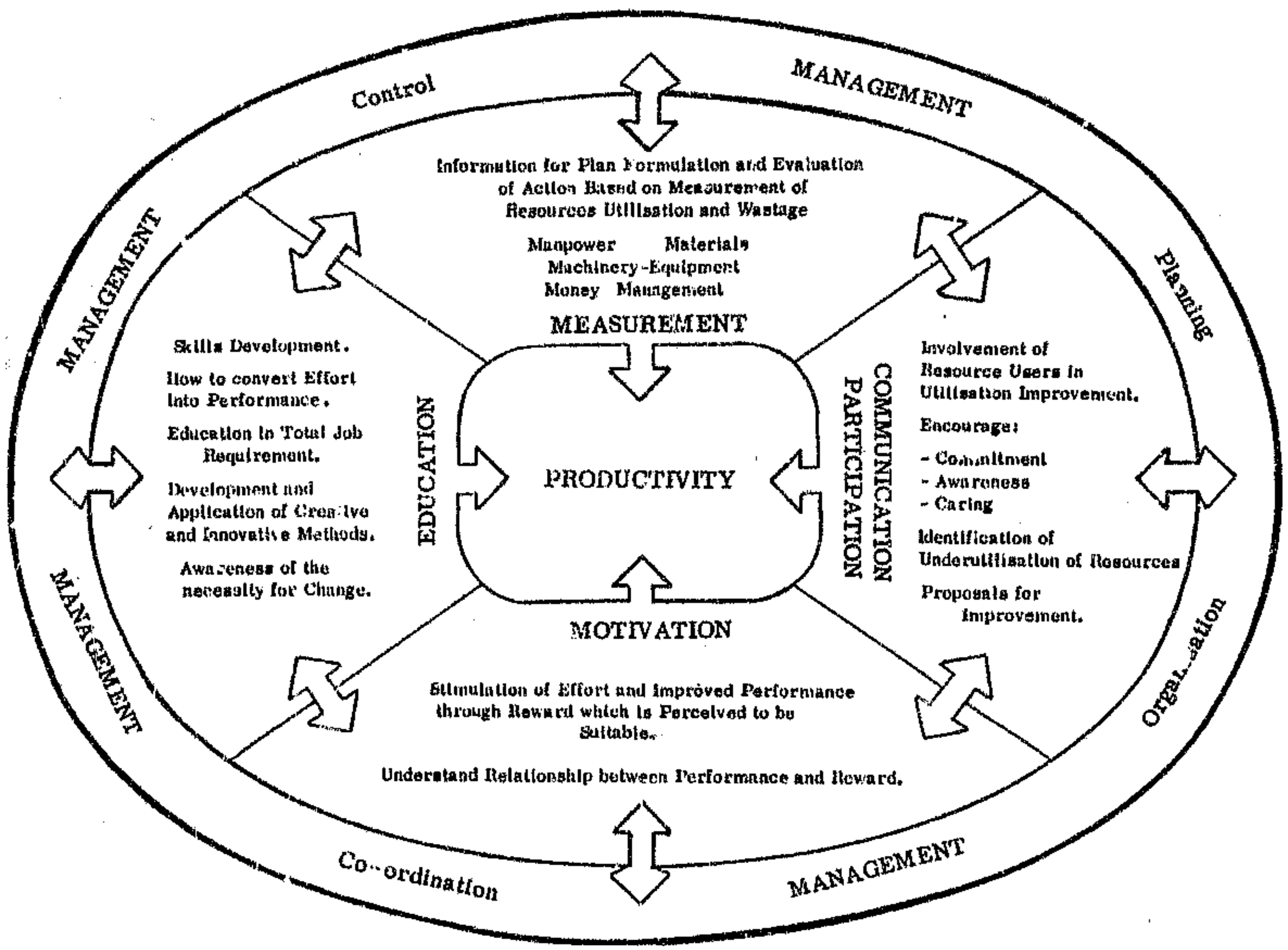


FIGURE 2.2 INTERACTIVE MODEL OF PRIMARY FACTORS AFFECTING PRODUCTIVITY

- the lack of suitable measuring techniques for monitoring productivity
- the lack of real participation by workers in decisions which affect their work
- the absence of worker motivation and a planned education programme which will help workers to develop cognitive and technical skills, and help them to realize their full potential
- the inadequate exercise of the main management functions of planning, organization, co-ordination and control
- the lack of awareness of the importance of materials handling - an activity which occupies the major portion of site labour.

## 2.7 Interactive Dynamic System of Management

Construction is a dynamic process during which inputs (manpower, materials, machinery, et al) are converted into outputs - structures and buildings. The effective utilization of the resources therefore requires an interactive dynamic system of management.

This thesis will describe an interactive model which was developed by the author to represent the construction process (Fig 2.2), and discuss the dynamics of the relevant interactions (ref. section 16.1).

It is proposed to use this model as a basis for evaluating the various components of the system (ref. Chapter 16), and for proposing ways of raising individual and overall productivity.

### 2.7.1 Description of the Model

The model (fig. 2.2) presents a systems and holistic approach to productivity improvement. The construction industry, as all other industries, is *"people driven"*. It is controlled by people and its resources are used (and misused) by people.

Since people are the motive power in productive resource utilization, it is important to consider the factors which affect their capacities and performance in a construction enterprise.

First there is the encompassing responsibility of management to lead and guide the enterprise by planning, organizing, co-ordinating, and controlling its activities (shown by the outer ellipse of fig. 2.2).

In order to achieve its objectives, management requires information regarding the extent to which its objectives are being achieved, and information which will assist them to take decisions for the more effective utilization of the resources employed in the enterprise i.e. for control purposes. This information must be based on a reliable system of measurement (shown by the upper segment within the ellipse).

It has been stressed that people are the primary and most important of all resources, and it will be shown that effective communication and participation can make a positive contribution towards improvements in resources utilization and hence productivity (shown as the right hand segment inside the ellipse).

People also require motivation. Participation, the sense of belonging, of being listened to, and contributing to a common cause or objective, are all motivating factors. Participation must also extend to material wellbeing through equitable sharing in the financial results of the enterprise (shown as the lower segment within the ellipse).

The productive capacity of people also depends on their levels of knowledge, cognitive skills, creative and innovative capacity; and this is dependent on primary and continuing education. The motivation must therefore extend to continuing education and skills development which will assist every individual to realize his full potenti·¹ ¹ hence his increased contribution to the productivity of his enterprise (shown on the left hand segment inside the ellipse).

Thus the functions of management and the four primary factors affecting productivity which are presented in the model constitute an interactive and dynamic[1] relationship, which when positively stimulated, will permit the enterprise to achieve continuing higher levels of prodr :tivity. (Presented here as the target at which all the segments aim).

The dynamics of these relationships are discussed in 16.1.

## 2.8 Methodology

This study was based on case h ;i ries which the writer compiled during the course of his professional consulting assignments to the industry. His work afforded him the opportunity to collect data relevant to the subject matter of this study; to observe site operations; to study management - employee communications; and to discuss resources utilization with management and site personnel in both building and civil engineering contracting companies.

The factors studied during the course of the research included :

- site organizational structure
- functional responsibilities

[1] Alexander 1974:28 states that: "*dynamic systems models attempt to catch the essence of systems that are in a state of flux ...... These systems are termed dynamic because they exercise a measure of self control over their performance*". Construction is, indeed, a dynamic system where things are in a constant state of flux, with inputs being converted into outputs (construction being put in place).

- planning
- communications
- co-ordination
- control
- motivation
- productivity measurement
- site lay-out
- materials handling methods
- plant and machinery utilization
- manpower utilization

It was possible to carry out this study on an ongoing basis, and hence develop and test productivity improvement practices.

### 2.8.1 Source of research Data

Five separate companies operating in different parts of the R.S.A. constituted the sources of the data used in this research.

| Company | Description | No of Contracts Investigated |
| --- | --- | --- |
| A | General building company | 10 |
| B | Civil engineering and building company | 18 |
| C | General construction company | 12 |
| D | Sub-economic housing company | 6 |
| E | General building and construction company | 8 |

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The contracts featured in this thesis are:

| | | |
|---|---|---|
| "Techtrain" | - | a technical training centre comprising numerous specialized buildings and workshops |
| "W" | - | a multi-storey building involving a concrete structure and brickwork |
| NS1 | - | a group of two storey school buildings with concrete structure and brick walling |
| TPO1 | - | a large hostel complex including housing and a large industrial kitchen |
| TDS2 | - | a large multi-storey hospital complex. |

It should be noted that the above companies are subsidiaries of national construction groups and that their financial statements are not published.

## 2.9 Past South African Research and Related Literature

There is a considerable fund of literature regarding productivity and resources utilization authored by writers whose experience and research is based in the U.S.A., the United Kingdom and Europe. The work of some of these writers is referred to throughout this thesis, in so far as their concepts apply to the subject matter of this research.

It has been stated that people use and misuse resources, and as such, are the most important element in the productivity equation. The labour force employed in the South African construction industry, especially in the semi-skilled and unskilled categories, because of their educational[2] and cultural background, is markedly different from the construction labour forces employed in Europe, the United Kingdom, and the U.S.A. In these circumstances, the management principles of organization, planning, co-ordination,

[2] This is discussed in chapter 4, section 4.2.2

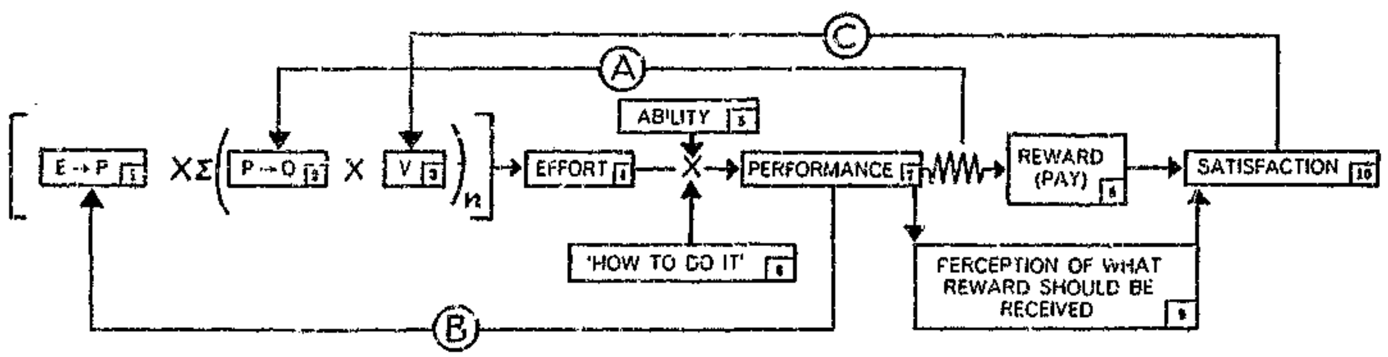



FIGURE 2.3 ORPEN PSYCHOLOGICAL MODEL OF JOB BEHAVIOUR OF BLACK WORKERS

motivation and control discussed by overseas writers must be adapted to suit South Africa's local industrial conditions and workforce.

Simon Bisheuvel appears to have been the most prolific and authoritative South Afric... writer on productivity and labour utilization. The only comprehensive work on the South African construction industry appears to be that which was directed by Bisheuvel and authored by Cortis, et al (1962). The characteristics of the black-white interface in the industry are discussed in this report and observations and recommendations are made regarding materials handling, work study, and working methods. The report was compiled at a time when legislation (work reservation in particular) inhibited the development of the largest section of the labour force i.e. the black workers. Since then circumstances have changed, and the withdrawal of work reservation restrictions now presents the industry with both the opportunity and the challenge to accelerate black worker development.

Biesheuvel (1980), in his article *Productivity, How to Understand Black People*, provides a knowledgeable commentary on black education and its effect on productivity.

Orpen C. (1976) in *Productivity and Black Workers in South Africa* has developed a psychological model of job behaviour of black workers. This model, Fig 2.3, presents the interrelated elements of effort, ability, performance, reward and satisfaction. He states (p. 129):

*"There appears to be nothing about black workers in general which makes it impossible for them as a group to respond positively to changes aimed at giving them better jobs and placing them in more responsible positions. All that we know about human motivation indicates that, under comparable conditions, black and white workers possess the same major needs and same essential goals."*

The proceedings of the *Symposium of Productivity in The Construction Industry* (1984) presented by the National Productivity Institute, in conjunction with the Universities of Cape Town, Stellenbosch, and Pretoria, provide a broad spectrum of observations on factors affecting productivity.

The following presentations were not worthy.

Dr Richard L Tucker, C.T. Wells Professor of Project Management and Director of the Construction Industry Institute at The University of Texas at Austin stated in his keynote address (1-2b) that labour "*is now the most expensive, and the most volatile, resource affecting a project's success*".

He stressed the importance of 'lost time' records and control and the importance of planning, communications and participation.

His paper "*Methods to Improve Construction Productivity*" (pp 131-152) discusses practical means of productivity improvement with emphasis on management commitment and communications, motivational activities, training for planning, work methods improvement, and evaluation and feedback.

I.S. Maddon in a paper entitled "*The Construction Industry*" (pp 34-40) stressed the vital role of manpower and their possible contributions to productivity.

The effect of poor communications and some ways of minimizing this were discussed by Prof. F Hugo, University of Stellenbosch (pp 109-117).

The impact of construction methods on productivity was the subject matter of Prof. F

Fourie's address (pp 118-124), in which he recommended work study as a means for controlling the utilization of resources.

"*The Objective Matrix - a measure of productivity*" was presented in a paper by James L Riggs, and further contributions on the subject of measurement were made by K Nutte (pp 209-231) and M Louw (pp 232-241).

The Unisa School of Business Leadership in their *Project Free Enterprise* (1984), provide important information on black employee perceptions of their position in industry, and formulae for achieving improved productivity.

The report indicates that black workers in the lower income brackets consider that training makes a major contribution towards improved productivity. The information presented in this report provides data which must be taken into consideration in developing communications, motivational and educational programmes for black employees.

The N the Central Statistical Services, and the Bureau for Economic Research of the University of Stellenbosch, have been referred to for statistical data on industrial productivity, and their information has been used to evaluate productivity trends in the construction industry.

Both the Building Industries Federation (South Africa) and the South African Federation of Civil Engineering Contractors have been most helpful and valuable sources of information with regard to labour statistics and labour training. These reference sources, and others, are referred to in the chapters that follow.

# CHAPTER 3

## THE CONSTRUCTION INDUSTRY'S PRODUCTIVITY AND POSITION IN THE SOUTH AFRICAN ECONOMY

### SYNOPSIS

This chapter sets out the background to the construction industry, and its contribution to the South African economy.

The section of the construction industry which was researched included housing and high rise projects and certain civil engineering structures. The study excluded the informal sector comprising building repairs and self employed artisans such as painters, bricklayers, carpenters, plasterers, et al.

The sources of investment are analyzed.

Construction cost increases are reviewed and the reasons for the changes in construction productivity over the past decade are considered. The industry's productivity is then compared with that of other countries.

The important role of the construction industry in the economy (and life) of South Africa will become evident from the information presented. The productivity of the industry is thus an important basis for analyzing the economic performance of the sector, and establishing the most promising factors that may lead to greater productivity.

## 3. A MACRO PERSPECTIVE OF THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

The gross domestic fixed investment of assets in the R.S.A. for the year 1988 amounted to R 38 887 million. The value of buildings and construction works put in place in the formal sector[3] during 1988 was R17 323 million (table 3.1). This is 44.5% of the gross domestic fixed investment by assets. The building industry accounted for R11 091 million (64.0%) of the total construction value, and the civil engineering construction industry accounted for the balance of R6 232 million (36.0%). The importance of the construction industry in the national economy is emphasized by a comparison of its asset value investment with the Gross Domestic fixed investment in the following sectors, as shown in table 3.1.

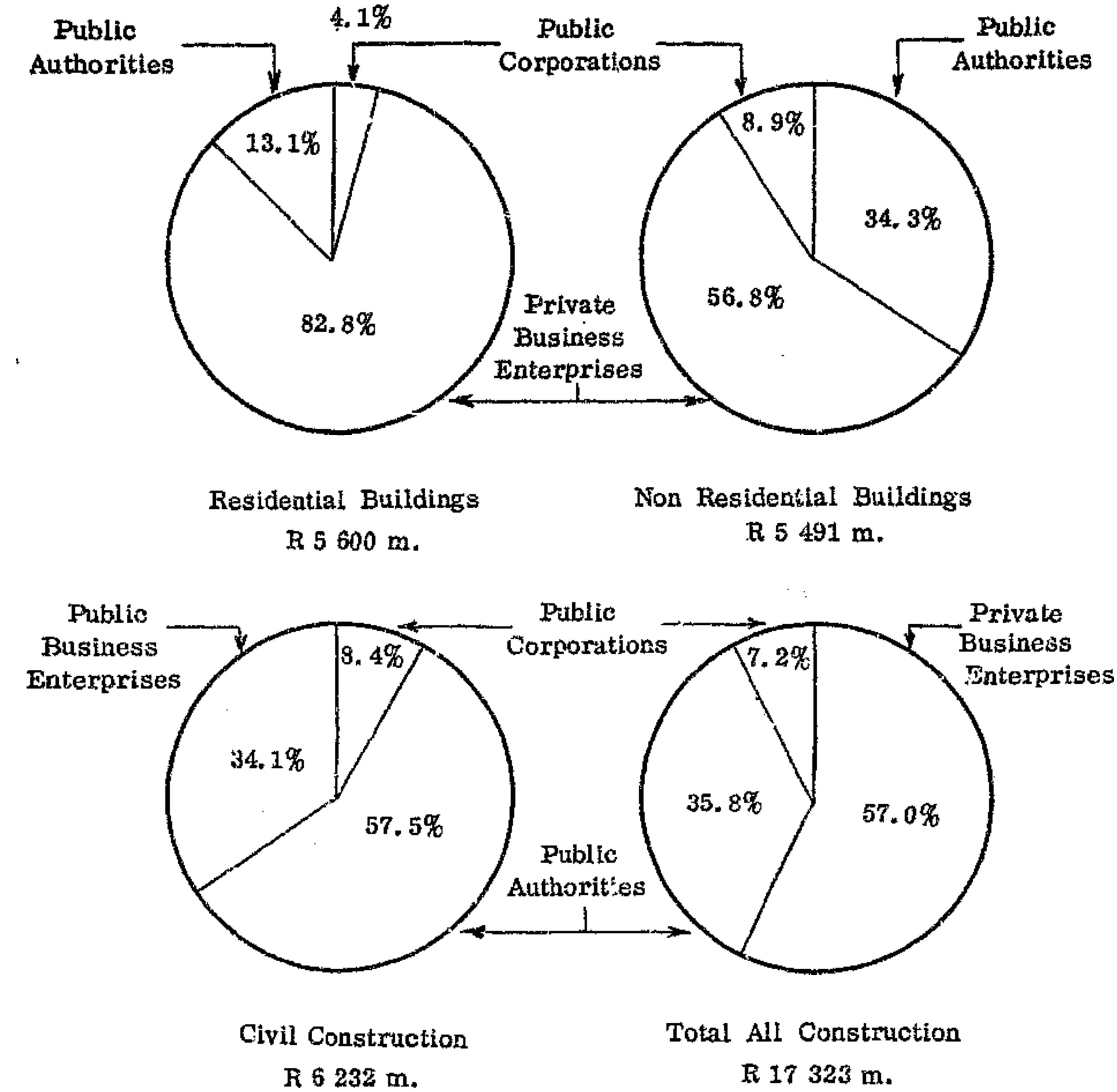
**TABLE 3.1**

**COMPARATIVE GROSS DOMESTIC FIXED INVESTMENT OF THE CONSTRUCTION INDUSTRY AND OTHER INDUSTRIES AT CURRENT PRICES (1988) R MILLIONS**

| INDUSTRY | VALUE |
|---|---|
| Agriculture, Forestry and Fishing | 1 225 |
| Buildings and Construction Works | 17 323 |
| Mining and Quarrying | 5 823 |
| Manufacturing | 6 439 |
| Electricity Gas and Water | 3 637 |
| Wholesale & Retail Trade Catering & Accommodation | 2 757 |
| Transport, Storage and Communication | 3 161 |
| Finance, Insurance, Real Estate and Business Services | 10 209 |
| Community, Social and Personal Services | 5 062 |

*SOURCE : Reserve bank Bulletin, March 1989*

[3] This does not include construction work done in-house by sectors such as private manufacturing, mines, trade, and private services.



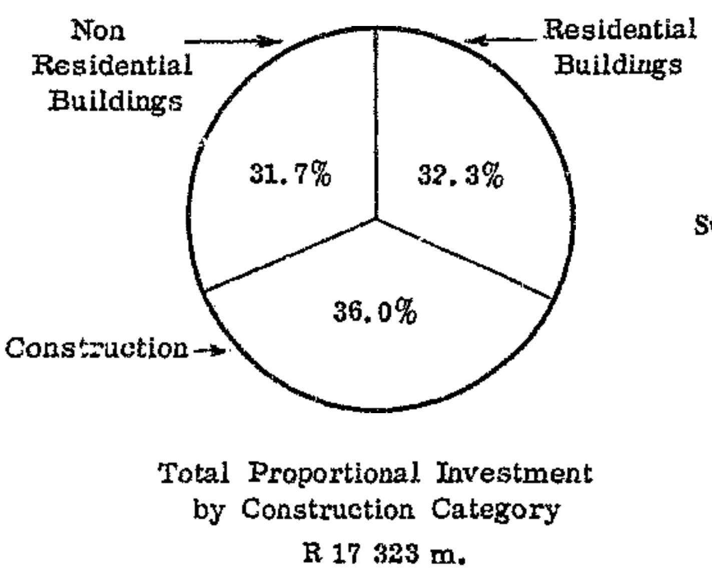




FIGURE 3.1

SOURCES OF DOMESTIC FIXED INVESTMENT BY SOURCE OF INVESTMENT AND CONSTRUCTION CATEGORY

Source: Reserve Bank Bulletin, March 1989

It should be noted that there is a considerable overlap in the work done by the building and civil engineering industries. In the case of concrete frame buildings, civil engineering contractors are in direct competition with conventional building contractors.

## 3.1 Sources of Investment

Figure 3.1 shows the sources of investment by construction category. It is interesting to note that residential buildings financed by private business enterprise are one of the major contributors to the industry's growth. Thus the number of housing starts is an important economic activity indicator for the industry, and the overall economy.

In the building industry, private business enterprises are by far the largest source of investment, with a contribution of 82.8% in the residential buildings category and 56.8% in the non residential buildings category. Hence the building industry is mainly dependent on private business enterprise prosperity and economic confidence, in its search for work and the employment of its resources.

## 3.2 The Effect of Labour Productivity on Contract Prices

This can be illustrated by reference to the record of tender prices reported in Table 3.2., overleaf.

In the companies surveyed, the cost of manpower relative to total contract value varied between 30% and 40%. It is also the most variable resource, and the effectiveness of its utilization is largely dependent on management effectiveness, planning, work methods, motivation, and effort.

## TABLE 3.2

## RANDOM RECORD OF SOME TENDER RESULTS

| DESCRIPTION | No. of Tenders | Highest | Lowest | % Difference |
|---|---|---|---|---|
| Office Block, Pretoria | 12 | 2 393 000 | 1 954 300 | 18.33% |
| Warehouse, Pretoria | 6 | 481 481 | 434 000 | 9.86% |
| Factory, Wadeville | 11 | 4 128 000 | 3 625 000 | 12.19% |
| Earthworks, R.W.B. | 6 | 361 429 | 270 290 | 25.22% |
| Transport Depot. Langl. | 7 | 1 647 504 | 1 118 864 | 32.09% |
| Reservior, Klipriver | 5 | 419 493 | 325 000 | 22.53% |
| Office Building | 12 | 2 099 188 | 1 894 113 | 9.77% |
| Office, Potch. | 7 | 1 020 364 | 829 414 | 18.71% |
| Specialised Building I&J | 15 | 3 787 400 | 3 080 549 | 18.66% |
| Precast Culverts | 6 | 458 000 | 296 060 | 35.37% |
| Undercover Parking | 7 | 109 579 | 86 393 | 21.16% |
| Office Alterations | 8 | 1 297 000 | 1 102 000 | 15.03% |
| Civic Centre, Germiston | 9 | 11 299 382 | 10 350 000 | 8.40% |
| SATS Bridges | 5 | 13 519 000 | 11 650 865 | 13.82% |
| Ext. Art Gallery, JHB | 8 | 6 230 348 | 5 395 000 | 13.41% |
| Factory, Vereeniging | 4 | 3 475 245 | 3 309 900 | 4.76% |
| Concrete Works, Germiston | 8 | 1 102 759 | 779 700 | 29.30% |
| Factory, Troyville | 10 | 14 200 000 | 12 448 072 | 12.34% |
| Bridge & Culverts, Vereeniging | 3 | 10 958 361 | 10 820 953 | 1.25% |
| | 149 | 78 987 533 | 69 770 413 | 11.67% |

The Business Roundtable[4] report A-1 (1982:5) states :

*'The quantity of labour required is more susceptible to the influence of construction management than are the quantities of either materials or labour'.*

Labour productivity is also effected by the construction methods and equipment used, and work simplification.

The tenderers were mainly large companies; but smaller builders competed against these companies for the smaller contracts.

The contracts listed ranged in price from R325 000,00 for a reservoir, to R14 200 000,00 for a factory; and price variations per contract ranged from 1.25% to 32.09%.

The bridge and culvert contract on which the price differential was a low 1.25% is not truly representative. The work involved jacking technology, which limited the contract to three bidders.

When comparing the tender prices on individual contracts it can be generally assumed that there is little difference in the materials component, which is specified. Sub-contract prices will vary, but it can be assumed that the tenderers will have approached many of the same sub-contractors, and that there is therefore a considerable degree of uniformity in sub-contract prices.

The main variables are therefore within the restraints of tender conditions, the supervisory

---

4 The Business Roundtable is an association in which the chief executive officers of some 200 major corporations in the U.S.A. focus and act on a wide range of public issues. The Roundtable's Construction Committee continues the work started in 1969 with the emphasis on quality, efficiency, productivity and cost effectiveness.

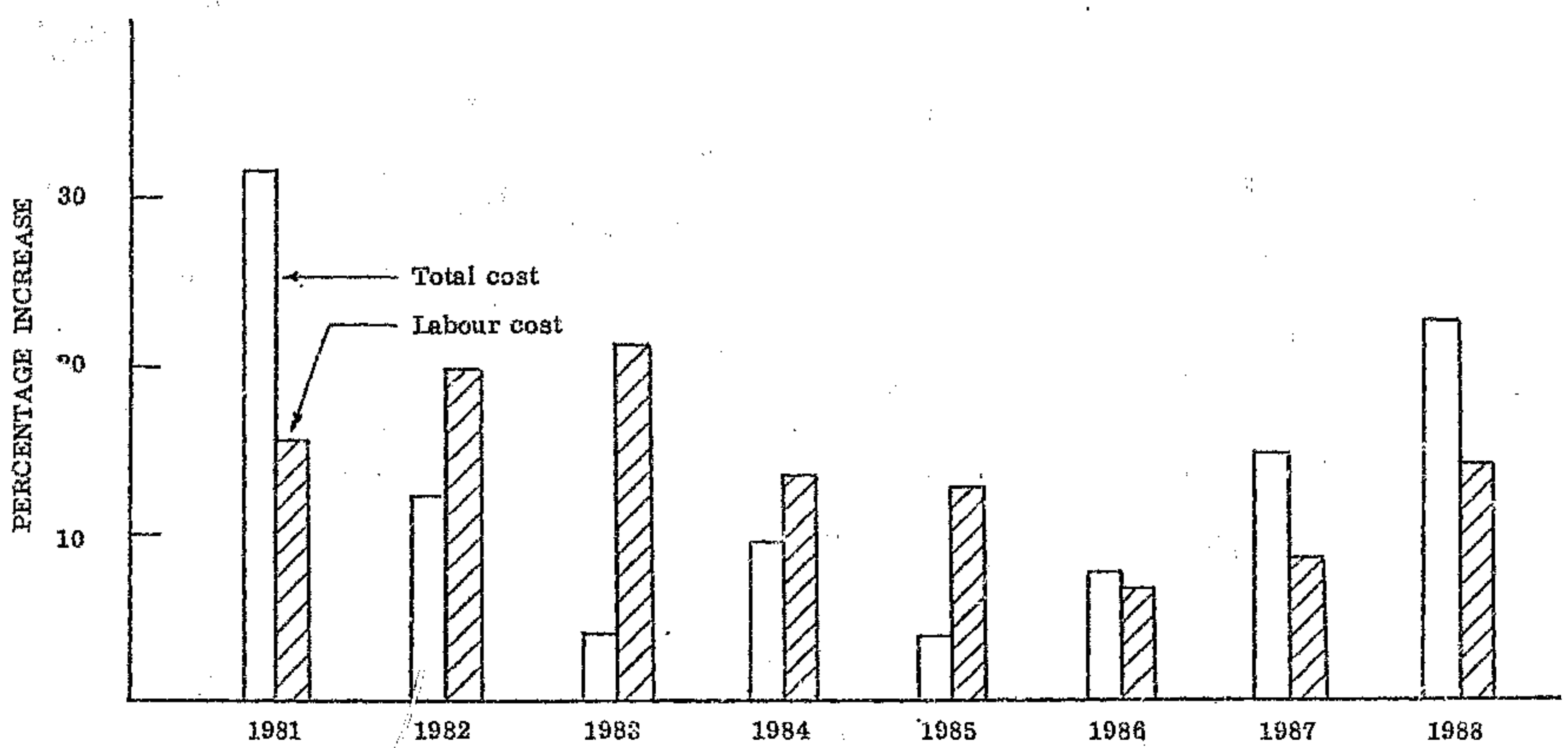



FIGURE 3.2 YEAR ON YEAR LABOUR AND TOTAL BUILDING COST INCREASES

Source: Stellenbosch University Bureau for Economic Research
Analysis of building and construction activity, July 1989. (own diagram)

structure, and the programme duration which is dependent on method, and labour productivity; with the latter being the largest variant.

Considering the larger contracts, where the bidding was limited to the large construction companies who have similar overhead structures, it can be concluded that the difference in contract tender prices indicates that there are variations in labour performance, and hence labour productivity.

This is emphasized by Ted Hodgkiss, Managing Director of Pretoria Portland Cement:

*The major cause of building price inflation is the inefficiency of the labour force. Many a job that should take two weeks lasts for six because of poor management"* *

It will be shown that activity studies and effort rating observations indicated potential improvements in labour productivity of up to 50%.

This fact presents opportunities for those companies, who can improve their labour's productivity and reduce their overhead costs, to increase their market share by more competitive bidding.

Considering the lower limit of labour content of 30% of total contract value (previously mentioned), and say that a 20% improvement in labour utilization is passed on to the owner, then the contractor can reduce his price by about 6%. This differential, in keen tendering situations, is usually more than sufficient to allow the tenderer to submit the lowest tender and thus obtain the contract.

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*Sunday Times, Business Times, Feb. 4.1990, p. 3

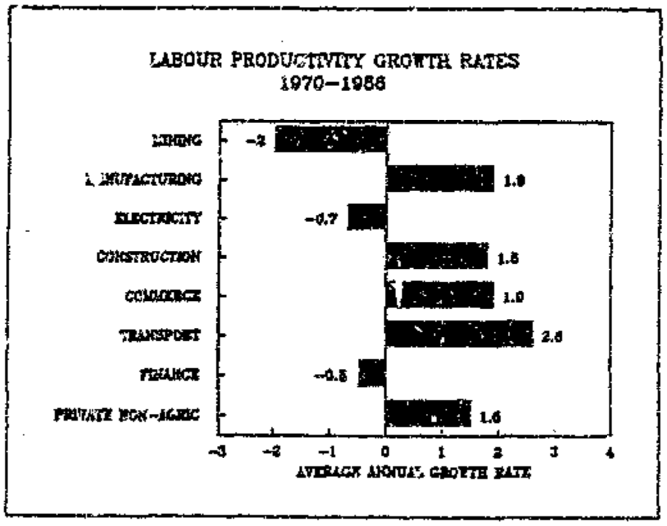
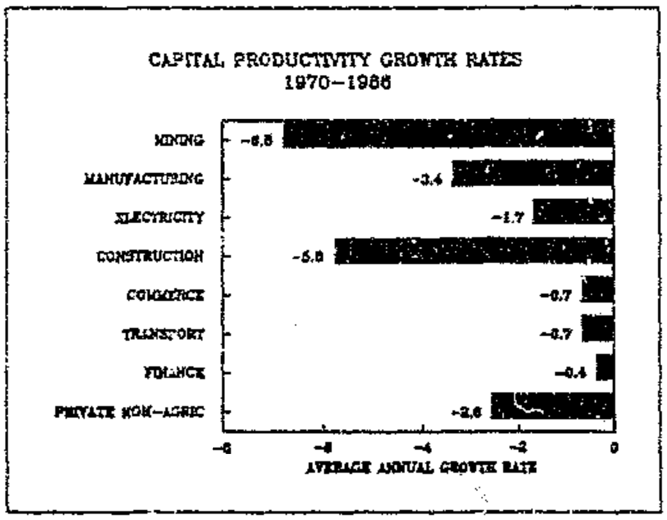



FIGURE 3.3

FIGURE 3.4



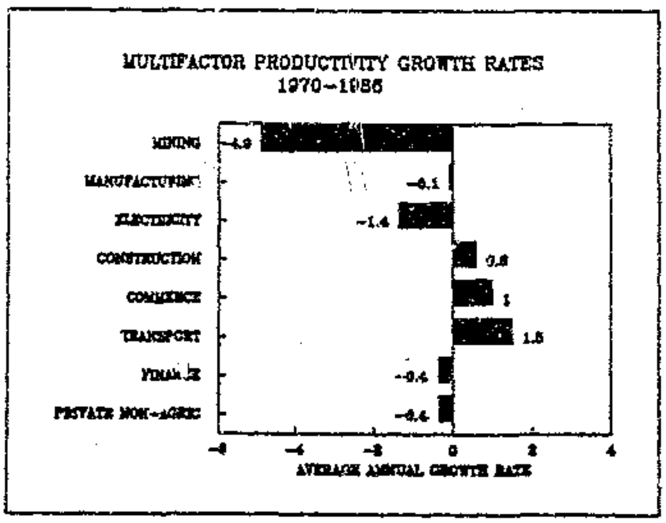




FIGURE 3.5

Source: NPI Productivity Focus 88

## 3.3 Construction Cost Increases

There has been a regular year on year in rease in labour and total building cost. These cost increases are shown in fig. 3.2. The only reduction in these increases occurred during the years 1983 to 1986 when there was a recession in the industry and contract prices became very competitive.

The cost increases can mainly be attributed to unavo'.'able extraneous cost increases and the poor utilization of own resources. This is clearly illustrated in figures 3.3, 3.4 and 3.5.

In spite of capital inputs into the industry, labour productivity only increased by 1.8 through the years 1970 to 1986. Capital productivity regressed during this period with a negative rate of -5.8; and multifactor productivity recorded a growth rate of only 0.6.

## 3.4 Comparison of Construction Productivity with other Countries

South Africa is not alone in respect of low construction productivity. Verschuren C. (1984) of the Netherlands Research Institute for Labour Economy in the Building Industry reports that the Dutch construction and housing industry has shown an average increase of 2.9% per annum in productivity. Regarding construction productivity in other countries, he presents an index compiled by Helmer Danielson and Mejse Jacobson which shows a negative change in productivity for Sweden for period 1971 - 1980.

Verschuren, in discussing the U.S.A., states that the U.S. construction industry recorded an annual improvement between 1948 and 1969 of 3%. This improvement has dropped in the last decade, and the construction industry is back to the level of productivity of twenty years earlier (1958). This is in contrast to the U.S. manufacturing industry which

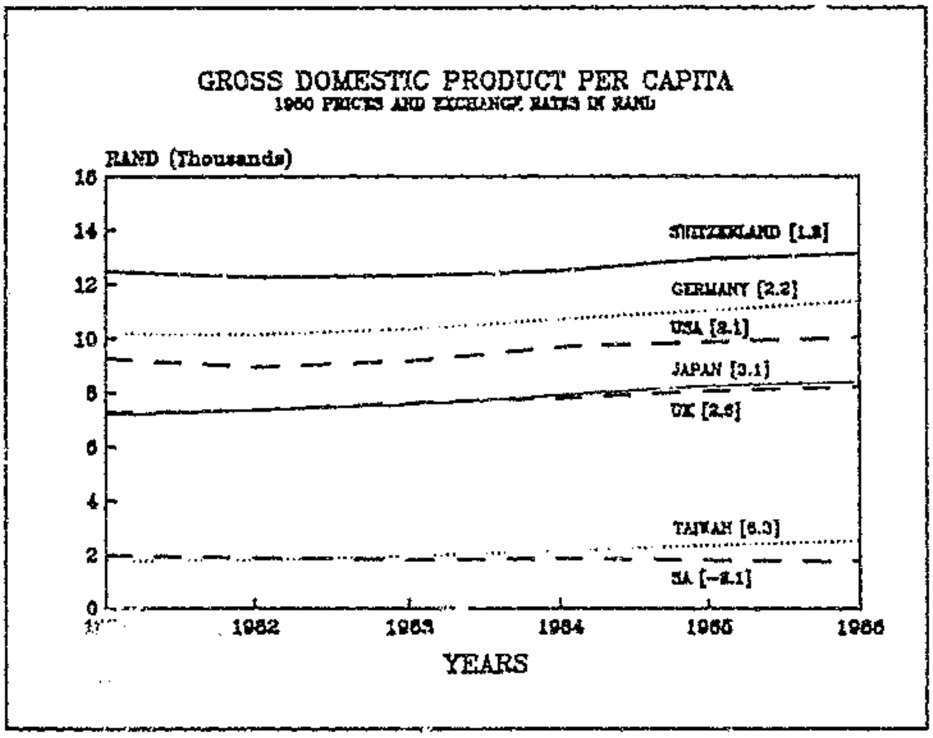



FIGURE 3.6

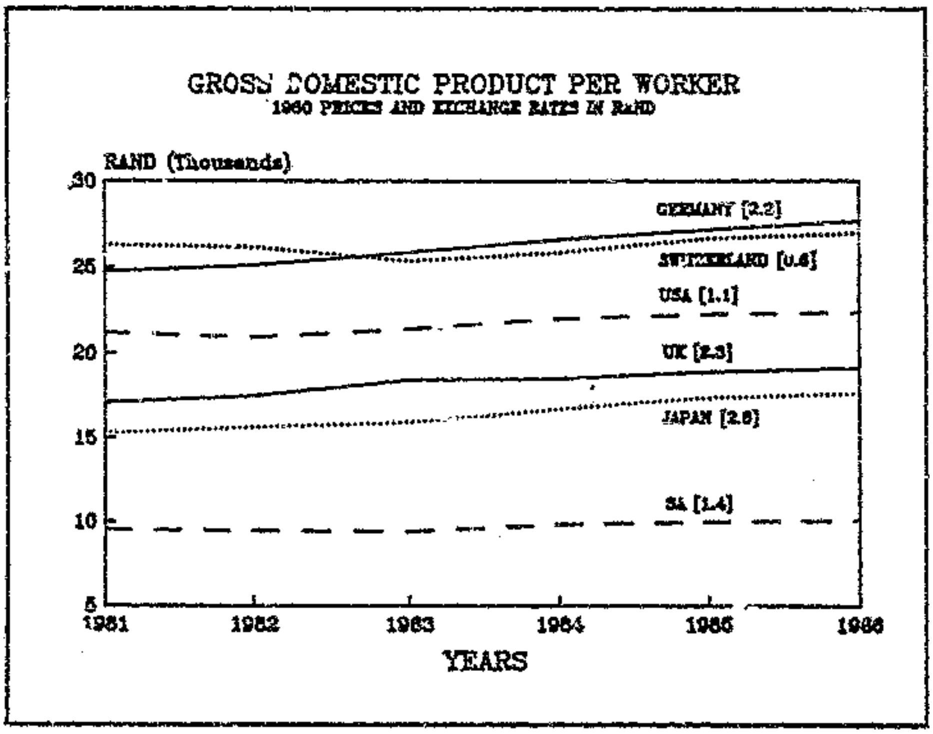



FIGURE 3.7

Source: NPI Productivity Focus 1988

has maintained an annual increase of 2.6% through to 1978. A report published by The Business Roundtable (1983 : 18) presents a more somber picture of productivity in the U.S. construction industry. It states :

*"... the Commerce Department published a set of productivity indexes for construction in May 1981, showing that productivity for construction put-in-place has declined from an index number of 100 in 1972 to 82.9 in 1978 - a worrisome drop of nearly 20%."*

## 3.5 Comparison of South Africa's National Productivity with other Countries

The South African News Summary (second quarter, 1985 : 16) stresses South Africa's low productivity when compared with countries of similar populations.

*"As one measure of South Africa's productivity a comparison is made with California, a state with much the same area and population. The G.N.P. of California is R700 billion, seven times that of South Africa."*

Figures 3.6 and 3.7 show a recent six year trend of South Africa's gross domestic product per capita, and gross domestic product per worker, compared with that of six other countries. The negative rate of -2.1% per capita is testimony to the country's poor productivity. If the population growth rate of 2.5% is taken into account, then there is a discrepancy of 4.6%. Therefore, unless there is an ongoing improvement in productivity, the country can obviously expect increases in unemployment and the related escalation in social instability.

According to the author's research and observations, some of the reasons for the low productivity are :

- The negligible contribution from that half of the population which is rural, untrained and impoverished.
- In some parts of the country social and living conditions outside the work environment inhibit productive work.
- Insufficient automation in manufacturing and materials handling keeps costs high.
- A lack of understanding and/or commitment to new philosophies of manufacture which have been so successfully employed in Japan and now in the U.S.A.
- Lack of skills, and low educational standards.
- Poor management practices.
- Inadequate quality assurance.

## 3.6 Conclusions

Productivity embraces the holistic concept of resources utilization. The elements which affect productivity are, indeed, multifaceted. Thus there is no single simplistic answer to productivity improvement.

One of the main reasons for the lack of productivity improvement in the construction industry is the ineffective utilization of manpower particularly in the area of materials handling, and management's inability to utilize effectively the substantial capital inputs of recent years. A comparison of the industry's productivity with that of other economic sectors such as manufacturing and transport, shows that the construction industry has much leeway to make up in the area of resources utilization.

Management's challenge is to review its philosophies regarding the utilization of resources input and processes employed. It is only by making changes for the better in these areas that improvement in output, and hence productivity, will be achieved.

Desirable changes regarding inputs and processes will be discussed in the following chapters.

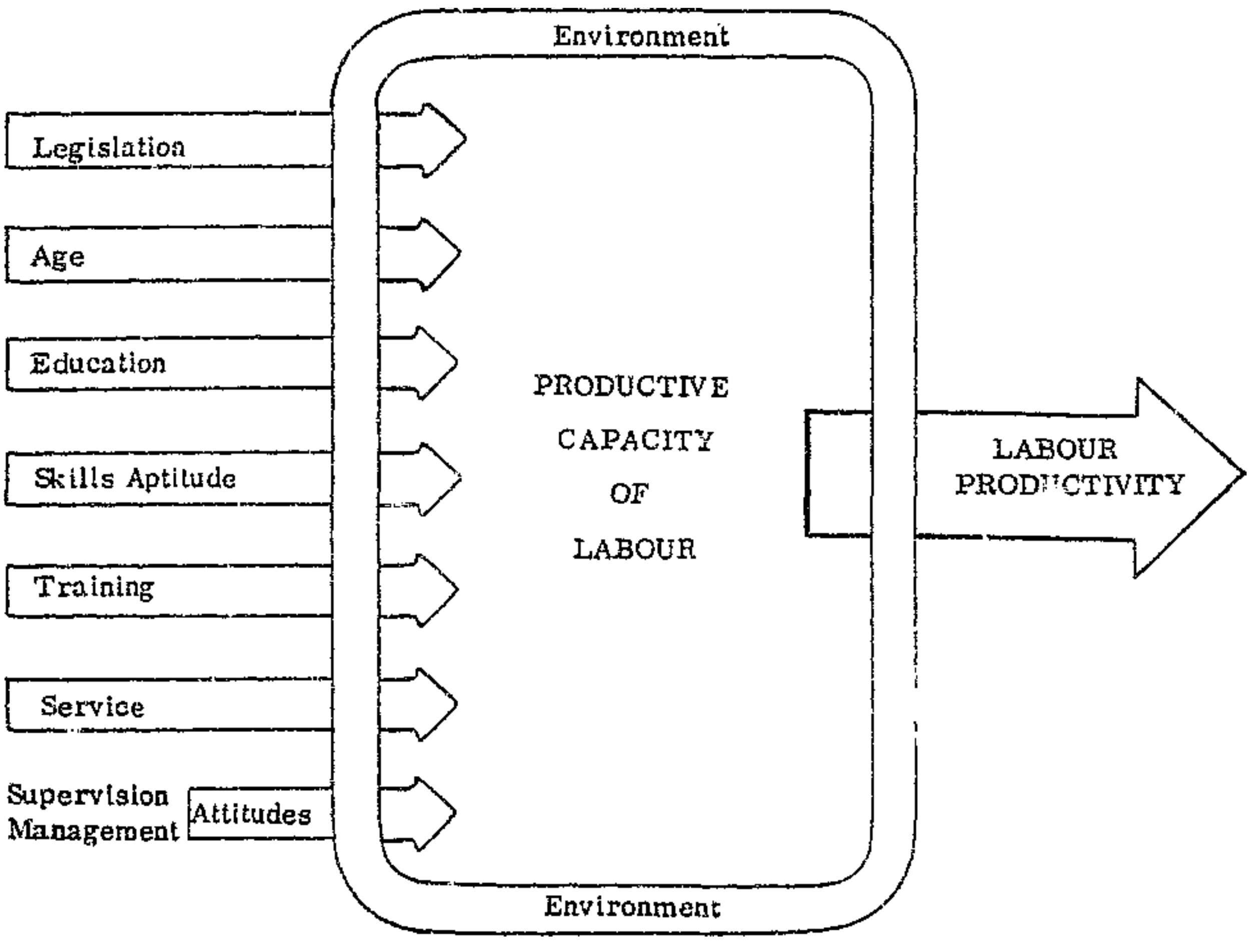



**FIGURE 4.1 ELEMENTS AFFECTING THE PRODUCTIVE CAPACITY OF LABOUR**

# CHAPTER 4

## LABOUR PROFILE

### SYNOPSIS

The Republic of South Africa has been blessed with abundant mineral resources and manpower. Yet the majority of the population is at a third world developmental stage. Thus, instead of being positive contributors to the country's economy, many are, in fact, a drain on the country's productive sector.

Manpower is the most important and critical resource in the construction industry, and it was therefore considered important to research the characteristics of this resource, establish its shortcomings, and hence develop recommendations for improving its productive capacity. Approximately 85% of the labour force are black, and the research regarding the labour profile in this industry was therefore focussed towards them.

This chapter describes the characteristics of the manpower employed in the construction industry and analyses the different elements which affect the productive capacity of labour. These elements are shown in the schematic input/output model, figure 4.1.

Separate analyses are made of building and civil engineering companies. It is shown that the major portion of the labour force consists of general workers who possess few skills, minimal education - if any, and relatively little service.

The age profile, education and training of foremen is discussed, as is their span of control, and the value of the work that they are responsible for.

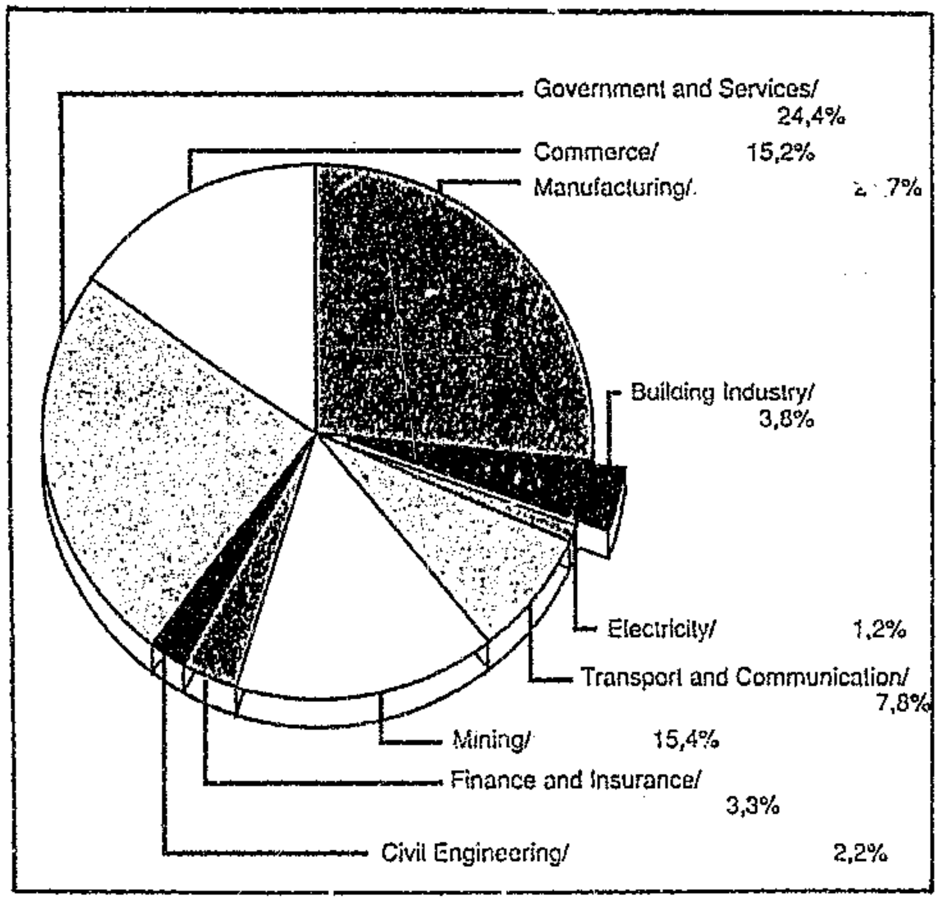



**FIGURE 4.2 RELATIVE SECTOR EMPLOYMENT - NON AGRICULTURAL SECTOR - 1987**

Source: BIFSA annual report 1988

It is concluded that the industry must r. iew its policy towards the education and training of black workers, and look to the black community as the source for the development of more supervisors in order to reduce the span of control, and institute more effective supervision.

## 4. LABOUR PROFILE

The data presented in this chapter comes from several sources. These include employers' organizations such as BIFSA and SAFCEC, the Central Statistical Services, and several construction companies operating in both the building and civil engineering sectors.

### 4.1 Labour Employed in the Construction Industry

During 1987 the construction industry (building and civil engineering) employed 300 000 people (BIFSA 1988). This is 6% of the total labour force in the non-agricultural sectors of the national economy, ref. fig. 4.2.

These figures only represent the formal sector. Many self employed blacks and whites are engaged in the informal sector. They do house construction and building alterations, tiling, plastering, painting and bricklaying. They do not belong to any organization and it is therefore impossible to quantify their numbers and the value of the work they do.

All the other sectors shown in Fig. 4.2, with the exception of finance and insurance, do some of their own construction work. In these circumstances it can be assumed that there are in the order of 400 000 people actually employed in construction, representing approximately 8% of the labour employed in the non-agricultural sectors of the country's

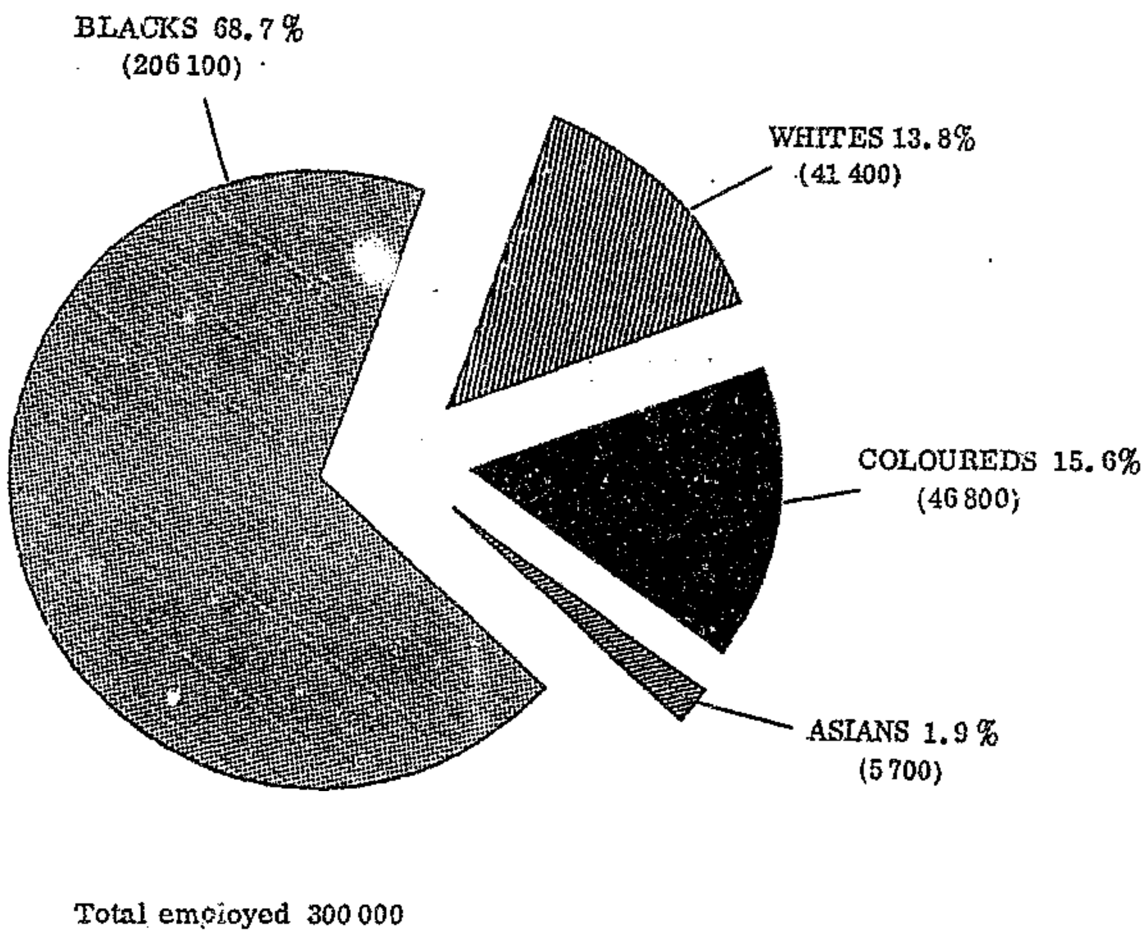



**FIGURE 4.3 ETHNIC COMPOSITION OF EMPLOYEES IN THE CONSTRUCTION INDUSTRY, 1987**

Source: BIFSA annual report 1988

economy.

When the number of dependents is added then there could be a minimum of 2 000 000 souls who are dependent upon the construction industry for their livelihood. This represents approximately 6% of the total population.

Building and civil engineering share common labour resources, and these will now be reviewed.

Figure 4.3 shows the ethnic composition of the construction labour force. It will be seen that white workers constitute only 13,8% of the labour force. The majority of non whites are black and they possess few skills. They are mainly engaged in materials handling.

Employees in the building industry constitute 63,1% of the total construction labour force, and 79,8% of their number are non-artisans (BIFSA annual report. 1988). The latter are hourly paid general workers. Their tasks include excavation, materials handling and providing assistance to the artisans.

## 4.2 Profile of the Work Force of a Building Company

A specific company was selected and analyzed by the author, and the results revealed the following data:

The company employed 1 610 people; 1 500 were general workers and 110 were employed in management, supervision and administration. Included in supervision were 27 foremen. This gives a foreman to general worker ration of 1 to 55.6. The effect on productivity of this span of control will be discussed at a later stage.

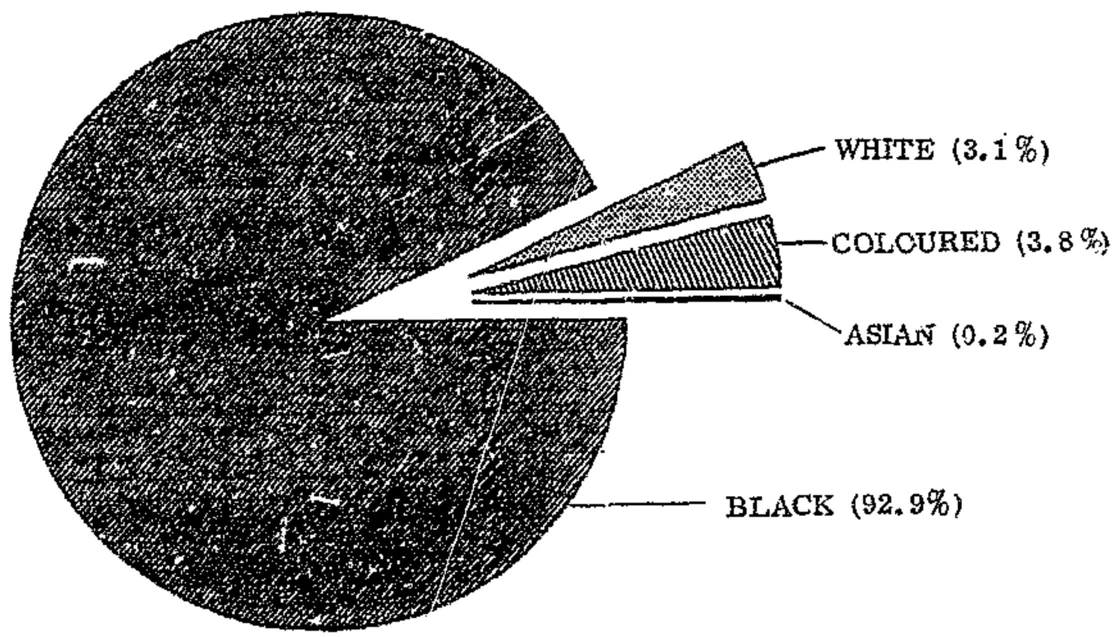



FIGURE 4.4 ETHNIC COMPOSITION OF THE GENERAL WORKFORCE

### 4.2.1 Ethnic make-up of general workers

Figure 4.4 shows the ethnic composition of the general labour force engaged in construction activities. 92.9% Are black and the balance consists of whites, coloureds and asians.

The preponderance of black employees is reflected in the fact that they are employed in all the labour categories as shown in Table 4.1.

**TABLE 4.1**

**ETHNIC COMPOSITION OF THE LABOUR CATEGORIES**

| LABOUR CATEGORIES | WHITE | | BLACK | | COLOURED | | ASIAN | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | NO. | % | NO. | % | NO. | % | NO. | % | |
| LABOURERS | | | 864 | 100 | | | | | 864 |
| APPRENTICES | | | 2 | 66.7 | 1 | 33.3 | | | 3 |
| OPERATIVES STEEL FIXERS, SHUTTER HANDS | | | 268 | 98 | 5 | 2 | | | 273 |
| LEARNER ARTISANS | | | 245 | 100 | | | | | 245 |
| SKILLED WORKERS | 46 | 40 | 15 | 13 | 51 | 44 | [illegible] | [illegible] | 115 |
| TOTAL | 46 | 3.1 | 1394 | 92.9 | 57 | 3.8 | 3 | 0.2 | 1500 |

It is noteworthy that this company is committed to black advancement and the training and development of its labour force; and this is shown by the fact that all the apprentices and learner artisans, with one exception, are black.

It will be noted that general workers and operatives together constitute 75.8% of the direct labour force, and that most of their work involves materials handling.

### 4.2.2 Educational profile of the hourly paid workers

An analysis of the educational levels of the 1 500 hourly paid employees provided the results shown in Table 4.2.

TABLE 4.2

EDUCATIONAL PROFILE OF HOURLY PAID WORKERS

| LEVEL OF EDUCATION | LABOURERS | LEARNER ARTISANS AND APPRENTICES | ARTISANS | OTHERS* | GANG BOSS/ INSTRUCTOR |
|---|---|---|---|---|---|
| Lower than Std. 5 | 60 % | 65 % | 65 % | 65 % | 59 % |
| Standard 5 | 17 % | 15 % | 10 % | 25 % | 14 % |
| Standard 6 | 10 % | 10 % | 13 % | 4 % | 18 % |
| Standard 7 | 6 % | 4 % | 6 % | 4 % | 5 % |
| Standard 8 | 5 % | 2 % | 5 % | 2 % | - |
| Standard 9 | 1 % | 3 % | 1 % | - | - |
| Standard 10 | 1 % | 1 % | - | - | 2 % |
| NO. OF EMPLOYEES | 864 | 248 | 115 | 273 | |

**Others: Concrete hands, shutter hands, steel fixers, truck drivers, operatives, etc.*

Of the above workers,

| | | |
|---|---|---|
| 1394, | 92,9% | are black |
| 46, | 3,1% | are white |
| 57, | 3,8% | are coloured |
| 3, | 0,2% | are asian. |

It will be noted from the above table that over 75% of hourly paid employees have an educational level of standard five or less. The gang bosses' educational level is much the same, with 73% having passed standard five or less. This is understandable since this company recruits its gang bosses and instructors from the body of hourly paid employees.

There is some evidence that a minimum of five years of formal education is necessary to establish permanent literacy. The permanence, however, is also dependent on the informal (pre school) education and quality of the formal education. It will be shown in chapter 6 that the quality of black education is questionable, and it must therefore be concluded that the majority of black workers are lacking in literacy.

A further matter for concern is that 80% of the learner artisans, who are all black, have a level of education of standard five or less (ref. Table 4.2). Bearing in mind the relatively inferior quality of black education, it does not auger well for the quality of artisan produced at the end of their training courses.

### 4.2.3 Age profile of hourly paid workers

Table 4.3 shows the percentage composition of workers by age group and skill category.

TABLE 4.3

WORKFORCE COMPOSITION BY AGE GROUP AND SKILL CATEGORY

| AGE GROUP | LABOURERS | LEARNER ARTISANS | MASTER CRAFTSMEN | CRAFTSMEN | ARTISANS | OPERATIVES |
|---|---|---|---|---|---|---|
| 20 minus | 2 % | - | - | - | - | - |
| 20 - 29 | 20 % | 41 % | - | 29 % | 29 % | 18 % |
| 30 - 39 | 36 % | 33 % | 28 % | 29 % | 29 % | 54 % |
| 40 - 49 | 32 % | 24 % | 40 % | 18 % | 18 % | 23 % |
| 50 plus | 10 % | 2 % | 32 % | 24 % | 24 % | 5 % |

The only teenage employees are to be found amongst the labourers. The bulk of employees are in the 20 to 40 age group, with relatively few in the 50-plus age group. This reflects the physical demands of the industry and the fact that the general worker does not appear to have a productive industrial life much beyond the age of 50.

### 4.2.4 Length of service

Table 4.4 shows the proportional length of service of the different skill categories derived from an analysis of the employees of the company described in 4.2.

TABLE 4.4

LENGTH OF SERVICE RELATED TO SKILL CATEGORIES

| YEAR SPAN | LABOURERS | LEARNER ARTISANS | MASTER CRAFTSMEN | CRAFTSMEN | ARTISANS | OPERATIVES |
|---|---|---|---|---|---|---|
| 0 - 4 | 84 % | 51 % | 75 % | 100 % | 100 % | 64 % |
| 5 - 9 | 7 % | 11 % | 13 % | 0 % | 0 % | 2 % |
| 10 plus | 9 % | 38 % | 12 % | 0 % | 0 % | 34 % |

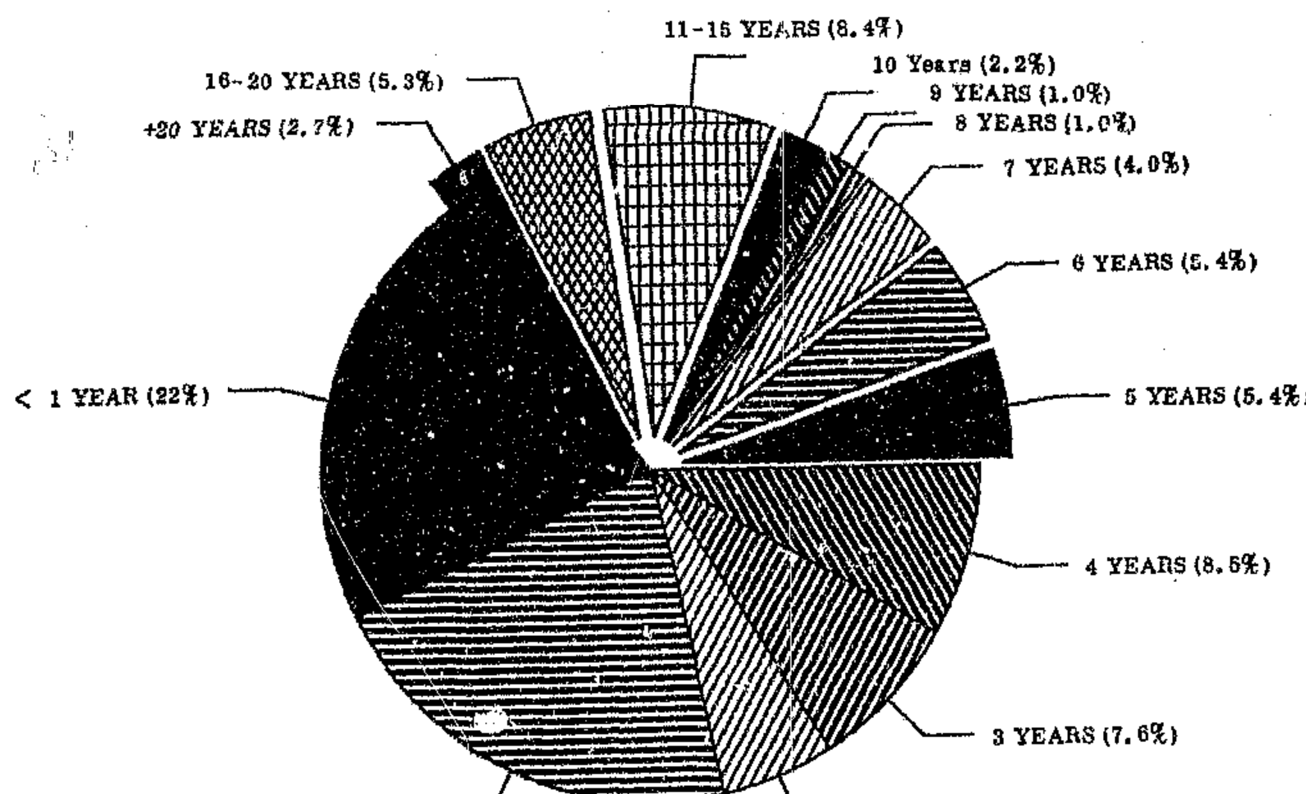



FIGURE 4.5 YEARS OF SERVICE, MIXED BUILDING AND CIVIL ENGINEERING CONTRACT - 322 EMPLOYEES

25×10

The foregoing table indicates that there is a very high labour turnover in all the labour categories, with over 50% of the labour force having less than four years of service.

The high turnover amongst labourers can be ascribed to the fact that most of them have their homes in rural areas and were until recently subject on influx control regulations and therefore itinerant workers. Few of them look upon their job as being permanent, and they undertake this work to supplement any income they may derive from their rural land base.

The 100% turnover in craftsmen and artisans is surprising. Management ascribes this to the fact that there is a shortage of skilled labour in the building industry, and most workers will readily change jobs for any pay increase. They do not lose out on service benefits because service is related to the industry through the industrial council and not to any particular employer.

Employers generally consider artisans and craftsmen to be unstable with regard to service, and hence readily hire and fire them. They are generally not considered part of the 'team' and in these circumstances there is little exchange of loyalties between management and skilled workers.

## 4.3 Mixed Building and Civil Engineering Contract (Company B)

The second company which was investigated by the author was one engaged in a mixed building and civil engineering contract. Figure 4.5 shows an analysis of the years of service of 322 black employees employed on this contract. This provides a more detailed analysis than that of the building company which was discussed previously.

As many as 43% of the labour force had less than two years' service and 64.6% had nought to four years' service. This correlates very closely with the building company where 64% of employees has four years' or less service.

The reasons for this high proportion of employees with minimal service are similar to those which have already been discussed in the previous section 4.2.4, dealing with length of service.

## 4.4 Labour Turnover Costs

Labour turnover involves the industry in considerable cost to little purpose. The cost of labour turnover can be appreciable. Manpower executives in the industry estimate the average cost of recruiting new employees to be at least one month's salary.

An additional cost of labour turnover is the learning curve. This is particularly applicable to the general worker and semi-skilled employee. Experience has shown that this learning curve can be of up to three months' duration.

Thus, if these itinerant workers are not re-employed in the industry, then there is the loss of investment in their training and skills development. In these circumstances there is input of resources into training and development, without a resultant economically productive output. This, in terms of the productivity equation, represents a serious loss in productivity.

## 4.5 Composition of the Labour Force in the Civil Engineering Industry

Figure 4.6 shows the relative composition of the labour force.

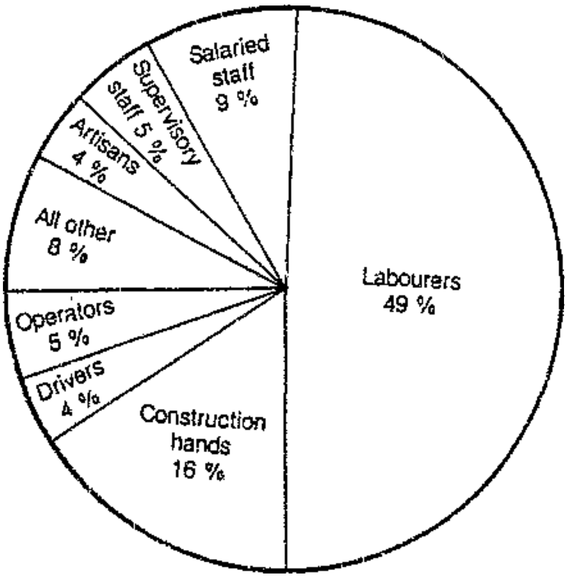



**FIGURE 4.6 COMPOSITION OF THE LABOUR FORCE - CIVIL ENGINEERING INDUSTRY**

Source : SAFCEC, 1988

The direct productive workers are represented by the following:

| | |
|---|---|
| Artisans | 4% |
| Operators | 5% |
| Drivers | 4% |
| Construction hands | 16% |
| Labourers | 49% |
| | 78% |

All the work done by the labourers and construction hands involves materials handling.

Thus 83.3% of the productive workers are engaged in materials handling. This correlates closely with the building industry where the general workers represent 82.6% of the productive labour force.

## 4.6 Profile of a Civil Engineering Company B

The analysis of the labour profile of a civil engineering based company which was part of this research, is of interest in illustrating the general position. Most of its work consisted of reinforced concrete structures. It did not engage in construction of roads and earthworks, but did compete for the building of factory premises and multi-storey buildings. It also engaged in mechanical and electrical installations.

The company employed a total of 3 947 people. 86.3% of all employees were black, and all but 2%, i.e. 3 326, were direct workers.

Table 4.5 shows the constitution of the labour force, supervision and head office administration.

**TABLE 4.5**

**EMPLOYEE COMPOSITION BY ETHNICITY AND OCCUPATION OF A TRANSVAAL CIVIL ENGINEERING COMPANY**

| ETHNICITY AND OCCUPATION OF EMPLOYEE | NUMBER OF EMPLOYEES | % OF TOTAL |
|---|---|---|
| BLACK - Semi-skilled | 1 244 | 32.3 % |
| - Unskilled | 2 082 | 54.0 % |
| WHITE - HOURLY PAID ARTISANS - Mechanical, electrical | 62 | 1.6 % |
| MONTHLY PAID | | |
| BLACK - Administration | 80 | 2.0 % |
| WHITE - Engineers ) Includes Contract - Technicians) Managers + Site Agents | 287 | 7.3 % |
| - Foremen | 100 | 2.5 % |
| Head Office Administration | 92 | 2.3 % |
| TOTAL | 3 947 | 100.0 % |

Foreman ratio 1 to 33.88

TABLE 4.6

BLACK LABOUR SKILL PROFILE - CIVIL ENGINEERING CONTRACT

| ACTIVITY | ADVANCED | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 | LABOURER | SUNDRY | GANG BOSS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Bricklayer | 11 | 5 | 2 | 1 | 3 | | | | 22 |
| Shuttering | 2 | 21 | 37 | 33 | 18 | | | | 111 |
| Steel Fixing | | 2 | 3 | 13 | 4 | | | | 22 |
| Concrete Placement | | 4 | 2 | 1 | 6 | | | | 13 |
| Section Leader | 2 | 1 | 2 | | | | | | 5 |
| Gang Boss | | | | | | | | 8 | 8 |
| Labourer | | | | | | 116 | | | 116 |
| Driver | | | | | | | 4 | | 4 |
| Nightwatchman | | | | | | | 1 | | 1 |
| Storeman | | | | | | | 1 | | 1 |
| Asst. Surveyor | | | | | | | 1 | | 1 |
| TOTAL | 15 | 33 | 46 | 48 | 31 | 116 | 7 | 8 | 304 |
| % OF TOTAL | 4.9 | 10.9 | 15.1 | 15.8 | 10.2 | 38.2 | 2.3 | 2.6 | 100.0 % |

First Line Supervisors:

| | | |
|---|---|---|
| | Section leaders: | 5 |
| | Gang boss: | 8 |
| | TOTAL: | 13 |

Average Span of Control is 304 ÷ 13 ≈ 23

The white, hourly paid, artisans (1.6%) were mainly employed on mechanical and electrical work.

Unskilled labourers accounted for 52.8% of all employees. This labour was involved in materials handling. The semi-skilled workers were employed in bricklaying, shuttering, steel fixing and concrete placement. As such, the bulk of their work also involved materials handling. The semi-skilled and unskilled black workers constituted 84.3% of the direct labour force. This again correlated very closely with the labour component in the building industry, which was engaged in materials handling.

### 4.6.1 Profile of site labour - Civil Engineering

This contract included civil engineering as well as some conventional building. The value of the contract was R18 000 000 and its duration was 18 months. The above sum included the work values of sub-contractors. All the direct labour on this site was black and all the foremen were white.

Table 4.6 presents an analysis of the site labour complement by activity and skills grade.

Of the total of 304 employees 262 were engaged in materials handling. This is 86.2% of the total, and correlates with the materials handling percentages already discussed.

### 4.6.2 Span of Control

Amongst the 173 skilled and semi-skilled workers there were only five black section leaders. This is equivalent to a first line supervisory span of control of 1 to 34.6.

there were eight gang bosses for 116 labourers, giving a span of control of 1 to 14.5.

Practical experience has proved that workers are more productive in the presence of direct supervision. The existing foreman to labourer ratio is such that it is impossible to apply eyeball control to the labour force.

It was found that the excessive span of control on one of the sites surveyed, was an important contributory factor to poor labour performance and low productivity. This was proved when a reduction of the span of control resulted in an improvement in labour performance and productivity.

Japanese management stresses the importance of a company's commitment to its people by favouring small spans of supervisory control (eight to 10 workers per first line supervisor[5]). Pascale and Athos (1981 : 191) quote a Japanese manager as saying :

*'Anyone who works for a company seeks approval for what he does and acceptance for who he is'.*

*'If you're striving to give employees a sense of being recognized for their unique contributions, you have to have enough supervisors to listen'.*

### 4.7 The Foreman

Management can be defined as getting things done through the active co-operation of people; and the continuing interface between management and the work force is the foreman.

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[5] (Pascale and Athos 1981 : 126)

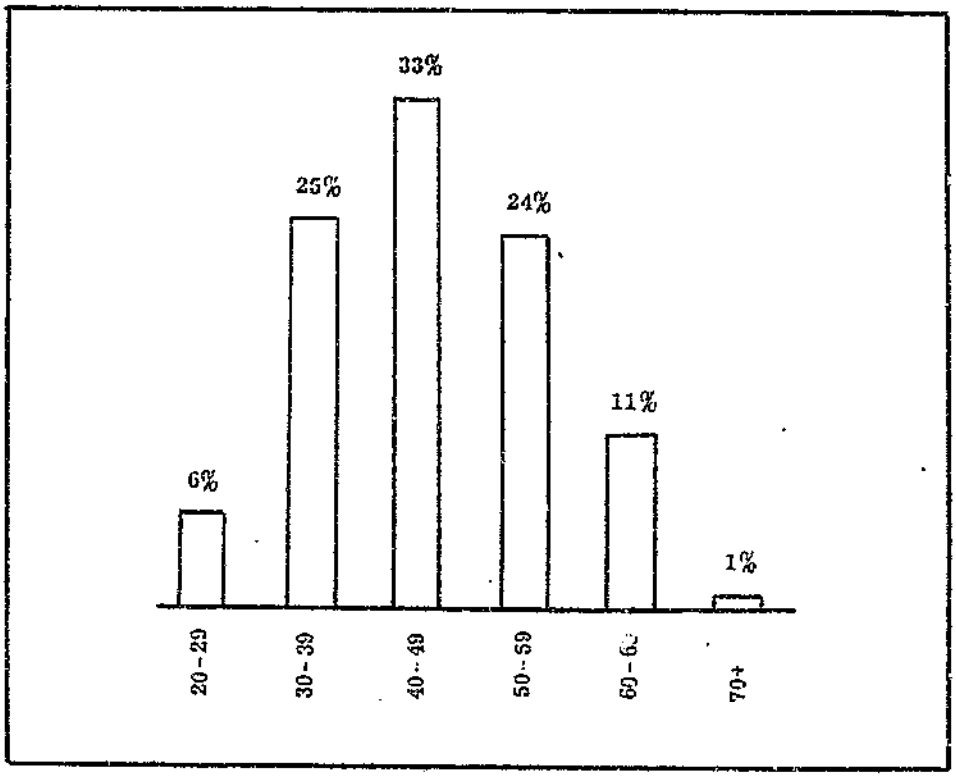


**FIGURE 4.7 FOREMEN AGE PROFILE**

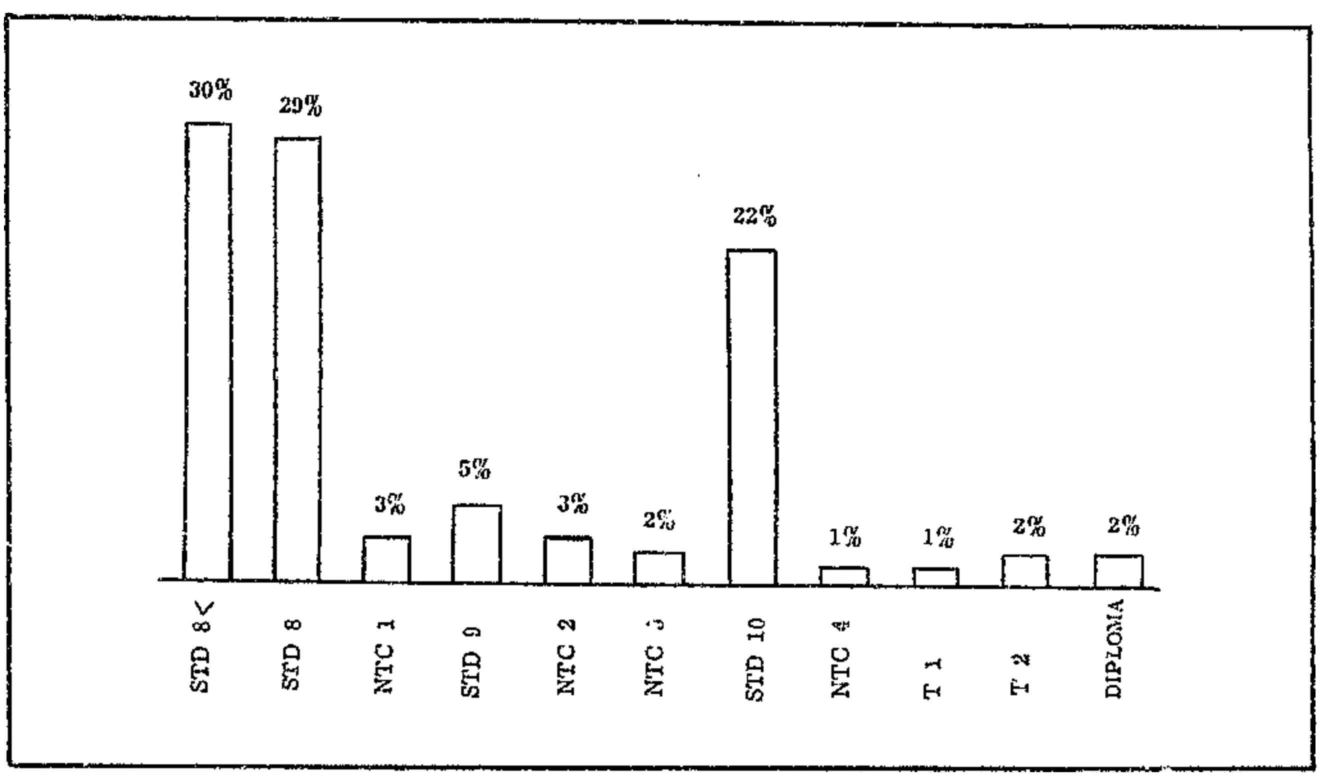


**FIGURE 4.8 FOREMEN EDUCATIONAL QUALIFICATIONS**

The foreman is in direct charge of labour, materials, equipment and plant. The influence he has on the company's wellbeing is often out of all proportion to his status and training and remuneration, and this will be shown by the value of the work for which he is usually responsible. His position in the industry is well described in the Cortis report (1962).

*'Modern developments in building techniques and the growth of large-scale building projects, have brought forward additional problems which have made new demands on the skill of building managers and their supervisors. The increasing cost of labour and materials, new pressure for capital resources to purchase mechanical equipment, all demand in turn increased efficiency from management and from labour at all levels. More particularly these increasing demands are made on foremen, who form such an important link in the chain, particularly in the medium and smaller firms. If in the past it was true that a good foreman was indispensable to a firm in its effort to make good on any quoted tender price, this is all the more the case today. In the future this will be true to an even greater degree'.*

In describing the ideal foreman's character the report states :

*'Above all he (the foreman) must be a reliable person with a keen sense of responsibility because he is left very much to his own devices'.*

This has not changed with time.

### 4.7.1 Foreman age profile, education and training

Research and analysis by the author of a construction company's personnel file revealed the following information regarding their foremen's age profile and educational qualifications. These are shown in figures 4.7 and 4.8. The total number of foremen was 100, and all were white.

### 4.7.2 Age profile

Only 31% were under the age of forty. This would indicate that fewer white foremen are going to be available to the industry. Skilled labour is the source from which foremen are promoted. In circumstances when there is a shortage of skilled labour, it is reasonable to suppose that if an artisan has not achieved foreman status by the age of forty, that it is most unlikely that he will make it in later years.

Fewer whites are entering the industry to undergo skills training. In these circumstances there will be an increasing shortage of emerging white foremen.

This situation thus presents a challenge to the industry to develop foremen from the non-white racial groups.

### 4.7.3 Education qualifications

30% Of the foremen had educational qualifications of less than standard eight, and 29% possessed a standard eight qualification. Thus 59% of the foremen surveyed had an educational qualification of standard eight or less.

### 4.7.4 Foreman training

Random sample interviews with individual foremen of the company surveyed revealed that at the time of their joining the company they had received a booklet dealing with human behaviour and interaction, but had not att[illegible]up courses in recent years.

Others had not attended any development or training courses since joining their companies, nor had they received any formal training in resources utilization. This reflects the commonly fragmented approach to training which is piecemeal and not ongoing. In these circumstances few if any benefits are derived from the money and time spent on training.

There was found to be a growing awareness at management levels of the necessity for a foreman's continuing education, but also inertia in implementing the necessary programmes.

The Human Resources Division of one of the companies surveyed had developed its own programmes which include subjects such as :

- Managing motivation for achievement
- Management simulation course (basics of supervision in behaviour modelling)
- Technical courses in formwork, setting out, materials and plant management, materials handling, storing and waste control.

Site management interviewed, questioned the practical applicability of the above courses, because few resultant benefits from these programmes were to be seen at site level.

Developments in technology and in the behavioural sciences require that foreman training, development and education be a continuing process.

BIFSA has developed a six part Foreman/Leading Hand development course which is of 16 days duration. This is a very practical course dealing with the elements of supervision, planning, resource and waste control, aspects of materials handl and technical functions such as concreting, levelling and setting out.

Ongoing education is essential, and if the BIFSA courses, in particular, are effectively implemented, they will fulfill an important function in the development of competent and caring site supervisory cadres.

### 4.7.5 Value of work controlled by foremen

A report of the National Productivity Institute commissioned by SAFCEC, entitled 'Productivity Key Ratios'[6], shows a ratio of foremen to direct workers of approximately 1 to 33[7]. On the basis of turnover figures for the industry, and the number of foremen employed, it can be estimated that, on average, the value of work (resources) controlled by a foreman over the period of one year, amounts to approximately R1 million.

None of the foremen interviewed had an adequate appreciation of the value of resources - manpower, materials, machinery and money - for which they were responsible.

The control of the above resources to the value of approximately R1 000 000 per annum requires a heightened sen of responsibility and awareness regarding their value, and expertise in their utilization. None of these talents was found in any abundance amongst the foremen interviewed. It is doubtful whether the industry's management would entrust the management of their own personal assets amounting to about R1 000 000 to persons with a standard of education of approximately standard eight (refer to figure 4.8), and limited post-school specialized courses pertaining to their fields of activity.

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6 Not published

7 The civil engineering company analyzed in section 4.6 had a foreman ratio of 1 to 33.9, and the building company, ref. section 4.2 had a ration of 1 to 55.6

## 4.8 Conclusions

It has been shown that approximately 80% of the labour force consists of general workers. They are mostly black, itinerant, and possess little education and skill. Their work, generally, can be classified as materials handling and this emphasizes the postulate that construction is largely a materials handling exercise. There is a high rate of labour turnover amongst these employees. Thus the limited skills which they acquire during their period of employment are often lost to the industry upon the worker's dismissal or resignation.

In view of the foregoing inhibiting factors it behoves the industry to review its policy towards the training and education of the general worker with specific emphasis on materials handling and work simplification.

Fewer whites are entering the industry to become skilled workers (table 4.1), and the industry is now faced with having to transfer skills to those non whites who have the aptitude and capacity to assimilate the necessary skills and apply them to the industry.

A study of the supervision profile also reveals that there is the urgent necessity to increase the number and quality of first line supervisors and foremen. It was found that the excessive span of control on one of the sites surveyed, was an important contributory factor to poor labour performance and overall productivity. This was proved when the span of control was reduced, and both labour performance and productivity improved.

The Central Statistical Services in its report for the Republic of South Africa, 1982, states that there was a negative growth rate in the total white population from 1960 to 1980, i.e., there was a decrease of 0.8%. The white to black ratio in 1982 was 1:3,8 and it is projected that this ratio will increase to 1:4,98 by the year 2000. The industry must therefore look to the black community as the source for the development of more supervisors in order to reduce the span of control, and improve the level of supervision.

# CHAPTER 5

## INDUSTRIAL LEGISLATION AND LABOUR DEVELOPMENT

### SYNOPSIS

It was considered important to look back into the past and establish the extent to which the industrial laws have affected the development of skills amongst black workers. This background information was considered essential reference material from which to establish the causes of present deficiencies in the workers' training and productive capabilities.

The historical review discusses the restrictive legislation which has inhibited the development of skills amongst the major portion of the South African population - the black people. The white trade unions have been party to discrimination and have, indeed, prevented blacks from acquiring skills by refusing to participate in their training.

However, economics ultimately dictated to politics. The restrictive legislation has been progressively eliminated and employer's bodies and government have introduced numerous training schemes for the development of black artisans. In spite of this there is still a considerable backlog of skilled workers.

Recommendations are made for on site skills training and the development of a qualified general construction worker. It is also recommended that the building and civil engineering industries pool their training resources to provide more economic and effective training programmes.

## 5. INDUSTRIAL LEGISLATION AND LABOUR DEVELOPMENT

The inhibitions and restrictions in the development of South Africa's black manpower resources can be traced back to 1907.

The earliest statutory discrimination against non-white workers was the Government Ordinance 17 of 1907, which allowed the employment of 'non-white' immigrants (Chinese) only as unskilled labourers.

This stemmed from the pressure which white miners brought to bear on the government to protect their position as skilled workers against the threat of the imported Chinese miners in 1904. Croen (1975 : 7) emphasizes the discriminatory precedent which this ordinance created :

*'As a result of political pressure (mainly from Britain) the Chinese miners were repatriated, never to return. However, the 'interlude' had the important consequence of making clear to the white miners that, with sufficient pressure, they could get the government, consisting mainly of farmers, to pass legislation effectively removing them from black competition'.*

The Mines and Works Act of 1911 further entrenched work reservation by prohibiting blacks from holding blasting certificates.

But little forethought was given to industrial growth and development, and the future need for an increasing number of skilled workers.

De Kiewiet (1941 : 66) comments :

*'Almost within the first year of Union, an Act of Parliament (the Mines and Works Act)*

*recognized that a new social and economic frontier had taken the place of the old frontier. Where the natives were once excluded from land and ample water, now they were kept afar from skilled labour and high wages'.*

## 5.1 Industrial Legislation

After the industrial unrest, which culminated in the great strike of 1922, the Industrial Conciliation Act was passed in 1924. The purpose of this Act was to provide a system of communication to prevent and settle disputes between employers and employees. It must be emphasized, however, that black workers were excluded from trade union membership, and hence excluded from the bargaining process. The 1924 Industrial Conciliation Act, now the Labour Relations Act 28, 1956, as amended in 1979, brought into being Industrial Councils for the different industries, including the building industry, but excluding civil engineering.

## 5.2 General Discriminatory Legislation

In addition to industrial legislation, there was the general discriminatory legislation of Influx Control (Black Urban Area Consolidation Act 25 of 1945) and the Group Areas Act (No. 41 of 1950) which further inhibited productivity.

The practical consequences of this legislation were manifold. Employers had to spend time and money registering workers whose permanent homes are in rural areas. Special hostel accommodation had to be provided. Workers had to go back to their families at month end after payday. This incurred the worker in transport costs, and often resulted in excessive month-end absenteeism, not to mention the social impact on family life.

Commenting on productivity constraints Rees (1985 : 31) wrote:

*'In many countries productivity growth relies upon technical progress. In South Africa we are a long way from this constraint. We have substantial opportunities for improvement that are not dependent on technology : rational allocation of education resources and a tax system that ensures that effort and reward are related are two of them. But most of all, we must cease imposing penalties on workers so impudent as to seek gainful employment, accompanied by their families, in trades and geographical areas which they themselves select as being the best venue for their skills'.*

### 5.2.1 Work reservation

The Trade Unions whose memberships were limited to whites, objected to any form of skills training for black workers; thus ensuring that all skilled work was reserved for whites. This resulted in work reservation agreements between employers and unions; and these were gazetted by industry and approved by the Minister of Labour.

Thus the history of work reservation which began in 1907, was institutionalized through the promulgation of the Labour Relations Act, 28, 1956.

### 5.2.2 Legislation amendments

Subsequent to the implementation of the recommendations of the Wiehahn Commission[8], there was a further amendment in 1979, which led to the establishment of Industrial Courts and the National Manpower Commission.

A further amendment in 1981 changed the name of the Act to the 'Labour Relations Act' and in terms of this act full trade union rights were extended to all industrial workers. But these rights were denied to domestic servants and agricultural workers.

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[8] Report of the Commission of Enquiry into Labour Legislation Parts 1 to 6 1979 - 1980

## TABLE 5.1

### INDUSTRIAL LEGISLATION AFFECTING MANPOWER TRAINING

| | |
|---|---|
| 1900 | |
| 02 | |
| 04 | |
| 06 | |
| 07 | Government Ordinance 17 'non-white' immigrants (Chinese) limited to unskilled labour |
| 08 | |
| 1910 | |
| 11 | Mines and Works Act prohibiting blacks from holding blasting certificates |
| 12 | |
| 14 | |
| 16 | |
| 18 | |
| 1920 | |
| | Miners' Strike. |
| 22 | Apprenticeship Act, No. 26 of 1922. |
| 24 | |
| 26 | |
| 28 | |
| 1930 | Apprenticeship Act Amended, No. 22 of 1930. |
| 32 | |
| 34 | |
| 36 | |
| 38 | |
| 1940 | |
| 42 | |
| 44 | Apprenticeship Act, No. 37 of 1944. |
| 46 | |
| 48 | |
| 1950 | Black Building Workers Act, No. 27 of 1951 |
| 51 | Apprenticeship Amendment Act, No. 28 of 1951. Training of Artisans Act, No. 38 of 1951. |
| 52 | |
| 54 | |
| 56 | Labour Relations Act, No. 28 of 1956. |
| 58 | |
| 59 | Labour Relations Act Amendment, Act No. 41 of 1959. Apprenticeship Amendment Act, No. 29 of 1959. |
| 1960 | |
| 62 | |
| 63 | Apprenticeship Amendment Act, No. 46 of 1963. |
| 64 | |
| 66 | |
| 68 | |
| 1970 | |
| 72 | Training Scheme for Civil Engineering Industry, Govt. Notice No. R 2352, 22 December 1972. |
| 73 | Civil Engineering Industry Extension of Training Scheme, Govt. Notice No. R 2362, 14 December 1973 |
| 74 | |
| 75 | Civil Engineering Industry Extension of Training Scheme, Govt. Notice No. R 2379, 19 December 1975 |
| 76 | Black Employees In-Service Training Act, No. 86 of 1976. |
| 78 | Civil Engineering Industry Extension of Training Scheme, Govt. Notice No. R 1915, 22 September 1978. |
| 79 | In-Service Training Act, No. 95 of 1979. |
| 1980 | |
| 81 | Manpower Training Act, No. 56 of 1981. |
| 82 | Training Scheme for Civil Engineering Industry, Govt. Notice No. R 2332, 29 October 1982. |
| | Wage Order for Civil Engineering Industry, Govt. Notice No. R2462, 19 November 1982. |
| 84 | |
| 86 | |

## 5.3 Civil Engineering Industrial Relations

The civil engineering industry did not have any trade unions. Without unions it was not possible to conclude an industrial agreement nor any job reservation agreement.

However, the artisans working in the construction (Civil Engineering) industry, eg., carpenters, subscribed to the existing restrictive trades practices, and thus little was done to develop skills amongst black workers.

It has been mentioned that the civil engineering industry, unlike the building industry, does not have an Industrial Council which is a platform where trade unions and management meet in order to negotiate wages and conditions of employment.

In these circumstances, wages and conditions of service are determined through negotiations between the South African Federation of Civil Engineering Contractors (SAFCEC), which is a registered employer's organization in terms of the Labour Relations Act, and the State. The agreed wages and conditions are then gazetted by the Department of Manpower in the form of a wage order for the industry.

## 5.4 Industrial Legislation Affecting Manpower Training

Table 5.1 was compiled to represent, chronologically, the legislation affecting training in the construction industry.

The first act of legislation regarding training, which applied to apprentices, was passed in 1922. There were only two amendments to this legislation during the next 29 years. This would indicate the maintenance of a status quo in skills training during this period, with little progress towards improvement. It was only in 1951, after the Second World

War, that a radical departure from the traditional apprenticeship training was permitted. This created opportunities for those ove. 21 years of age to train and qualify as artisans; but it was not until 1972 that the civil engineering industry introduced a formal training scheme.

## 5.4.1 Black worker training legislation

The first official training received by blacks was in terms of the Bantu Building Workers Act (No. 27, of 1951). But these workers were restric. ed to employment in black areas. The first act which permitted the training and use of black workers in urban areas was passed in 1976.

It should be noted that during a 62 year time span during which 17 Acts and Governm. nt Notices were gazetted, eight were recorded during the first 41 years, and nine during the last 12 years. It is significant that 76 years elapsed after the turn of the century before the first item of legislation was passed with regard to the training of black employees and their permissible employment in urban areas : the Black Employees in-Service Training Act, Number 86 of 1976.

This indicates that the industry has shown little foresight regarding local skilled manpower development. The importation of artisans has proved to be costly. The result is that the local population's earning powers have been inhibited because of the lack of skill which in turn has affected adversely their productive capacities.

## 5.4.2 Training of black workers

It is axiomatic that all economic progress involves specialization and all specialization involves training.

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It is axiomatic that all economic progress involves specialization and all specialization involves training

There has been a singular lack of awareness in the industry of its labour requirements and the necessity to develop a growing body of skilled workers to serve the industry.

It has been shown that the majority of employees in the industry is black. As the majority, they would logically be the source for artisan recruitment. However, in addition to legislative restrictions, the upward mobility of these workers has in the past also been restricted by employer and white worker attitudes.

This is clearly recorded in a study by Cortis et al (1962 : 26) for the building industry sponsored in 1962 by the Council for Scientific and Industrial Research, the National Institute for Personnel Research, the National Development and Management Foundation, and directed by S Biesheuvel.

The study describes supervisory attitudes towards the unskilled worker as follows :

*'They are given virtually no responsibility and are required to show no initiative. This is largely because their positions are regarded by supervisors as temporary'.*

Semi-skilled workers - artisan's hands - were those who came closest to skilled work. But that was where their development ended.

The report further observes :

*'The majority of these workers learn to know the various tools and types of materials used ... but seldom reach the stage where they can use their own initiative to decide what must be done next'.*

*'In South Africa ... racial barriers preclude the assistant from making any suggestions to*

*the skilled artisan. Supporting evidence is given by an attitudinal study carried out by NIPR which revealed that bantu in all occupational groups generally think very little of the job of an artisan's hand. It is regarded as a 'shadow job' in which the man is seen to do no more than assist a European, using none of his own abilities'.*

These attitudes are reflected more recently in the BIFSA pamphlet entitled 'Education and Training', published in 1984, with regard to construction workers.

*'Although it has always been accepted that the only requirement for this job was a healthy strong body which could perform mechanically with a minimum of intelligence required - the building industry has revised its approach and now endeavours to train these men to their utmost abilities'.*

### 5.4.3 Historical artisan training

From the early 1920's, a skilled worker was one who had completed an apprenticeship in terms of the Apprenticeship Act No. 26 of 1922, as amended by Act No. 22 of 1930, and the subsequent Apprenticeship Act No. 37 of 1944.

Serving an apprenticeship involved a five year employment period with compulsory attendance of night classes at a technical college. Those who had passed standard eight at a trades school, before commencing their apprenticeship, obtained a remission of one year and were thus only required to serve four years.

The Apprenticeship Act did not stipulate any racial restrictions. In practice, however, both the educational levels required and the attitudes of white skilled artisans who were members of trade unions, ensured the exclusion of blacks from becoming apprentices.

During the Second World War (1939 - 1945) many young whites who would normally have entered a trade for training enlisted in the armed forces; and the apprenticeship age restriction of fifteen prevented them from being indentured as apprentices upon their return from army service. Thus industry (and construction was no exception) virtually lost a generation of skilled workers.

It must be mentioned that many of the entrants into the trades in pre-war years had high development potential. This is clearly illustrated by the number of university graduates who served an apprenticeship before commencing their university studies. Others advanced through the ranks to high office in industry and became entrepreneurs in their own right. The void left by these achievers was not adequately filled in the post-war years by young people coming into the industry in sufficient numbers.

Potential recruits to artisan ranks were further depleted by the university and other study grants to ex-servicemen who otherwise would not have been able to afford tertiary education.

### 5.4.4 Non-white training

The Training of Artisans Act, No. 38 of 1951, did provide for the training of coloureds and asians. But even if qualified, these non-white workers were not recognized, and were debarred from working in the Transvaal and the Or ıge Free State.

In the meantime blacks did receive some training in terms of the Bantu Building Workers Act (No. 27 of 1951). They could qualify, but could only work in black areas and could not be employed legally as skilled workers in urban areas.

The development of skills was further inhibited by work reservation as stated by Cortis et al (1962).

*'An aggravating factor has been the introduction of work reservation as defined in Act No. 28 of 1956, as amended by Act No. 41 of 1959. Builders were unanimous in condemning the legislation and in pointing out how it removed whatever incentive they may have had to train bantu labour. Where new equipment is introduced, builders are loath to admit bantu labour to semi-skilled jobs because of the threat that the job will be reserved. Though the sample of builders we visited is rather small, we feel that their unanimity of expression is significant'.*

In an effort to overcome the shortage of skills, employers fragmented work to reduce the period of initial training and to assist the black workers to reach top productivity as quickly as possible. A typical example was the introduction of steel shuttering and support equipment which requires relatively little skill in assembly and disassembly.

But economics dictate to politics. By early 1970 the shortage of artisans was such that the trade unions did not have sufficient members to undertake the work required. This led to the introduction of 'black operatives' in work such as bricklaying, painting, carpentry and plastering.

### 5.4.5 Training facilities, methods and achievements

There is a considerable amount of overlap in the work done by the building and civil engineering companies. Apart from the classical civil engineering work such as the construction of bridges, roads and earthworks, irrigation and sewerage systems, civil engineering companies compete with building companies for high-rise building contracts, factories and general reinforced concrete structures.

et al (1962).

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FIGURE 5.1 FORMAL, NON-FORMAL AND INFORMAL EDUCATION AND TRAINING IN THE BUILDING INDUSTRY

# Formal, Non-Formal and Informal Education and Training in the Building Industry

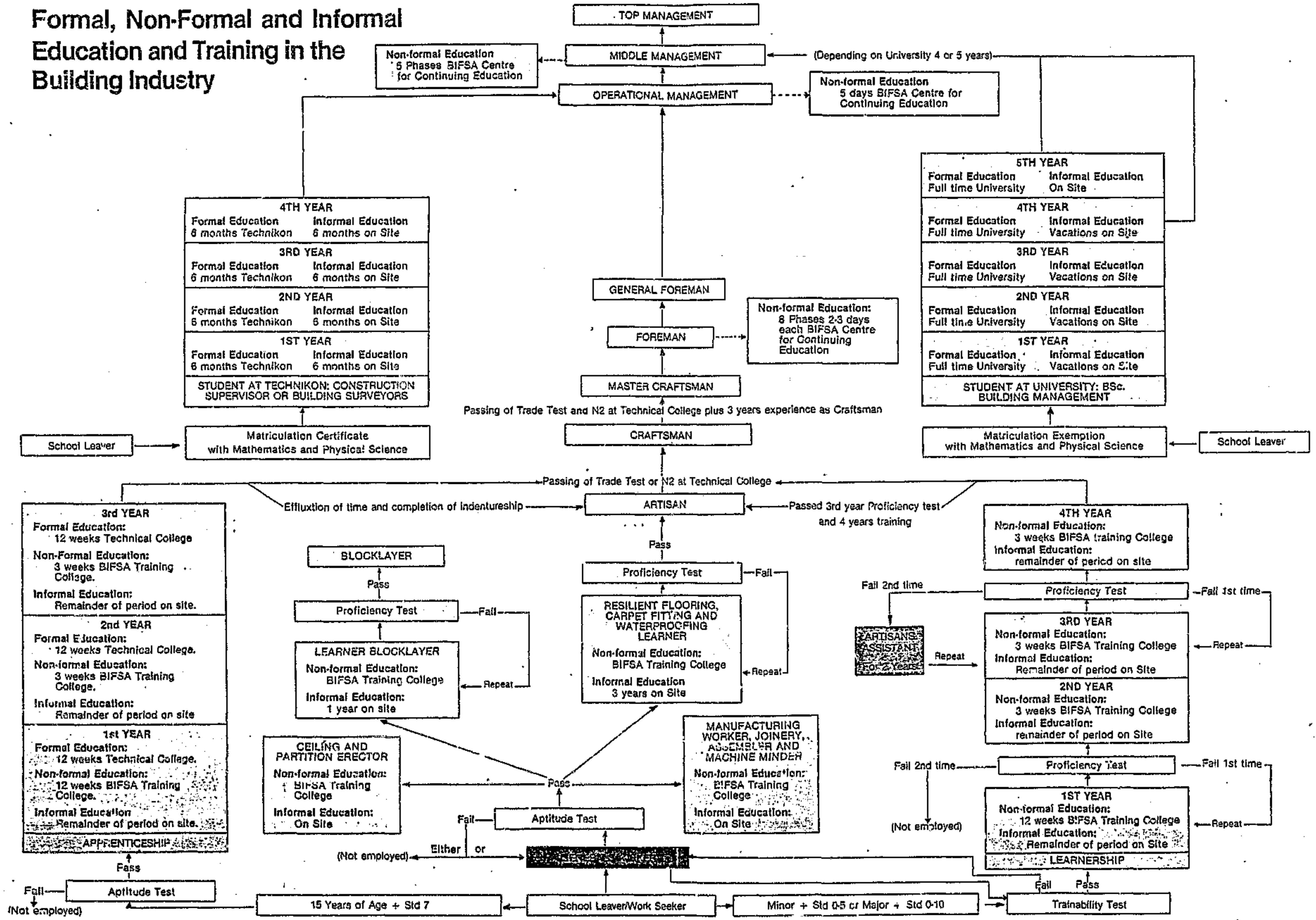


FIGURE 5.1

The building and civil engineering industries are represented by separate bodies :

| | | |
|---|---|---|
| Building | - | Building Industries Federation (South Africa) |
| Civil Engineering | - | SAFCEC (South African Federation of Civil Engineering Contractors) |

Each industry offers its own training facilities, and their respective career paths differ.

The Manpower Training Act, No. 56 of 1981, repealed the Bantu Building Workers Act and opened the way for the training of all workers irrespective of colour and race. The practical application of this act has resulted in the development of two career paths for the training of skilled workers in the building industry, as shown in fig. 5.1.

### 5.4.6 B[illegible] industry training

Figure 5.1 illustrates the formal, non-formal and informal education and training available within the building industry.

Career paths to artisan and craftsman level are available through apprenticeship for the 15 year old school leaver, who has passed standard 7, or the major (21) with suitable aptitude through a learnership.

### 5.4.7 Artisan development in the civil engineering industry

It has already been noted that the civil engineering industry has never had an Industrial Council nor has it had formal apprenticeship training. The result is that it has never developed artisans. Those that were employed in the industry were drawn from other industries such as building, and included carpenters, bricklayers, et al.

The construction side of civil engineering mainly involves reinforced concrete structures. Thus the main activities are shuttering, reinforcing, steel fixing and concrete placement. Apart from bricklaying operations, there is generally little requirement for the artisan skills employed in the building industry.

The training offered by the civil engineering industry is therefore markedly different from that of the building industry.

### 5.4.8 Civil Engineering Industry Training Board (CEITB)

At its annual general meeting in September 1971, the South African Federation of Civil Engineering Contractors resolved to establish a training scheme for the civil engineering industry.

#### 5.4.8.1 Training courses

Since its inception, the CEITB has developed numerous training courses for its members, and also publicizes courses offered by other agencies, which have been approved by the Department of Manpower and the National Training Board. These courses are listed in the Course Directory published by the CEITB. The courses listed in this directory apply to management, supervisory and technical training.

Other courses are published in the training bulletins issued by the Board.

#### 5.4.8.2 Civil engineering training spectrum

During the year ended June 1988, 6900 employees completed training courses which have been approved by the Training Board for grant payments.

Table 5.2 shows the number of employees who attended training courses during 1988.

**TABLE 5.2**

**CIVIL ENGINEERING TRAINING BOARD**

**NUMBER OF EMPLOYEES ATTENDING TRAINING COURSES 1988**

| Category/course | Number attending | Remarks |
|---|---|---|
| Technicians | 165 | Technikon training |
| Management | 565 | |
| Supervisory | 3 030 | General foreman to gang boss |
| Skills | 1 095 | For general workers |
| Supporting | 2 045 | Industrial relations, safety, 6 M. Short one day courses. |
| Total | 6 900 | |

Source: Civil Engineering Industry Training Board

The total number of employees in the formal sector of civil engineering in 1988 was 96 000. The 6 900 employees who attended training courses during 1988, thus represent 7.2% of the total employed.

A review of the type of course completed clearly shows that the training has been directed towards the staff and supervisory sections of the employee spectrum. Only 15.9% of the employees trained, attended the skills courses.

According to the composition of the labour force (refer to Fig. 4.3), 86% of the labour force are direct workers. This represents 82 560 employees. Table 5.2 shows that only 6 900 of these employees attended training courses. This represents 8.4% of the direct labour force. It is appreciated that the above figures are limited to approved training courses. But it is questionable whether the foregoing rate of training is adequate to develop the necessary skills required to maintain satisfactory improvements in labour productivity.

## 5.5 Critique Regarding Skills Training and Recommendations

The nomadic nature of construction work is such that it mainly attracts migrant workers. Their job tenure is relatively short, eg, 42% have less than two years of service, refer to Section 4.3.

Bearing in mind the low level of formal education, it is extremely difficult to help them develop skills in such a short period of time.

Much of the recruiting is done on site - especially on the smaller contract - where recruiting personnel are not qualified to employ scientific selection techniques.

The skills training is usually done at off-site training centres where the courses are of approximately three weeks' duration. Working conditions are different from those on site. The work consists of erection (shuttering) or building (bricklaying) and the work done is dismantled after completion. This is psychologically undesirable and affords the worker little creative satisfaction.

The training is directed towards the acquisition of know-how and achievement of acceptable quality. No attention is paid to the productive effort of the trainee, i.e.

quantity of production required during a given time allowance.

All this adds up to the fact that the training is being done under artificial conditions which do not prepare the trainee for the on-site production requirements (challenges) of quantity and quality. This can and does lead to situations where workers are getting skilled rates of pay but are not giving the required production. The result is dismissal and the additional cost of labour turnover, or inflation due to 'high' pay and low productivity.

Site management criticism of present training practices obtained in the course of interviews, included the following :

- when the site is busy they cannot spare their workers for training.
- when the site is slack then they cannot afford to train them and would rather dismiss them.
- the training they receive 'is a waste of time' because it does not equip them to cope with the job requirements on site.
- the training centres are costly to maintain and ineffective. This comment often stems more from emotion than practical reality, and portrays the not uncommon antipathy of site personnel towards head office staff departments.

**5.2.4 On-site training**

Most other industries, particularly mechanical and electrical engineering, have recognized the value of on-site training. Equally, the construction industry can benefit from increased skills training on site.

The activities on which the trainees are engaged should not be critical so far as the construction programme is concerned. The instructor should be qualified in skills training and communications but should also be a member of the production team with a keen sense of awareness regarding productive effort and production quantity, quality and cost.

The following Gravesian concept (Graves C W) is, indeed, applicable in the appointment of instructors/teachers.

*"Since people learn in different ways from different kinds of teachers/trainers, the task of education or training is to match learners, teachers, and educational strategies."*

By instituting this practice the cost of training will be greatly reduced; the trainees will be productive and have the satisfaction of being part of the team and of seeing their completed work as part of the overall project. They will be working under site conditions, and develop an understanding of site production requirements in terms of method, quantity and quality.

The site management objection of additional cost can be met by subventions from the training grants provided by the Manpower Development Fund (government).

The on-site training must be approved by the Department of Manpower, but that should not present an obstacle.

An alternative to on-site training can be the training of workers in the erection of sub-economic housing and infrastructure civil works in areas such as Soweto. The additional millions of Rands which the government is now spending on training through the established training centres will thus become productive, and not be spent on sterile work which is erected (such as shuttering) and then dismantled, or broken down (brickwork).

In practice it would mean that the construction division of the training centres be removed to sites such as Soweto, where the concept of productive training can be implemented and where the trainees probably live.

## 5.6 The Qualified General Construction Worker

The concept of worker training and skills development is still based on the original concept of limited craftmanship with workers being trained in limited skills such as bricklaying, shuttering, steel fixing, concrete casting, etc. This narrow range of skills, leads to the under-utilization of labour. This particularly applies on contracts where these activities are not on-going. A further undesirable and costly consequence is the necessity to transfer or dismiss workers for whose specialized skills there is no longer a need.

The fact that there is no longer any restrictive legislation regarding training and the skills development of the bulk of the labour force i.e. black, presents a challenge to the industry.

The necessity for better training of low income workers is emphasized in the Project Free Enterprise Report (1984). Those in the earnings brackets of up to R[illegible] per month rated better training as the most important factor (42% to 46%) for achieving improved productivity.

Thought should therefore be given to the development of a "General Construction Worker" who will have undergone a multi disciplinary training and will be skilled in all the general construction activities.

This will result in job enrichment and provide the industry with better qualified and experienced workers. The enterprising individual amongst these workers may well provide the nucleus of a small business construction industry which suitably financed can help to alleviate the housing shortage amongst blacks, and through the transfer of their skills to the black people, provide increased employment opportunities which are so badly needed.

Fragmentation of training places additional responsibility on supervisory management. The current span of supervisory control, as mentioned in section 4.6.2 is already excessive, and the introduction of a well qualified, self disciplined general work could well be an asset to the industry.

## 5.7 Duplication of Training Facilities

It has already been mentioned that the building and civil engineering industries employ common skills in areas such as bricklaying, shuttering, carpentry, steel fixing and concrete placement (casting). In spite of this, BIFSA and SAFCEC have developed and maintain separate training programmes and facilities. This duplication involves unnecessary additional cost to the industries concerned, as well as the general taxpayer (through grants from the National Training Board).

One can conclude that thought should therefore be given to the consolidation of training programmes and facilities which are of common concern to both sections of the construction industry. Such a consolidation could provide for the exchange of practical experience in training methods, with the resultant development of better and more effective programmes, to the ultimate benefit of all concerned.

## 5.8 Review of Training Methods

The recommendations of the "Pittendrigh" report published by the Human Sciences Research Council (1985) on behalf of the National Training Board, regarding technical training are of an evolutionary nature. They are based on the original centuries old craft concepts of apprenticeship and learnership.

It must be appreciated that the institution of apprenticeship was developed at a time when technological development was at an elementary stage with little scientific content. The design of engineering structures, buildings and machines was empirical, and this in the absence of modern machine tool technology and accuracy, called for high degrees of craftmanship.

Technological development has blurred the lines of division between the different traditional crafts (skills). For example, the original skill of applying protective coatings and decorative finishes which was limited to the use of paint, now extends to the application of plastic and composite cladding materials. Environmental control in buildings involves metalwork, electrical wiring and electronic controls.

The design and construction of modern structures and buildings requires an interdisciplinary approach, and the industry needs therefore to identify the skills required which can bring to fruition modern design and applied technology in a third world environment.

This calls for a radical revision, and possible departure from present training methods to ensure that future industrial manpower needs are served. This is, indeed, a subject matter for urgent research.

It is recognized that training is indivisible from education, and whatever new training methods are developed they will, perforce, have to be based on a sound educational foundation.

## 5.9 Conclusions

The historical review discussed the restrictive legislation which has inhibited the development of skills amongst the major portion of the South African population - the black people. The white trade unions have been party to discrimination and have, indeed, prevented blacks from acquiring skills by refusing to be party to their training. However, economics ultimately dictated to politics. Restrictive legislation has been progressively repealed, but the industry will not be able to operate in a truly free enterprise environment until all discriminatory legislation is abolished.

Consequent to the legislative changes, employers' bodies and government have introduced numerous training schemes for the development of black artisans. In spite of this there is still a considerable backlog of skilled labour.

This is emphasized in the BIFSA annual report (1988 : 121)

*'However it is worrying that the level of apprenticeship training in South Africa is below the required level and unless contractors and sub-contractors are prepared to substantially invest in their manpower, then the skills shortage in South Africa is likely to be further accentuated.'*

Technical skills in this day and age must be based on a concomitant level of education and training. On-site training should where practical, replace the off-site training practices, which are costly and non productive.

It is recommended that the concept of a qualified general construction worker be introduced into the industry. Such a worker will have undergone a multi-disciplinary training and will be skilled in all the general construction activities.

It is also recommended that the building and civil engineering industries pool their training resources. This could result in more economical and effective training programmes.

# CHAPTER 6

## BLACK EDUCATION AND ITS EFFECT ON SKILLS DEVELOPMENT

### SYNOPSIS

This chapter discusses further the educational component of the holistic approach and deals with the importance of education in acquiring cognitive skills. The quality of black education is compared to that of whites, and it is concluded that it is of a lower standard. The high school drop-out rate is a further contributory factor to the generally low level of education amongst blacks.

Generally, the level of education of the South African labour force is much lower than that in first world countries.

The diversity of ethnic languages and their absence from the teaching curriculae in white schools in former years is proving to be an inhibiting factor in white/black communications.

The importance of non-formal continuing education is stressed, and recommendations are made for the introduction of craft training and technical education in elementary schools.

## 6. THE IMPORTANCE OF EDUCATION

Training and development courses are aimed at providing systematic learning experiences which will make workers more proficient in their jobs.

These courses cannot be effective, however, unless the trainee possesses a sound educational base which has provided him with a basic education in literacy, language comprehension, arithmetic (mathematics) and cognitive skills. Education must be part of a person's total development process.

Discussing the South African educational scene, Rees,. (1985 : 27) writes :

*'The reason people want education for their children is because they are living in a society where there is a positive pay-off to acquiring knowledge and skills which are valued in the job market. The increasing clamour in South Africa for more and better educaion facilities should be welcomed as evidence of an efficient incentive system'.*

He goes on to say :

*'Inefficiency in education investment is one important cause of low productivity in South Africa'.*

The importance of education and skills is stressed by economist Lester Thurow (1985:17). He asserts that the level of education and skills for Japanese or German workers is higher than it is for American employees, and goes on to ask :

*'How can we have a competitive economy with a labour force that just does not measure up?'*

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*'How can we have a competitive economy with a labour force that just does not measure up?'*

In looking at the possible scenarios for the 1990's, Sunter (1987 : 40) places education and the work ethic at the top of his list of six factors which constitute the portrait of a winning nation; and goes on to say:

*'On the brink of the knowledge - intensive 1990's, the foremost characteristic of a 'winning nation' has to be the quality of its education system.'*

However, knowledge, the same as all assets, must be put to work. There have been numerous instances, particularly in Natal, where black workers after undergoing training at training centres, have not been able to find employment. The result has been the waste of training costs, and the ultimate atrophy of the limited skills which the trainee acquired.

It is therefore suggested that one of the effective sources of initial employment for the emergent young black knowledgeable people could be the informal black construction sector, and the related ancillary industries such as the manufacture of kitchen and bathroom fittings, and the installation of electrical and plumbing services.

## 6.1 Quality of Black School Education

Quality is a relative concept, and in South Africa one must compare black education with that of whites. The first observation is that black and white education are the responsibility of eighteen different ministries and governmental departments.

In these circumstances there is complete separation of school facilities, teacher training, and curricula. Significantly there is also a great disparity in the monies spent per pupil in black and white education.

The average per capita expenditure on whites per annum in 1978 was R724; for blacks it was only R71, i.e. 9,8% of that spent on white education. (R Todd, Inside South Africa, September 1987, p. 9).

The differences in spending on black and white education are being reduced, but are still substantial.

The following are the amounts spent per pupil during 1986.

PRIMARY & SECONDARY SCHOOLS

| | |
|---|---|
| Whites | R2 746 |
| Indians | R1 952 |
| Coloureds | R1 330 |
| Blacks | R 456 |

*SOURCE: Spokesman, Department of National Education*

The spending on black education per pupil had increased to 16.6% by 1986, of that spent on white education.

According to a spokesman from the Department of National education:

*'The reason for the low spending on black education is that 70% of the expenditure comprises teachers' salaries. Approximately 90% of black teachers are underqualified and hence are paid lower salaries than whites. Black teachers' qualifications mostly range from standard eight to matric plus a two year diploma. Special efforts are now being made to raise the qualification levels of black teachers.'*

The increase in spending on black education is commendable, but this must be accompanied by quality improvement. The time pay-off on investment in education is from 10 to 20 years. Thus the country is faced today with the inadequacies of the past and this may continue into the foreseeable future.

Biesheuvel (1980 : 22), commenting on educational expenditure wrote :

*'.... South Africa should look upon its expenditure on education as a kind of defence expenditure - defence against internal unrest and violence, which will most assuredly follow if we do not achieve our productivity targets and have to face the prospect of mass black unemployment'.*

Considered against current circumstances they were, indeed, prophetic words.

### 6.1.1 Differential between black and white educational standards

Enquiries made did not reveal any definitive researched information regarding the differences in the levels of black and white education.

Empirical opinions obtained from educational authorities[9], however, confirmed that there are substantial differences, ranging from two to three years or more in standards of education. For example, a recent (1985) English reading age test conducted on blacks who passed standard 10, and which involved word recognition, related to a white equivalent level of approximately standard three.

Considering the relative educational levels of Black South Africans, the comment of Lester

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[9] a. Prof. Don White, former Dean of the faculty of Education, University of the Witwatersrand
b. Mr Morapeli, Head of Soweto Teacher's Training College

Thurow's statement previously quoted is indeed applicable to the South African construction industry. It may well be paraphrased to ask :

*"How can we have a productive construction industry with a labour force possessed of minimal education and skills?"*

### 6.1.2 Drop-out rate affecting black advancement

Bisheuvel (supra : 22-27) emphasized the effect of the school drop-out rate on black advancement. He writes :

*'A further aspect of educational inadequacy is the drop-out rate. Though the percentage of the black population at school has grown from 5.18% in 1935 to 21.07% in 1975, attendance dwindles from 21.85% in sub A, to 4.04% in form 1 and to 0.24% in form 5'.*

In summing up he says :

*'This is a far more serious impediment to the advancement of blacks into higher level jobs than the remaining statutory and customary barriers, which are all crumbling at the moment.'*

More recent education statistics quoted by Sunter (1987 : 40) show an improved position. He states :

*'Secondary school ratios are about 89% for whites, 80% for asians, 44% for coloureds and 35% for blacks. The matric pass rate compared with the total number of eighteen year olds is 61% for whites and between 5% and 10% for blacks. That is just not good enough for South Africa to be a 'winning nation' in the knowledge-intensive 1990's, even with a satisfactory political dispensation.'*

Tragically, black scholars, with radical encouragement, were (in 1986) committing themselves to the concept of "no education before liberation". This resulted in the burning of books and schools, and the boycotting of classes and examinations.

These actions did incalculable harm to the development of black youth. Ultimately, the liberated could lack the capacity to utilize resources effectively. This will result in a wasting of existing assets, and a lack of ability to replace them. The consequences will be a progressive reduction in the standards of living and quality of life for all concerned.

## 6.2 Cognitive Skills Development

Inadequate education affects the development of cognitive skills. The relative absence of cognitive skills amongst black workers is partly explained by Biesheuvel (supra : 22-27).

*'The pupil-teacher ratio is adverse, and has deteriorated of late to 1 : 49.2. On top of all this, teachers are poorly qualified for their particularly demanding task, especially in the lower standards where the foundations for later effective learning should be laid. What is the result? Those who do emerge eventually from the primary or even from the secondary school, are too used to rote-learning, too concerned with passing examinations at all costs, to be able to profit fully from further more advanced education and training where understanding, insight into the relatedness of things, problem solving, ability to proceed from the specific to the general are of paramount importance. Not only do many blacks therefore start with some initial handicap in that their learning potential may have been depressed by adverse early environmental conditions, but they are further disadvantaged by scholastic circumstances which fail to make proper use of the abilities with which they enter the educational system.'*

## 6.3 Comparative International Educational Levels

It is of interest to make a broader comparison between black educational levels in South Africa and those in some of the first world countries. The following table sets out the minimal school attendance requirements in South Africa, compared with those in some other countries.

TABLE 6.1

COMPARATIVE COMPULSORY EDUCATIONAL LEVELS IN SOUTH AFRICA AND OTHER COUNTRIES

| COUNTRY | COMPULSORY EDUCATION | MINIMUM SCHOOL LEAVING AGE/ YEARS OF EDUCATION | REMARKS |
|---|---|---|---|
| R.S.A. - Whites<br>- Blacks | Yes<br>No | 16/10 | |
| GERMANY | Yes | 16 | Minimum 9 years at main school. Thereafter 3 years vocational school part-time to qualify in skilled trade. |
| JAPAN | Yes | 16/ 9 | 6 years Grammar School. 3 years Junior High School. |
| UNITED KINGDOM | Yes | 16/ 9 | |
| U.S.A.** | Yes | 16/ 9 * | *State controlled education in New York State |

**Source: National Data Book and Guide to Sources: Statistical Abstract of the United States 1984, 104th Edition, U.S. Department of Commerce.

It will be noted that there is compulsory education in all the above first world countries, with nine years of schooling, and a minimum school leaving age of sixteen. This also applies to white South Africans. There is, however, no compulsory education for black South Africans.

It is also of interest to note the educational attainment of labourers in the USA, which in 1982 was as follows :

| | |
|---|---|
| Less than four years of high school | 43.7% |
| Four years of high school only | 39.5% |
| One to three years of college | 12.7% |
| Four years of college or more | 4.1% |

*Source : *National Data book and Guide to Sources: Statistical Abstract of the United States 1984, 104th Edition, U.S. Department of Commerce.*

According to the foregoing statistics 56.3% of labourers have an educational attainment of four years of high school or better.

## 6.4 South Africa's Educational Handicaps

All the foreign countries reviewed in table 6.1 have compulsory education. This ensures a minimum of nine years of compulsory schooling during which the basics of reading, writing and arithmetic can be learned. They also have a common ethnic language and culture. The latter facilitates communications and the transfer of knowledge and skills.

In the Republic of South Africa there are two official (English and Afrikaans), and the following eight black ethnic languages:

| | | |
|---|---|---|
| North Sotho (Pedi) | - | Lebowa |
| South Sotho | - | Lesotho |
| Tsonga (Shangaan) | - | Louis Trichardt area |
| Tswana | - | Bophuthatswana |
| Venda | - | Vendaland near Lebowa |
| Xhosa | - | Transkei and Ciskei |

| | | |
|---|---|---|
| Zulu | - | Zululand |
| Swazi | - | Kangwane |

Over 90% of the direct workers employed in the industry are black. Yet it is only in recent years that some white schools have introduced black languages into their curricula.

The lack of education and ability to communicate limits the black worker's capacity to acquire skills. This is a critical inhibiting factor in developing the productive capacity of the major part of the work force in the construction industry. The inability of all sectors of the community to communicate with one another effectively has affected trust, the appreciation of one another's cultures, the understanding of the free enterprise system and the role of the worker in the company in which he is employed.

## 6.5 Continuing (non-formal) Education

It has been stressed that the bulk of the labour force, the black and coloured peoples, who are employed in the industry possess little formal education. This is, indeed, a serious handicap in a rapidly developing technological age.

In the present circumstances the industry cannot afford to wait for an influx of a new generation of workers with the necessary educational qualifications, but must, in order to help itself, promote in-house education.

The challenge to the industry therefore is to identify those workers who can assimilate knowledge and benefit from continuing non-formal education.

The de Lange report on the Provision of Education in the RSA (1981) emphasizes the importance of continuing education which it classifies as non-formal. It states (4.4.4 p.93)

*'The adequacy of the planned provision of education in a modern society cannot be measured only in terms of formal provision but should also be evaluated on the basis of both formal and non-formal provision!'*

*'Non-formal provision is directed towards literacy, induction, in-service training, retraining, support programmes (for parents, for example), ad hoc needs, a second chance for those who either never entered the formal system or left it early, upgrading of individuals with inadequate educational levels so that they can re-enter the formal system.'*

Education in the non-academic environment, to be effective, must be an ongoing process. This is a philosophy which is being applied by Japanese industry with outstanding success.

Ryokichi Hirono[10] (1983), in discussing the establishment of foreign corporations in Japan emphasizes :

*'The development of individual employees must also be a major policy of organization, especially the development of their intellectual capacities and technical skills and the fulfillment of their diverse personal needs'.*

He goes on to say :

*'....human resource management will no longer be the monopoly of the personnel department or education and training department or individual relations department, but will have to be the concern of every manager in all the sections, departments and divisions of the corporate organization'.*

*'This will require an unequivocal commitment by corporate top management to management*

10 Professor, Seikoi University, Tokyo, Japan

*development programmes at all levels'.*

## 6.6 People Development

It is obvious that by the very complexity (and scope) of the skills required, specially by supervisory personnel, that the development of people cannot be realized effectively by attending a course of a week's duration every few years. This particularly applies to those with levels of education ranging from standard five to matric, where the capacity for absorbing knowledge after a lapse of time, is possibly limited.

Education, like training, should logically not be limited to new employees, but should be a continuous and on-going process.
The potential of workers should be assessed, and a suitable educational path (part of their career path) planned for them. Their progress should be subject to regular review, as this will encourage and permit the person concerned to develop and achieve their full potential.

This is indeed a challenging task; but its fulfillment should in time be rewarding to the company, the individual, the industry and the country.

## 6.7 Recommended Technical Education

The introduction of craft training into elementary school education, and the progressive extension of this training to secondary or high school levels, could provide an important base for the development of manual skills, and encourage those scholars who have the aptitude and interest to pursue a technological career.

Such a programme will require the establishment of suitably equipped school workshops, staffed with qualified technical teachers.

The technical education should be ancillary to the general educational syllabus, and should include subject matter such as technical drawing and trade (craft) theory. The latter, at the most elementary levels, could include a knowledge of basic tools, machines, materials and their characteristics, and methods of measurement.

The practical work should, as far as is practicable, be productive. At the advanced level, the pupils could participate in school expansion projects by building additional classrooms, toilet facilities, etc. This will have a positive psychological effect on the student and gratify his creative instinct.

Most of the scholars educated at these schools will probably enter the trades and rise to positions where they can provide guidance to the general workers in the industry. Others with superior scholastic ability may aspire to professional status.

The introduction of scholars to manual craft work at an early age, could stimulate an abiding interest in technology, and thus lead them towards a career which will be both interesting and rewarding.

## 6.8 Conclusions

Discrimination has adversely affected black education, skills development and training, and contributed to high levels of labour turnover.

The inferior education in black schools emphasises the necessity for employers to institute in-house continuing education in order to improve cognitive skills and productivity.

In terms of demographic projections there will not be sufficient skilled people to serve South Africa's future industrial development needs. It is therefore essential to accelerate the current training programmes and ensure that workers are economically productive during their training periods. Training is indivisible from education, and whatever new training methods are developed they will, perforce, have to be based on a sound educational foundation.

The past (and present) attitudes of supervisory management to black workers and their development has also inhibited their productive capacity and affected the construction industry's levels of productivity.

Real progress will not be achieved without positive supervisory and management attitudes towards manpower development and education. The commitment to human resources development must be a mutual one at the highest level, between the government, industry, and black communal leaders. Unless this takes place, the education, training and development of industrial manpower is likely to continue to be fragmented and will fail to serve the needs of the industry and country.

# CHAPTER 7

## THE FUNDAMENTALS OF PRODUCTIVITY MEASUREMENT

### SYNOPSIS

Measurement is a basic component of the holistic approach to resources utilization, and this chapter discusses the fundamentals of productivity measurement, with specific reference to the construction industry.

The importance of measurement in formulating plans and evaluating action is discussed, and shown in the form of a systems control model.

Measurement and information criteria are defined, and a category of productivity measurements is proposed with regard to the input elements in the productivity equation, as well as overall measures of company and sector productivity.

## 7. Productivity Measurement

Improved productivity is the product of creative and innovative utilization of resources.

The effectiveness of action and resultant performance, can only be evaluated through measurement and this concept is illustrated in the systems control model shown in figure 7.1.

It will be seen from the model that performance measurement provides the necessary information for the evaluation of the effectiveness of both the plan and action. The feed-back thus obtained helps to revise the original plan for improved action, and the achievement of enhanced results. Thus an effective method of measurement is an essential requirement to improve the productiviry of the resources used in the industry.

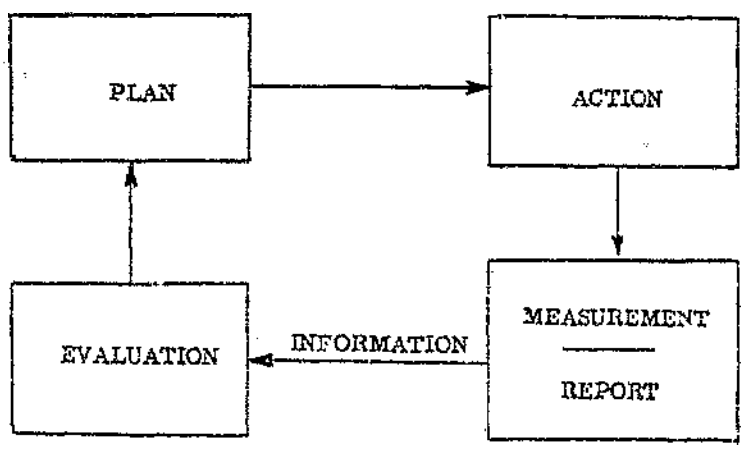


FIGURE 7.1 SYSTEMS CONTROL MODEL SHOWING THE MEASUREMENT FUNCTION RELATIVE TO PLANNING, ACTION AND EVALUATION

The importance of productivity measurement is stressed by Peter Drucker.

*'Without productivity objectives a business does not have direction. Without productivity measurement, it does not have control'.*

The foregoing may be paraphrased :

*'You can't control what you can't measure; and you can't control what you don't measure'.*

The importance of productivity measurement is further emphasized by the fact that the Business Roundtable of New York City U.S.A. commissioned an investigation into the decline of productivity in the construction industry. The report (A-1, 1982:1) concluded "that better ways of measuring construction productivity are needed".

The report (supra : 3) stressed that effective measurement will help owners and contractors to :

- Determine how effectively the project is being managed.
- Detect adverse trends quickly and hence take corrective action, and implement the concept of guidance management.
- Determine the effect of changed methods or conditions.
- Identify both high and low areas of productivity and reasons for the differences.
- Owners will have the further advantage of comparing the performance of different contractors.

The above report's summary also emphasizes that :

*'Measurements of productivity are probably prerequisite to improving it - by quantifying both*

*current performance and the effects of changed methods and conditions'.*

Experience in various production situations has shown that the measurement of an individual worker's results will invariably lead to improved performance. For example:

Work recording (which is a facet of work measurement), especially by the worker himself, coupled with the daily presentation of results on a prominently displayed board, presents him with a challenge; and this practice was proved during the course of this research to motivate workers to improve their performance. Thus measurement is an essential ingredient in every productivity improvement programme.

Productivity measurement provides a guide towards productivity improvement. Improvement is invariably the result of changes in resources input and/or process. Hence one of the purposes of measurement is to track and assess change.

It was stated in Chapter 1 that productivity is the relationship between output achieved and the resources applied. This relationship, therefore, defines productivity as a resource utilization concept. It is noteworthy that the Organization for European Economic Co-operation (1955) defines productivity in a similar manner.

The measurement of productivity, in terms of the above definition therefore involves establishing measures for the outputs and inputs. Thus productivity measurement consists of a family of measures that reveal various aspects of the output / input relationship.

Figures 1.1 and 1.2 illustrate that construction is a multidisciplinary activity. As such, and because of the multiplicity of inputs, previous writers contend that there is no single measure of productivity.

Laufer (1985) in discussing measuring criteria states :

*'It is difficult to find a measure which answers all criteria and, as in other situations, it is best to devise a number of methods to measure the same performance element.'*

The Roundtable researchers recorded in their Summary on measuring productivity (1983:49).

*'....No satisfactory measurement of industry - wide construction productivity is now available, ... a single measure of productivity would not suffice for such a complex industry.'*

Jerome A Mark, (1971) Assistant Commissioner for Productivity and Technology, Bureau of Labour Statistics, U.S. Department of Labour, has stated :

*'No one measure is the right or best measure.'*

It is, indeed true that no single measure is realistically applicable to the construction industry, but it will be shown that within a company, a single measure of economic productivity can be used to measure contract productivity and trends in the effectiveness of total resources utilization.

## 7.1 Information Criteria

Information, based on the realistic measurement of resources utilization, should fulfil the following criteria :

1) Indicate the extent to which the planned objectives are being achieved.
2) Help to determine the reasons for the success or failure of action taken.

3) Provide guidance, and aid management in taking decisions towards improving resources utilization, and hence achieve more profitable gain.

4) Information should be produced with fewest operations in the shortest possible time and at least cost.

The latter criterion is particularly important, since the construction process is of transient character, and many of the activities are of limited duration. In these circumstances it is imperative that the measurement and evaluation of performance be done expeditiously.

## 7.2 Measurement Criteria

Measurement provides the information for the evaluation of performance and control. Control, in turn. is exercised at two levels :

i) Self control. This will usually involve discrete measures.

ii) Control of operations for which one is responsible. This may include both discrete and overall measures.

Laufer (1985) divides measurement criteria into two groups :

administrative and psychometric.

The first group includes feasibility, understandability and acceptability, adaptability and efficiency (time and cost). The second group includes validity, reliability and sensitivity.

The necessity for participants at all levels of the construction process to understand the basis of measurement is all important. If they do not understand, then they are unable to measure their performance and hence to *CONTROL* and to strive to *IMPROVE* their results. And without understanding, there cannot be a full commitment towards improvement goals.

The subject matter of this research includes identifying and developing practical means of measuring resources utilization.

The difficulties and complexities involved in measuring construction productivity stem from the fact that there are a multitude of inputs and related outputs. This is particularly valid during the different construction phases, prior to a project's completion. At these interim stages it is extremely difficult to measure with mathematical accuracy resources input and output. This particularly applies to resources such as granular materials whose utilization measurement requires the measurement of stock piles.

The measure, in these instances, must be practical to the extent where it limits, if not eliminates, subjective judgements.

In practice, the measurement / cost benefit relationship precludes mathematical accuracy, and the measures to be discussed will therefore take into account the criteria of practical validity and sufficient sensitivity to indicate trends in improvement or regression of resources utilization.

Four main categories of measurement are proposed in Fig. 7.2.

The first involves discrete measurements which apply to the unique inputs such as manpower, materials, machinery, money et al.

The second involves an economic measure of productivity which encompasses all the economic inputs and the aggregate economic outputs. The result is presented in the

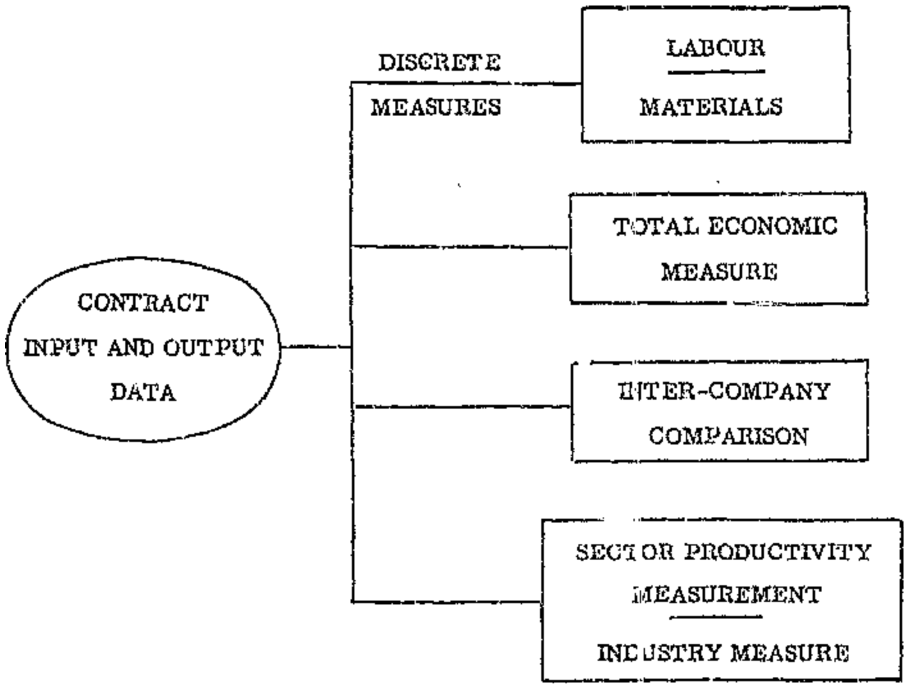


**FIGURE 7.2 PROPOSED CATEGORIES OF PRODUCTIVITY MEASUREMENT**

form of a productivity ratio which, when compared with a base ratio will indicate whether there has been an improvement or deterioration in the aggregate utilization of resources.

The third measure is an intercompany comparison of productivity ratios of companies engaged in similar construction activities e.g. housing, high rise buildings, power stations, roads et al.

The fourth measure is a sector productivity measure for the construction industry, which in terms of a productivity ratio, will show improvements or retrogression in productivity in the different sectors of the construction industry on a regional and / or national basis.

### 7.2.1 Discrete measures of productivity

The discrete measures of productivity apply to individual resources inputs.

The economics of measurement dictate that the benefits to be gained must justify the administrative costs involved; and that the resultant information is produced sufficiently timeously to permit evaluation of the action taken, and if needs be, revise plans and action in order to obtain improved results.

The main resources inputs may be listed as follows :

(i) Manpower
(ii) Materials
(iii) Machinery
(iv) Management
(v) Money
(vi) Subcontractors
(vii) Local authority services

(viii) Energy

The first six of the above resources constitute the bulk of contract value, and as such, economically justify measurement.

The different applicable methods of measurement will now be discussed in the following chapters.

## 7.3 Conclusions

Previous writers have concluded that there is no single applicable measure of productivity to the construction industry, and that it is best to devise a number of methods to measure the same performance element.

Having defined the applicable information and measurement criteria, it will be shown in the following chapters how a single measure of economic productivity has been developed which can be applied to the evaluation of contract productivity and trends in the effectiveness of total resources utilization.

# CHAPTER 8

## MEASUREMENT OF MANPOWER PRODUCTIVITY

### SYNOPSIS

This chapter is concerned with identifying the different criteria and means employed in the construction industry to measure the performance and productivity of labour. The validity of these measures is discussed, and subsequently applied to evaluate the productivity of site manpower.

Site observations and research established that excess labour was being employed; and case studies regarding how labour reductions were achieved are discussed.

A reliable method of recording lost time was developed, and is described.

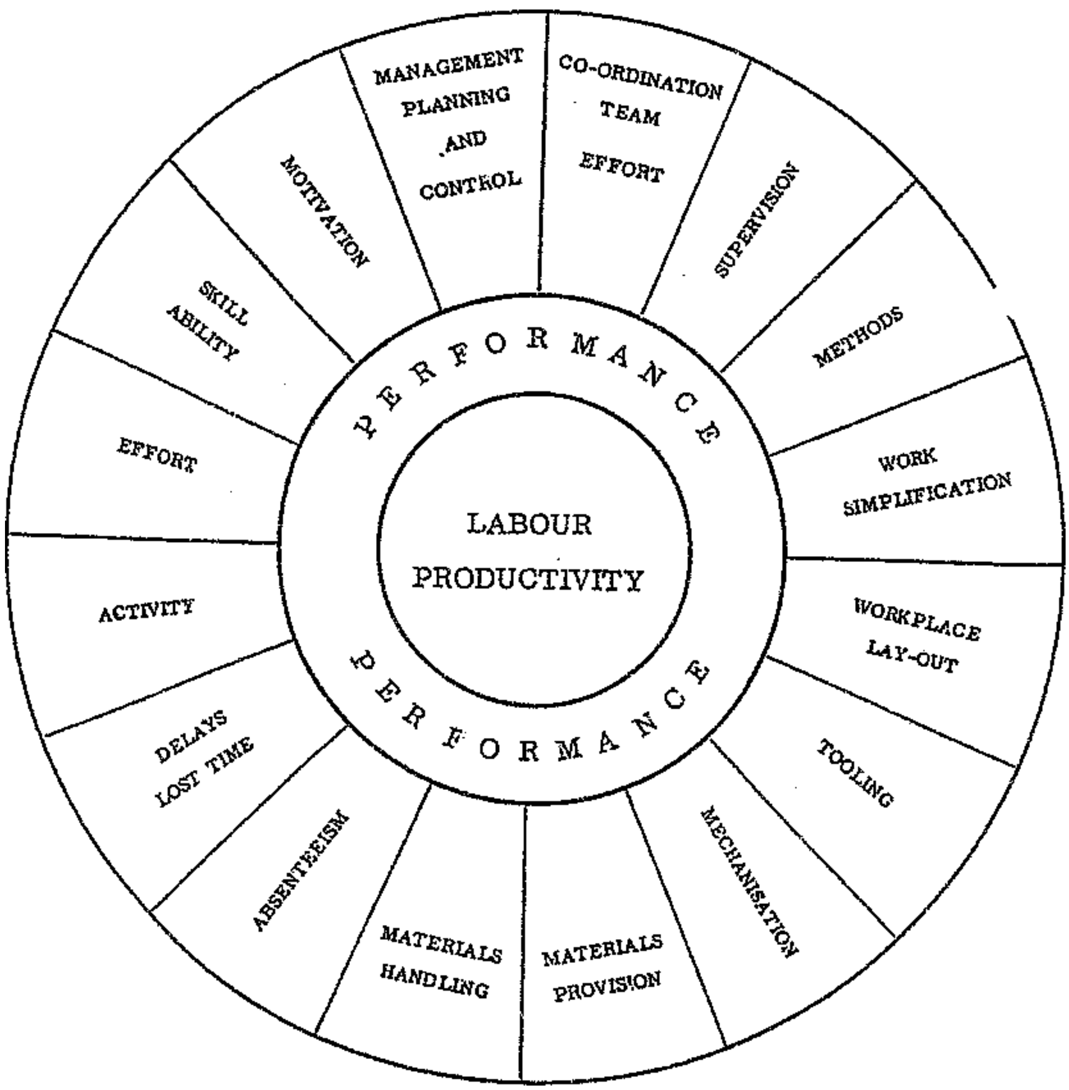


**FIGURE 8.1 FACTORS AFFECTING LABOUR PRODUCTIVITY**

# 8. THE ELEMENTS OF MANPOWER PRODUCTIVITY MEASUREMENT

In considering the measurement of labour productivity a distinction must be drawn between the measurement of productivity and the measurement of performance.

*PRODUCTIVITY MEASUREMENT* involves a ratio of output to resources input. As such, it is not finite; but the resultant comparative ratio provides an assessment of improvement or regression in the effectiveness of resources utilization.

*PERFORMANCE MEASUREMENT* is an aggregate measure of production over a period of time; and to be meaningful, should be compared with a set standard of performance.

*Measurement is the basis of performance information. Performance information cannot be obtained without measurement, and measurement cannot be effected without standards.*

The discrete measures employed in the construction industry, particularly those relating to labour, are invariably measures of performance and not measures of productivity. Both labour productivity and performance are affected by numerous factors.

## 8.1 Measuring Labour Performance

The Measurement of manpower performance can be divided into two main categories.

1) Overall performance i.e. production per unit of time.
2) The effectiveness of manpower utilization in terms of effort and time utilization.

Numerous factors affect labour performance, and hence labour productivity. Figure 8.1 was developed to show the main factors that are practically relevant to labour productivity in the construction industry.

The different applicable performance parameters and standards used in the industry will now be discussed.

### 8.1.1 Value of output per man-unit

One of the most common measures is value of output per employee or per man-hour. But this method has economic failings. Construction work is non standard, and, invariably requires different types and levels of skill which are remunerated on varying scales. Hence equating the output to the number of workers is not meaningful, nor comparable; even for the same type of structure.

The value of output will also vary with changes in prices of materials and labour; whereas hours is a non variable parameter. Thus for a realistic comparison, it is necessary to convert (adjust) the value of output to a constant value base by making allowances for price changes in the input of resources. This presents problems, and the adjusting indexes used will invariably be subject to query, because so much will depend on the resources mix of materials, plant, services and labour.

In order to obtain realistically reliable data, one must compare like with like and not rely on the comparison of an adjusted variable with a constant i.e. adjusted values over a broad time base with hourly input.

Herbert Stein (1971) (Member, Council of Economic Advisers to U.S. President Richard Nixon) emphasizes this point :

*'For many analytical and policy purposes the simple figure of output per hour is inadequate'.*

### 8.1.2 Measurement of labour utilization (efficiency)

The method in common use for measuring labour utilization involves measuring the work completed over a period of time, usually per week or month, and then comparing the allowed[11] labour cost of every completed activity with the actual labour cost for that activity.

The completed work is then compared with the actual cost of the labour employed to do that work. This comparison provides a labour cost recovery figure, which in practice is often referred to as the labour efficiency. e.g.

$$\text{Labour Efficiency} = \frac{\text{Allowed labour cost of Work completed} \times 100\%}{\text{Actual Cost of labour employed}}$$

### 8.1.3 Quantum measures of performance

Different norms are used to measure the different construction activities. These norms usually involve a quantum unit of production per man per day. The following is an example of the norms applied in practice.

| | | |
|---|---|---|
| Excavation | - | Cubic metres per man per day (dependent on the equipment used). |
| Bricklaying | - | No. of bricks per man per day with a distinction between common bricks, face bricks, and special bricks, piers, straight walls and corners. |

[11] The allowed cost is usually based on the estimate, and comparisons with the estimate inhibit attainment of optimal results.

Formwork -

Shutter Erection - Square metres erected per man per day (dependent upon shutter design and equipment used e.g. cranes and any other lifting tackle, and the level above ground).

Other activities such as plastering, tiling, paving, etc. are measured in a similar way.

The foregoing measures of performance are only meaningful when compared with an acceptable norm or standard. The standard, in practice, is usually that used in the estimate leading to the tender value - "the tender allowable".

## 8.2 Performance Standards

The establishment of practical and realistic standards of performance in the construction industry present unique challenges which involve some of the following aspects.

One of the difficulties in developing productivity standards is the difference in input and output in the various end products of the construction industry.

For example, domestic housing construction, involving much brickwork and little mechanized equipment, will require a larger labour input than a multistorey concrete clad structure involving gang shutter work, tower cranes, and concrete pumps.

Therefore while a realistic economic measure of productivity can be applied, standards will vary with the type of construction. This must be taken into account when making comparisons of productivity and performance. Additionally, there is the aspect of unique site location, unique architectural design and construction complexity which will affect the unit work content of the activities to be measured.

## 8.3 Work and Production Standards

Production standards (work values) are essential in compiling cost estimates as a basis for contract tendering. In practice, however, they can only provide a guide towards measuring labour performance.

The standard set for labour performance must take into account the applicable working conditions for the activity under consideration, and the potential for optimal labour performance.

*The ultimate work value set should be agreed to by the worker concerned so that there is a commitment on his part to the agreed level of performance.*

The standard must be at a level which will ensure the recovery of the estimated labour cost, and still encourage the worker to optimize his earnings by increasing output.

Work values (in construction) cannot, and should not be synonymous with fixed rates. Should they be synonymous, then Shimmin's observations may well apply.

Shimmin (1959) writes :

*'Both the ratefixer and the operative know that the final value for the job will bear little or no relationship to the time it actually takes. The ratefixer with tongue in cheek, not only expects but is prepared to climb down in bargaining. Ultimately, both settle for some value between extremes which by nature of the compromise will be a potential source of trouble and dispute in the future'.*

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## 8.4 The Measurement of Effort and Activity

The measurement of quantum production related to time does not take into account the worker's effort, activity and loss of production resulting from delays and lost time.

Improvements in these factors have been proved to make a major contribution towards improvements in labour productivity, and it is considered appropriate that the method of measuring these factors be discussed.

### 8.4.1 Effort rating

The concept of effort rating was pioneered by Charles [illegible] Bedaux[12] who developed a rating based on the 60 minute clock, where a 60 performance, is comparable to walking on a flat surface, at 3 miles per hour or 20 metres in 14,9 secs. This is the work effort expected from a worker for his basic pay.

Bedaux established a standard unit of work which he called the 'B'. This consisted of a portion of work and a portion of rest. The rest portion being dependent on the degree of fatigue associated with the task being performed.

The worker's effort was observed and rated up or down relative to a 60 performance base.

Subsequently the British Standards Institute set out a scale of rating which is recommended by the International Labour Office, and which is based on a 0 - 100 scale,

---

[12] Bedaux did not publish his work, but applied his system of labour [illegible] incentives to numerous industries throughout the world. A [illegible] unit is given in the Production Handbook p. 1205; editors [illegible] Bangs John R; published in New York by the Ronald Press Company 1954.

## TABLE 8.1

## EFFORT RATING SCALE RECOMMENDED BY THE INTERNATIONAL LABOUR OFFICE

| Scale 0 - 100 | Description | Comparable Walking pace (m.p.h.) 20 metres in sec. |
|---|---|---|
| 0 | No activity | 0 |
| 50 | Very slow; clumsy; fumbling movements; operator appears half asleep; no interest in the job. | 2<br>20m. in 22.4 sec. |
| 75 | Steady, deliberate, unhurried performance as of a worker not on bonus; expected work in return for an operators basic pay. | 3<br>20m. in 14.9 sec. |
| 100 | Brisk and businesslike, as of a qualified worker on bonus; necessary standard of quality obtained with confidence. | 4<br>20m. in 11.2 sec. |
| 125 | Very fast, well above that of trained worker; high degree of assurance | 5<br>20m. in 8.9 sec. |

with 75 being the work effort expected from a worker for his basic pay. This rating scale is shown in Table 8.1.

### 8.4.2 Activity measurement

This can readily be done by employing a work sampling technique which will provide a measure of the effectiveness of site labour utilization.

Work sampling techniques are widely used in industry; but of the companies surveyed none applied these techniques to construction activities. This method has the advantage of giving answers in minutes or hours (depending on the number of workers to be observed) thus enabling supervision to practice the concept of 'guidance management' - making things happen. Management can then direct their attention to those operations which are sub-standard while the operation is in progress, rather than after the fact, when many of the costs have been irrevocably incurred.

### 8.4.3 Instantaneous activity sampling

This is a simple and effective field technique which permits a ready assessment of excess labour employed, imbalance in team operations, and indications of lost time during activities. The practical application of this technique is described in section 8.5.3.1.

Activity is not synonymous with performance and productivity. Performance connotes accomplishment which of necessity involves the elements of productive work and effort. However, construction cannot be accomplished by inactive workers, so although it is not an exact indicator of productivity, it is a useful management tool and guide towards effective manpower utilization. If the usefulness of the work is considered, together with a rating of the workers' efforts, then it can become a realistic measure of manpower performance.

### 8.4.4 Labour utilization factor

Activity sampling discussed above provides a further useful measure of labour productivity in the form of a Labour Utilization Factor.

The Labour Utilization Factor is the ratio of the number of workers doing effective work compared with the total number of workers observed, i.e.

$$\text{Labour Utilization Factor} = \frac{\text{No. of effective workers}}{\text{Total no. of workers observed}}$$

The Labour Utilization Factor for the 345 workers studied (ref. section 7.7.3.1) was 0.504, and in the exemplar shown in Figure 8.3, 0.625.

In terms of the foregoing definition, a Labour Utilization Factor provides a numerical measure of the effectiveness of direct labour, site supervision, and management.

## 8.5 Site Observations

### 8.5.1 Labour cost recovery

The following are the results of six different contracts in terms of labour recovery for different activities.

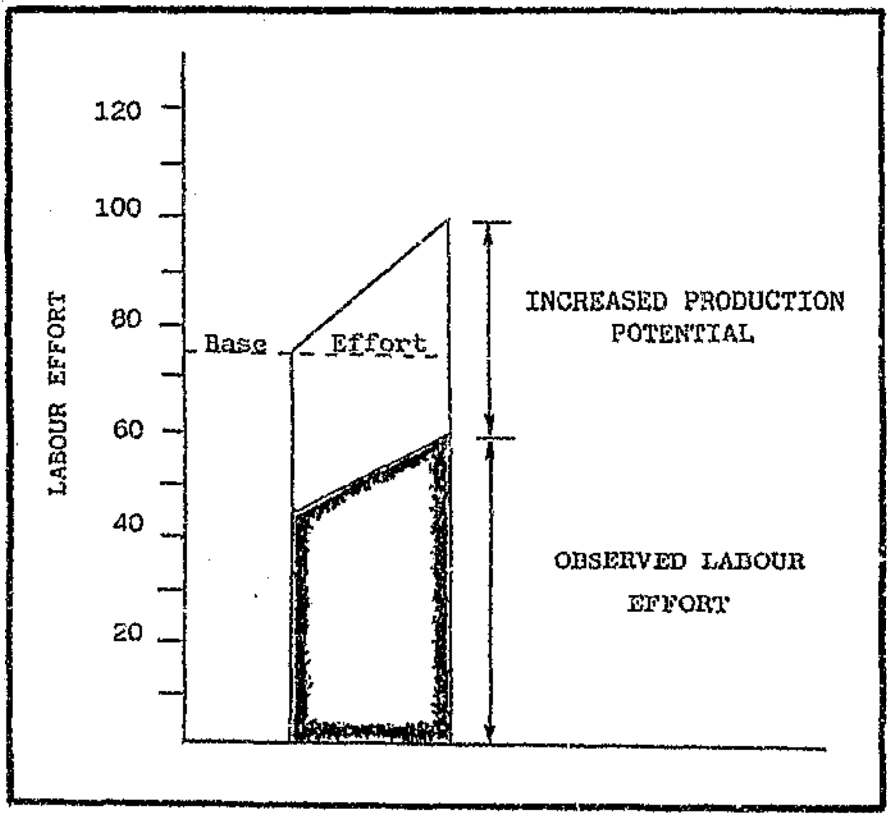



**FIGURE 8.2 EFFECT OF IMPROVED LABOUR EFFORT ON PRODUCTION OUTPUT**

TABLE 8.2

LABOUR COST RECOVERY ANALYSIS

| ACTIVITY | CONTRACT | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| | % | % | % | % | % | % |
| Excavation | +8.8 | -41.6 | -148 | +6.1 | +21.3 | -11.8 |
| Concrete placement | +27.3 | -10.8 | -27.6 | -10.4 | +55.1 | +3.1 |
| Formwork | -13.5 | -41.6 | -322 | -42.6 | -51.1 | -20.5 |
| Brickwork: | | | | | | |
| - commons | -59.3 | -7.4 | -7.5 | -10.1 | +6.8 | -34.4 |
| - facings | -36.2 | -1.7 | -17.8 | -9.8 | -8.5 | -22.5 |
| Plaster | +31.9 | +13.3 | +7.7 | +0.9 | +20.7 | +3.2 |
| Tiling | | +33.9 | +35.0 | +16.6 | | |
| Carpentry | | | -75.7 | | -15.1 | |

\- Labour Loss vs allowable.
\+ Labour gain vs allowable.

Table 8.2 shows that there was an under-recovery of labour cost, compared with the allowed cost, on all contracts. Formwork, in particular, showed consistent losses. The plastering and tiling activity was sub-contracted for all contracts, and site management was able to negotiate rates which were less than the allowed cost.

### 8.5.2 Observed labour effort

Labour effort rating observations on sites, according to the BSI scale, including allowances for fatigue, contingency and synchronization, ranged between 45 and 60, which relates to 60% and 80% of the 75 base level of performance effort.

Taking the upper level of performance effort of 60, leaves a shortfall of 15 performance points before the worker measures up to earning his basic pay[13]; and in order to earn his basic pay he must therefore increase his performance by 25%. Considering that

[13] This involves the assumption that the worker's pay scale is based on a "fair day's pay for a fair day's work".

## TEAM ACTIVITY RATING

CONTRACT ______________ DATE 6 Feb 1985

TEAM Sub Station.

ACTIVITY Dagga + BRICK SUPPLY REF. ______

FOREMAN G. J. Roux.

| ACTIVITY | 1 Dagga MIXER | 2 BRICK WHEEL/B | 3 DAGGA WHEEL/B | 4 BRICK WHEEL/B | 5 BRICK STACKER | 6 | 7 | 8 | TIME START |
|---|---|---|---|---|---|---|---|---|---|
| | ✓ | ✓ | ✓ | ✓ | | | | | 11.19 |
| | | | | | ✓ | | | | 11.20 |
| | ✓ | | ✓ | ✓ | ✓ | | | | 11.21 |
| | ✓ | | ✓ | ✓ | | | | | 11.22 |
| | ✓ | ✓ | | ✓ | ✓ | | | | 11.23 |
| | ✓ | ✓ | | | | | | | 11.24 |
| | | ✓ | ✓ | ✓ | | | | | 11.25 |
| | ✓ | ✓ | ✓ | | ✓ | | | | 11.26 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | 6 | 5 | 5 | 5 | 4 | | | | |

TOTAL MAN UNITS 40 ACTIVE 25 ACTIVITY 62.5%

OBSERVED BY [signature]

FIGURE 8.3 TEAM ACTIVITY RATING

workers on an effective incentive scheme can sustain effort at 100, and earn an extra one third over and above their basic pay, then the potential for increased labour performance goes up by 67%. This is illustrated in figure 8.2

### 8.5.3 Survey of excess labour on sites

A series of team activity ratings was made on different contracts in order to establish the extent of excess labour employed.

#### 8.5.3.1 Method of study

Figure 8.3 shows the form used for recording the observations. The vertical columns on the right hand side provide for recording the activity or inactivity of up to eight workers. Details of the work they are doing or remarks regarding their activities are provided for on the left hand side. Observations are made every minute and a tick is recorded against every worker who is active.

The activity rating is computed at the end of the study by dividing the total number of ticks recorded by the total man units. The total man units is the number of workers observed, multiplied by the number of observations.

It should be noted that the observations only record whether an employee is active or inactive. The study does not provide for two important elements :

1) whether useful work is being done. Observations in this regard can be noted under the heading "Activity".

2) The effort of the active workers. (Refer to Section 8.4.1)

Results of observations on 345 workers indicated that there was approximately 37% excess labour being employed in the activities which were sampled.

Parker, et al (1972 : 42) stated that the 'Range of proportions in construction labour sampling is usually between 40% and 60%' which is comparable with the figures obtained in the above observations.

The potential for labour reduction is however, much greater. It was noted during observations that there were numerous opportunities for work simplification and the elimination of unproductive effort. The average effort rating of the active workers seldom exceeded 55.

Thus a conservative estimate of the potential for labour utilization improvement in the activities studied is as follows:

Excess labour is 37%

Therefore labour complement can be reduced to 63%

Observed effort rating was 55

Therefore at normal 75 effort rating the required labour complement will be:

$$63 \times (55 / 75) = 46\%$$

Thus potential for improvement is + 100%.

The presence of excess labour on an observed site was highlighted during a politically motivated stay-away (May 1987). In spite of 25% absenteeism, all the programmed activities were completed with the lower labour complement.

## 8.6 Labour Reduction

The foregoing labour reduction assessment comprises two factors :

i) The reduction of excess inactive labour

ii) The reduction of the labour complement through increased effort of the remaining team members.

The results of the activity studies created an awareness amongst foremen and managers of the inactive labour employed in the various construction activities. A contributory factor to the employment of this excess was the site policy of establishing teams of finite number under a team leader for the different activities such as excavation, concrete placement, shutter erection, etc. These teams were then allocated to tasks without consideration of the labour content involved.

### 8.6.1 Labour reduction achieved

Labour reductions were achieved in three phases. The first phase involved team activity analysis. This facilitated the review of the labour content in the different site activities and helped allocate labour to ensure a balanced operation to the exclusion of inactive workers. This provided immediate economies as per the following examples.

1) The monthly wage bill on a mixed building and civil engineering contract was reduced by R27 000,00.

   more specifically :

2) A team of eight workers was involved in erecting shuttering and pouring concrete

for a retaining wall. After erecting a section of shuttering the whole team would go onto the concrete pouring operation. The latter operation however only required three men : two to guide the kibble suspended from the crane, and one to vibrate the concrete. The overall team of eight was found to be excessive, and was reduced to six. The concrete placement operation was limited to three men, and the other three were employed in preparing the next section of shuttering during the concrete placement operation.

3) A team engaged only in placing concrete, consisting of six workers was reduced to three.

4) Teams of six engaged in steel reinforcing assembly operations were reduced to four.

The above examples are representative of the labour economies achieved in the numerous activities where (the) team activity analysis was applied and supervisory action taken to eliminate employment of excess labour.

The second phase involved the introduction of work simplification in order to reduce the labour content of the activity. Practical examples of this phase of the work are described in Chapter 11.

The third phase involved the application of financial incentives for the hourly paid workers.

The observed labour effort was assessed, and an allowance made for fatigue, and if needs be, a co-ordination factor. This, together with the quantum of construction required, facilitated the computation of the size of team and time required to complete the work involved.

*The size of team and time required were discussed with and agreed to by the team leader, together with the bonus levels which he and his team members would earn if the work were completed in less time than the standard agreed to.*

Additional bonuses were to be earned if the work was completed with fewer workers than the team strength set and agreed to.

The following are two examples of the results achieved.

**Concreting of Culverts** : the team leader reduced his team strength by 20% and completed the work in 85% of the time allowed.

**Bricklaying** : the introduction of a bricklaying incentive on two separate projects produced the following results :

| | |
|---|---|
| Project A | Increase from 310 to 410 average brick units per man per day<br>Productivity increase = 32.3% |
| Project B | Increase from 335 to 420 average brick units per man per day<br>Productivity increase = 25.4% |

The work being done included common bricks, face bricks and faggots. Each was given a unit value on the assessed work value involved. Thus every worker, irrespective of the type of brickwork he was allocated had an equal opportunity to earn a financial bonus.

Details of the administrative work involved in the hourly paid incentive plans is discussed in Chapter 15 under motivation.

## 8.7 Lost Time Measurement

The only records of lost time which were found to be kept by site supervision were related to weather stoppages, and production delays for which compensation could be claimed in the way of extension to the programme, or money claims for design alterations, late receipts of drawings, or stoppages occasioned by the consultants or owners. No records were maintained of the numerous delays resulting from poor supervision, lack of planning, inadequate supplies of materials, equipment and instructions, nor the lost time incurred in rework of faulty construction.

A three year study commissioned by The Business Roundtable, involving 250 seasoned construction experts found that more than half the time wasted during construction is attributable to poor management practices. Local site observations have confirmed a similar situation.

Many of the production delays analyzed were found to be the result of a lack of planning and direct supervision. In these circumstances the use of the *Foreman Delay Survey* is difficult to implement, because foremen consider that the recording of the information called for is a reflection on their supervisory effectiveness - which it often is.

An effective way to obtain delay information is to get the recording done by the person whom the delay affects, but who is not responsible for the hold up. This principle was applied by the author to the des[illegible] and introduction of the production diary (see Figure 8.4).

NAME Suresh DAY Mon. 2

CONTRACT G.P.O. MONTH March

ACTIVITY Bricklaying NO.

| | |
|---|---|
| 7 | Waiting for scaffolding for ancillary store. |
| 8 | 15 min. (1) B/L |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 1 | |
| 2 | (2) Bricklayers labourers have to load mortar into dumper |
| 3 | 2 lab @ 1/2 hr. |
| 4 | |
| 5 | |

FIGURE 3.4 PRODUCTION DIARY

### 8.7.1 Diary forms

The diary consists of 31 pages - a page per day, and a monthly refill is provided to all diary users.

The top of each page provides for :

- the name of the user
- the name of the contract
- the activity the user is engaged in
- the day of the week
- the month
- the activity reference number (for cost allocation purposes)

The rest of the page is subdivided into 11 hours with two lines being provided for every hour.

The back of the page is ruled in 5mm squares and provides space for general work instructions, sketches, and notes.

The last fold-out page of the diary is an attendance record of team members employed in the different activities on the contract. Ref. Figure 8.5.

The diary was issued to every team leader, foreman and site supervisor. It not only provided a means of recording lost time, but also served the purpose of formalizing communications e.g. the recording of instructions and work details, as well as labour control.

## ATTENDANCE RECORD

CONTRACT TechtRain

MONTH October 1986

| | DATE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACTIVITY<br>REFERENCE NO.<br>Bricklaying | 0146 | 0146 | 0146 | Sat. | Sun. | 0150 | 0150 | 0150 | 0150 | 0150 | Sat | Sun. | | | | | | | | | | | | | | | | | | | |
| | TEAM LEADER | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Peddy | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 2 | Keith C. | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 3 | Ram A. | ✓ | A | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 4 | Pat Mast. C. | ✓ | ✓ | ✓ | | | A | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 5 | Bekula A. | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 6 | Steven L. | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 7 | Wiseman L. | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | A | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 8 | NYOKa L. | ✓ | ✓ | ✓ | | | A | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 9 | PetRus L. | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FIGURE 8.5 PRODUCTION DIARY ATTENDANCE RECORD

### 8.7.2 Recording of lost time

Every team leader was required to record all standing time in his diary, showing the actual time of day lost, and the reason for the loss. Similarly, foremen were also required to record all down time on plant, e.g. mixers, dumpers, trucks, cranes, etc.

All the users of the diary were either on a production incentive plan or, as in the case of foremen, on a gain-sharing plan. It was thus in their interest to identify and record delays with the view to their reduction and possible elimination.

### 8.7.3 Lost time analysis

This was done on an analysis sheet (refer to Figure 8.6) from the daily diary sheets which were submitted by the diary users. In the bricklaying project it was found that the greatest delays were occasioned by shortages of mortar and delays in scaffold erection. Both were the result of poor supervision and a lack of effective planning.

The production of the information alerted management to the losses being incurred. Corrective action was taken and the lost time in the bricklaying project was reduced by approximately sixty percent, representing approximately 4% of total paid time.

## 8.8 Conclusions

Site observations and the data obtained revealed the following contributory factors to poor labour productivity :

- Inadequate and itinerant supervision; with a span of control varying from 30 to 40

## LOST TIME RECORD

CONTRACT: ______

SECTION: WORKSHOPS

FOREMAN: L. DA

TEAM 1 CH. 3 B/L 4 A.L.

FROM: 9TH MARCH '87

TO: 13TH MARCH '87

| DATE | GANG | ACTIVITY | ABSENT | LATE START/ EARLY FINISH | WEATHER | WAITING MAT. | WAITING EQUIP. | WAITING INSTRUCT. | REMARKS | REWORK | MISC. | REMARKS | DAILY TOTAL HRS. | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-3 | SURESH | BRICKLAYING | | | | ½ | | | | | | MORTAR - POWER | 0-50 | 5.56 |
| " | " | " | | | | | 1 | | | | | HOIST - NO POWER | 1-00 | 11-10 |
| " | " | " | | | | ½ | | | | | | SCAFFOLD | 0-50 | 5.56 |
| 10-3 | " | " | | | | | ½ | | | | | HOIST - NO POWER | 0-50 | 5.56 |
| 11-3 | " | " | | | | | ¼ | | | | | SCAFFOLD | 0-25 | 2-78 |
| 12-3 | " | " | | | | | | | | | | NO - PROBLEMS | — | — |
| 13-3 | " | " | | ⅙ | | | | | | | | LATE AFTER LUNCH | 0-17 | 1.89 |
| | | | | | | | | | | | | | | |
| | | TOTAL FOR 5 DAYS | | 10 MIN | | 1 HR | 1 HR-45 MIN | | | | | | 2-92 | 6-49 |

**FIGURE 8.6 LOST TIME RECORD**

## LOST TIME RECORD

CONTRACT: ______

SECTION: WORKSHOPS

FOREMAN: L. DA

TEAM 1 CH. 3 BL. 4 D.L.

FROM: 9TH MARCH '87

TO: 13TH MARCH '87.

| DATE | GANG | ACTIVITY | [illegible] | LATE START/ EARLY FINISH | WEATHER | WAITING MAT. | WAITING EQUIP. | WAITING INSTRUCT. | [illegible] | REWORK | MISC. | REMARKS | DAILY TOTAL HRS. | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-3 | SURESH | BRICKLAYING | | | | ½ | | | | | | MORTAR - POWER | 0-50 | 5-56 |
| 〃 | 〃 | 〃 | | | | | 1 | | | | | HOIST - NO POWER | 1-00 | 11-10 |
| 〃 | 〃 | 〃 | | | | ½ | | | | | | SCAFFOLD | 0-50 | 5-56 |
| 10-3 | 〃 | 〃 | | | | | ½ | | | | | HOIST - NO POWER | 0-50 | 5-56 |
| 11-3 | 〃 | 〃 | | | | | ¼ | | | | | SCAFFOLD | 0-25 | 2-78 |
| 12-3 | 〃 | 〃 | | | | | | | | | | NO - PROBLEMS | — | — |
| 13-3 | 〃 | 〃 | | ⅙ | | | | | | | | LATE AFTER LUNCH | 0-17 | 1-89 |
| | | | | | | | | | | | | | | |
| | | TOTAL FOR 5 DAYS | | 10 MIN | | 1 HR | 1 HR-45 MIN | | | | | | 2-92 | 6-49 |

FIGURE 8.6 LOST TIME RECORD

site information regarding hold-ups which would not, in normal circumstances, have come to their notice.

The results of the research indicated that improvements in labour utilization and productivity require the following action.

1. The introduction of work simplification with specific reference to materials handling. The latter is particularly cogent in view of the fact that approximately 80% of the labour employed is involved in materials handling (ref. Chapter 4). Attention must also be given to work place lay-out.

2. The manning of labour activities must take into account labour content.

3. The number of workers allocated to the different tasks should be checked with regr[illegible] [illegible]m activity ratings.

4. There should be effective motivation of workers through good supervision, effective communication, timely provision of equipment and materials, and suitable financial incentives for the timely completion of work to acceptable quality standards.

# CHAPTER 9

## MEASUREMENT AND CONTROL OF MATERIALS WASTAGE

### SYNOPSIS

The value of the materials resource input into construction ranges between forty and forty-five percent of total contract value. The measurement of materials utilization and control of wastage is therefore an important component of the holistic approach to resources utilization.

This chapter discusses the types of waste and their occurrence in the construction industry.

The procedures for measuring waste are described. Site observations and reconciliation of materials utilization revealed excessive wastage of materials. Reasons for the excessive wastage are identified, and the solutions which were implemented to reduce the wastage are described.

Aspects of quality, and the problems of rework are discussed.

It is concluded that the systematic measurement of waste and awareness of the cost of losses resulting from waste are essential prerequisites to reducing these losses.

# 9. MEASUREMENT AND CONTROL OF MATERIALS WASTAGE

Materials productivity is synonymous with materials utilization, and the percentage materials utilization (productivity) may be defined by the following ratio :

Materials content of completed work x 100 / Materials input

The difference between materials input and materials content of the completed work is accounted for by waste.

Walkerdine (1978) defines waste as '*The difference between the value of those materials delivered and accepted at site and those properly used as specified and accurately measured in the work, after deducting the cost of saving of substituted materials and any materials transferred elsewhere*'.

Waste is big business in all production processes and it occurs in numerous ways. Although it is not possible to make anything without waste, its existence must be acknowledged, and its occurrence monitored.

According to L E Davis formerly Executive Director of BIFSA, estimates made of wastage losses in the building industry in South Africa during 1984, amounted to the order of R350 million. The main reasons for these losses were categorized as wastage of materials, losses due to theft and negligence, and lost time due to poor material management.

This R350 million represents approximately 5% of the value of materials purchased by the industry.

## 9.1 Types of Waste

Waste can occur in many forms, and can be categorized into two principal types: direct waste and indirect waste.

### 9.1.1 Direct waste

This waste can be grouped under the following 13 headings :

#### 9.1.1.1 Transport and delivery waste

- Short delivery
- Damaged goods
- Damage in off-loading and stacking (breakages)
- Damage resulting from inadequate site storage or facilities

#### 9.1.1.2 Internal site transit and storage waste

Much of this waste is the result of excessive handling, unimaginative transportation methods and poor storage.

Inadequate and narrow transport lanes result in vehicles damaging stacked materials.

A common cause of materials wastage is the storage of excessive quantities on site. This particularly applies to bricks, sand and stone. The position is aggravated in the case of a large site with multiple storage locations of these materials, which also compounds the problem of measurement.

Skoyles (1978) has shown that careless stacking and handling of materials account for three times more waste than any other cause.

### 9.1.1.3 Conversion and production waste

This type of waste includes losses resulting from the uneconomic usage of materials, and the usage of the wrong materials.

Examples of this type of waste include :

- The ordering and use of uneconomically sized sheets, and lengths of timber in formwork and roof structures. This results in excessive cutting and materials wastage.
- Burning holes in steel shutter panels when wooden shutterboard is easier to adapt, and avoids the waste of steel panels.
- Cutting of complete face bricks to provide halves, when damaged bricks can be used for this purpose.

### 9.1.1.4 Spillage waste

Spillage waste occurs as a result of :

- Mortar being mixed on bare ground without the use of a suitable mixing board
- Mortar being wasted during the course of bricklaying
- Plaster falling off walls during plastering, and being left to harden
- The mixing of more mortar than can be used in the time available, with the

excess being left to harden overnight

- Concrete spillage when it is ' ing placed
- Overfilled dumpers and wheelbarrows of mortar and/or concrete being transported over bumpy ground with resultant materials spillage.

### 9.1.1.5 Concrete wastage

This occurs when there is an oversupply in situ, with the result that excess deliveries are dumped to become backfill.

### 9.1.1.6 Sand and store wastage

Quantitatively, the greatest wastage on site is due to poor storage of sand and stone which is often dumped on any bare ground that is readily available.

This results in losses because the material weathers and spreads over a larger area than the original dump occupied. The resultant material losses often exceed 30%. This can be avoided by the approach adopted in the case of a well planned batching plant which provides for bulkheads to contain the material and stop it from spreading, and concrete bases to safeguard the bottom layers of material.

### 9.1.1.7 Hourekeeping waste

Poor housekeeping and ineffective and unplanned storage facilities are the cause of considerable losses of shuttering material, support equipment, reinforcing steel, sand, stone, cement and bricks.

The importance of good housekeeping cann . be overstressed :

*HOUSEKEEPING MEANS A PLACE FOR EVERYTHING AND EVERYTHING IN ITS PLACE*

Good housekeeping is part of effective materials management. It contributes to minimizing materials and equipment wastage, and to improvements in overall productivity.

### 9.1.1.8 Equipment damage and losses

One of the main causes of equipment damage and losses is the inadequate and unplanned methods of storage.

Careless horizontal stacking of steel shutters causes damage to the shutter faces and results in poor concrete surfaces.

A frequent cause of damage to shuttering equipment results from not hosing down the shutter assembly after a concrete pour, with resultant damage to the shuttering when attempts are made to remove the set concrete.

The larger companies usually hire their equipment from an in-house equipment supply company and the hire charges are time related. The absence of a suitable control system and site management awareness regarding equipment cost, results in damaged equipment not being written off. Hence hire charges continue to be incurred by the contract, for unserviceable equipment.

A further source of loss, is inadequate maintenance, and under-utilization. This particularly applies to plant items.

9.1.1.9 **Criminal waste**

This results from theft and short deliveries by suppliers. The latter is very prevalent in the case of stone and sand deliveries. Checks have revealed short deliveries of as much as 27%.

In practice, however, deliveries are seldom checked.

A BIFSA report quoted by Hood (1987) concluded that losses on building sites ranging from hand tools to bulldozers cost companies more than R200 million per annum. These losses were incurred through theft, fraud and vandalism. The BIFSA survey showed that employers generally did not realize how much they were losing or that wastage on site directly affected company profits.

This lack of awareness stems from the absence of information regarding the value of losses, ineffective measurement of materials utilization, and incomplete (or lack of) equipment and machinery records.

9.1.2 **Indirect waste**

This involves substitution waste, production waste and negligent waste.

9.1.2.1 **Substitution waste**

This occurs when more expensive materials than those specified are used as for example when face bricks are used to build internal walls, or unnecessarily high MPa concrete is cast.

### 9.1.2.2 Production waste

Production waste is the result of more materials than are necessary being used, for which the contractor will not be paid, e.g. the additional plaster required to cover uneven brickwork.

### 9.1.2.3 Negligence waste

This type of waste occurs in the course of faulty work which must be redone, and in the case of over excavation which requires additional concrete which will not be paid for.

In his address to the 1988 annual general meeting of the Institute of Building, D.N. Fraser, former president of BIFSA (now Executive Director), referred to the building industry as a "re-work" industry. He quoted two reasons for the excessive re-work :

i) unacceptable quality
ii) Variation orders from owners, consultants and architects

He illustrated the aspect of quality by saying :

*'In complimenting an architect on the design of a recently completed building (which we also did not build) he thanked me and wryly stated that it was the first building that he had seen built twice, such was the incompetency of the contractor'.*

The excessive instruction changes to the contractor is portrayed by his further comment: *'Over the entire contract period which was in excess of twelve months, the number of revisions to drawings together with the number of site instructions and variation orders were* *equivalent to either a drawing instruction or variation order being issued every 10 minutes of every working day. That instance is not unique. It is duplicated all over the country at a staggering cost which no industry or country, let alone, South Africa, can affordl.'*

The excessive number of orders can in part be attributed to insufficient forethought and planning. Fraser did not state the costs of re-work, but did mention the adverse effect which it had on the morale of the work force.

The above are examples of waste which must be measured, if it is to be controlled, and losses and costs minimized.

With regard to the work involved in measuring indirect waste, Skoyles (1978) states:

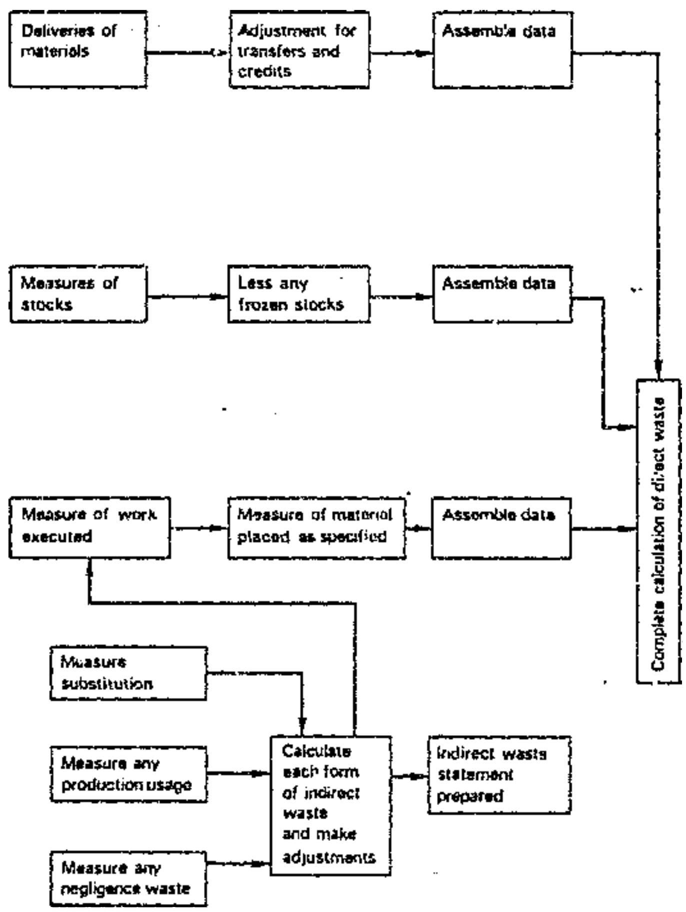
*'Experience has shown that the extra work, and the cost involved, is minimal, once personnel are familiar with procedures'.*

### 9.1.3 Machinery and equipment utilization

Productivity of machinery depends upon utilization. The measurement of productivity requires accurate records of productive time and unproductive time. The latter must be analyzed for pure standing time, down time, i.e., inoperative time - available and non-available machine time.

The evaluation of the utilization of equipment - such as supports, trestles and shuttering - also necessitates the recording of time utilized and time stored.

The contracts surveyed used batching plants, tower cranes and hoists, but none maintained records of utilization and down time.




E. R. Skoyles

FIGURE 9.1 SCHEMATIC OF SITE ACCOUNTING FOR MATERIALS WASTAGE

## 9.2 The Measurement of Waste

The complete calculation of the extent of waste requires the measurement of materials deliveries, of stock on site, of materials put in place, as well as of the indirect waste which has occurred during the construction reference period.

It is noteworthy that indirect waste can only be measured at the time of the occurrence, i.e. during the progress of work. Usually it is covered up in some way by the time of practical completion.

A logical sequence of action has to be followed in order to make the reconciliation, and the frequency of measurement and checking will depend on the value of materials being consumed. Figure 9.1 illustrates the procedures to be adopted to compute the value of waste.

### 9.2.1 Site observations : reconciliation of wastage allowances and actual wastage

Seven different contracts were studied to establish the extent of materials wastage. Wastage allowances for the different materials used in the construction process were readily available. These allowances are based on the economic utilization of the materials concerned, and are used by the estimators for contract pricing, and by the quantity surveyors for reconciling materials usage. However, it was found to be exceedingly difficult to obtain reliable data regarding actual materials wastage.
There are two main reasons for this :

- The first is the poor level of site housekeeping. This causes practical difficulties in measuring materials stock levels.

- The second is the lack of professional application on the part of site quantity surveyors to the aspects of materials and wastage measurement.

A practice has developed in the industry, over many years, whereby costs are shunted between contracts in order to show better results for poorly performing contracts. This results in unreliable performance figures being presented to management. In these circumstances, cost review meetings (which are a feature of the industry) are, indeed, a waste of time because one cannot control what is not measured.

The lack of reliability of reported figures on materials utilization is evident from Table 9.1 which compares the actual cost of some basic materials with the allowed cost. The allowed costs included the wastage allowance shown in column (1).

TABLE 9.1

MATERIALS WASTAGE ANALYSIS

| MATERIAL | % Waste Allowance (1) | CONTRACT | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G |
| Bricks | 5,0 | + 2,2 | + 22,6 | + 4,2 | + 4,4 | + 8,1 | - 4,2 | + 13,9 |
| Cement | 2,5 | + 33,0 | + 31,6 | + 15,8 | - 3,2 | - 23,4 | - 16,7 | + 16,4 |
| Sand | 30,0 | + 12,6 | + 12,5 | + 5,6 | - 15,9 | - 37,7 | - 60,0 | + 14,6 |
| Stone | 10,0 | | | | - 5,2 | - 21,9 | - 4,1 | + 17,9 |
| Timber | 7 - 10 | | | | + 5,2 | | | |
| TOTAL * | | - 1,2 | + 19,2 | + 3,6 | + 1,5 | - 6,5 | - 10,9 | + 15,6 |

* Includes other materials not listed above

\+ % Excess materials used above allowable, which includes waste allowance

\- % Materials used less than allowable, which includes waste allowance

Note : The above excludes variation orders.

Contracts E and F, in particular, show that less cement, sand and stone were used than actually put in place (as measured). It is also noteworthy that these two contracts were completed at a loss!

These results would indicate support for the comments made regarding the questionable practices and reporting by some site quantity surveyors.

Skoyles (1976) states :

*'The Building Research Establishment in the United Kingdom has found that on average twice as much actual wastage occurs than the wastage allowed in the original wastage estimate'.*

This may be interpreted as meaning that the original allowances may be unrealistic.

However, site inspections have revealed that there is a serious lack of awareness and caring amongst management and supervisory staff regarding the utilization of materials and equipment. This is evident from the wastage of concrete through spillage, broken bricks, excess mortar, and poor housekeeping of equipment.

The following are some observed examples of materials wastage.

None of the sites visited had suitable nor sufficient storage bins for small but costly items such as clamps, wedges and connectors.

This resulted in equipment lost in construction dirt, and in backfill.

Frequent transportation damage was observed when wheelbarrows were used to transport face bricks. There seemed to be a complete lack of appreciation of the unit cost of a brick by the worker transporting them (and that also often applied to site supervision), since the bricks were thrown into the barrow with resultant chipping of the edges.

Observed cases of criminal waste included :

- Mortar supplied in silos over a period of four months was found to be 118 cubic metres short supplied. This shortfall was valued at R7 080.

- One million bricks were short supplied to a large housing contract. It was found that the truck drivers were removing the top layer of bricks en route from the yard to the site.

In both the above cases, the builders were recompensed for the shortages by the suppliers.

The cost of not maintaining a record of materials storage locations, and poor housekeeping, is exemplified by the following occurrence :

An expensive load of reinforcing steel was off-loaded on a vacant piece of ground to be used in an adjacent structure. The ground next to the reinforcing stockpile was subsequently excavated for the construction of a culvert, and the excavated material dumped on top of the reinforcing steel, completely covering it. When the steel was required, it could not be found and this resulted in the additional costs of re-ordering the required steel and in construction delay. When the original steel was eventually located it was superfluous to the contractor's requirements, and was sold as scrap.

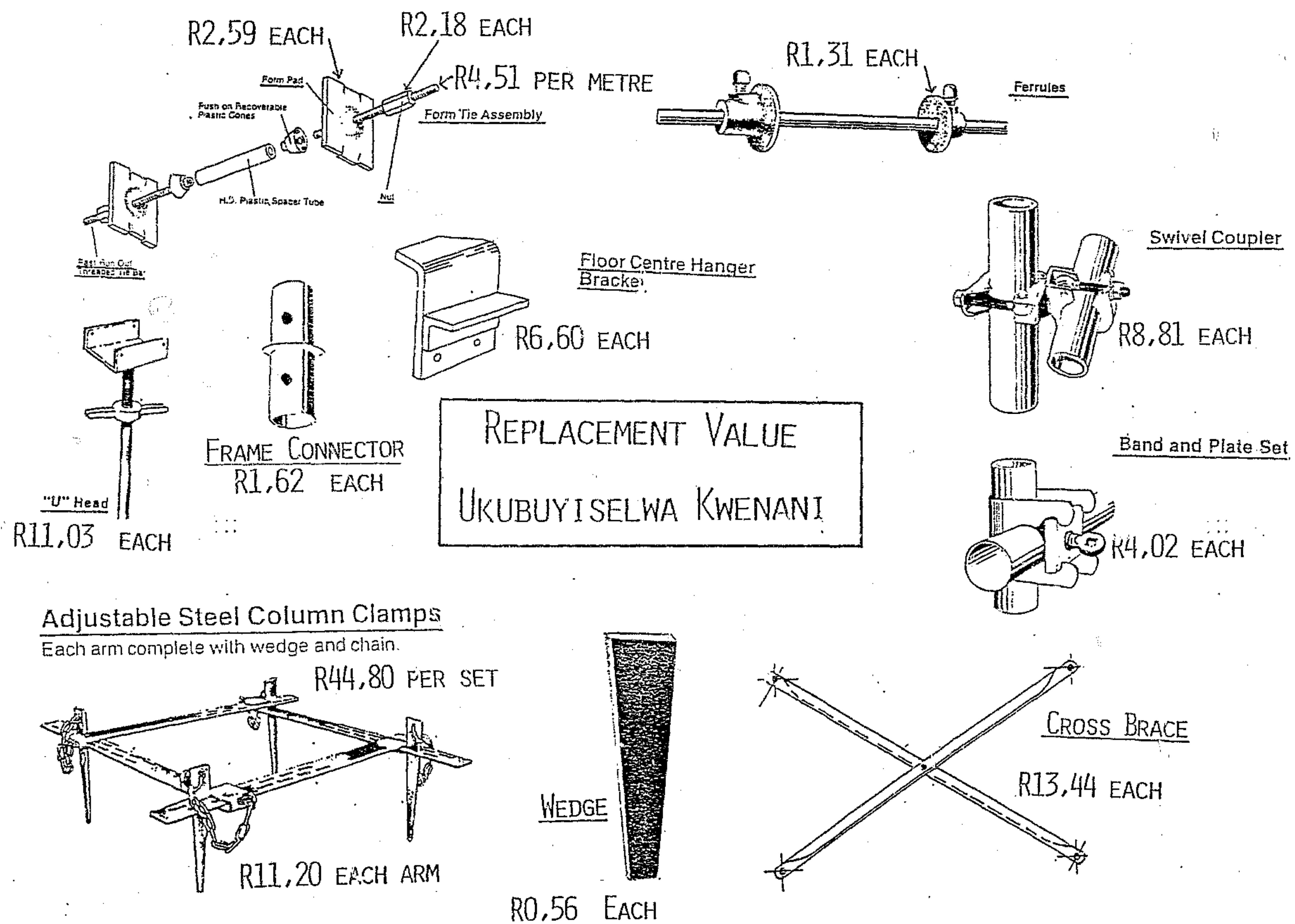



FIGURE 9.2 ILLUSTRATED PAMPHLET SHOWING COST OF EQUIPMENT

## 9.3 Waste Avoidance - Some applied solutions

A prerequisite for the reduction of losses resulting from waste, is a keen sense of awareness regarding their origin, incidence and cost, and a proprietary interest in reducing these losses.

The following practices were introduced to help reduce waste.

1. An illustrated pamphlet, as shown in figure 9.2, was designed and exhibited at all the prominent work places on sites. It helped educate workers regarding the value of the equipment they were using.

2. Stacking storage bins (ref. fig. 11.6) were designed and introduced for the storage, safekeeping and transportation of small items of equipment such as clamps, wedges, connectors, etc.

3. Special brick handling trolleys (ref. fig. [illegible]1) were developed and introduced. These helped to reduce brick breakage and chipping and facilitated handling.

4. A special check list was compiled and introduced to encourage and facilitate good housekeeping Ref: appendix A.

5. Portable bins were constructed from scrap shutter materi[illegible] the storage of granular materials, This helped to reduce wastage and permitted the salvaging of unused material.

6. Mortar mixing boards were introduced as a standard practice.

7. Guidance was provided in site lay-out to minimize handling and provide improved materials control.

8. A campaign was introduced to avoid over excavation, concrete spillage and transport spillage from wheelbarrows and dumper trucks.

**9.3.1 Reduction of waste through materials management**

In its total concept materials management encompasses effective systems of planning and control for the elements of design, specification and procurement; scheduling of deliveries, packaging and transportation, reception and accounting for both materials on site and materials used in the construction process i.e. storage and the suitable protection of all materials before and after completion of the construction process.

The above holistic and integrated approach requires the co-operation of architect, engineer, materials suppliers and contractor at the early design stage and on an ongoing basis throughout the contract. This is seldom achieved in practice because of the temporary (and often tenuous) mutually convenient economic relationships which exist between the parties involved in the contract.

In practice, the purchasing function is one of the few elements in the total materials management spectrum which is effectively implemented. The lack of attention to the other elements such as scheduling, packaging and transportation, accounting and storage, was found to lead to unnecessary losses.

For improved materials utilization, it is essential that materials management commands the attention of management on the same level as all other management responsibilities such as organization, planning, motivation and safety.

## 9.4 Conclusions Regarding Waste

The different types of waste and the circumstances in which waste occurs have been discussed. Waste, more so than accidents, is avoidable. The key to avoidance is a heightened sense of awareness regarding the cost of waste amongst all employees, and particularly a sense of caring for all the resources in their charge. A 50% reduction in wastage can in many cases make the difference between a contractual profit and loss, and in some cases double the profit margin.

The changes introduced on site helped to reduce waste and improve contract results. But the absence of effective measurement procedures precluded the measurement of the results achieved.

Awareness of waste will not be achieved unless it is systematically quantified. It is therefore essential to have effective site accounting to help identify the extent of the losses as they occur and while there may still be time to do something to reduce them.

However, the size and value of the contract should always be borne in mind; and it may not always be cost effective to incur the necessary clerical cost to provide the desired measures of materials utilization.

## 9.5 The Measurement of Quality

Productivity must include a quality dimension. It serves little purpose to increase quantity at the cost of lower quality which is unacceptable to the client.

*Quality may be defined as the degree to which a product or service conforms to a set of predetermined standards related to the characteristics that determine its value in the market* *place and its performance of the function for which it was designed.*

The quality standards in construction are in practice a matter for agreement between the owners and/or the supervising architects and consultants (ref. Appendix C, Section 5.3). Quality assurance is often practiced to ensure quality, but the facts of construction are that

*QUALITY CANNOT BE INSPECTED INTO A PRODUCT; IT CAN ONLY BE BUILT INTO IT!*

In practice every supervisor and worker must be his own quality assurance officer.

None of the companies surveyed maintained detailed records of the cost of rework and sub-standard quality production. This is essential in order to establish a quality productivity ratio. (Q.P.R.)

Q.P.R. = Initial cost of product / [Initial cost of product + cost of rework (repair)]

It will be seen from the above equation that quality measurement cannot be effected without a record of the cost of rework.

It is well to remember that:

Quality is free! Quality means caring. Caring for :

- the people working on the site
- the materials being used
- the plant and equipment used

- the level of skills being applied
- the final product
- one's own and the company's interests
- the client's interest
- the environment
- the community in which we work and live

It means having an empathy for all the resources in one's care, and doing the greatest good in discharging one's responsibilities.

The important changes are qualitative. There is little, if any, increase in cost in producing quality work, but the increased pay-off is considerable.

In order to safeguard quality and ensure that the specified construction procedures are adhered to, a series of quality assurance check lists were designed for the different basic activities such as excavation, formwork and concrete work. Copies of these lists are shown in Appendix E. These check lists proved to be very effective in improving quality and reducing rework.

# CHAPTER 10

## THE FINANCIAL MEASUREMENT OF CONTRACT RESULTS

### SYNOPSIS

This chapter discusses the contract measures of productivity in current use. The management information used to evaluate contract status is reviewed.

A composite measure of economic productivity is developed which is based on the concept of production value, and a productivity ratio is used as a total measure of economic productivity and contract performance. The productivity ratio is then used to evaluate productivity and measure contract results.

Recommendations are made to use the productivity ratio as the basis for inter-company productivity comparisons and the assessment of national and regional productivity norms.

# 10. THE FINANCIAL MEASUREMENT OF CONTRACT RESULTS

The following are the measures of productivity practiced by the companies which were investigated. These will be discussed and their merit evaluated.

## 10.1 Contracting Turnover per Supervisor

This measure is a money value in rands and is obtained by dividing the company's total turnover by the number of contract supervisory personnel.

This statistic is not a meaningful measure of productivity for the following reasons :

- The turnover being in money value is affected by cost escalation and the depreciation of money, whereas the number of supervisors is a numerical figure not affected by changes in money values.

- Total turnover includes sub-contractors' contributions to the final value of a contract. The sub-contractors' work usually requires less supervision than one's own work; and the proportion of work contracted out will affect this statistic. Hence this ratio does not compare like with like, and cannot be considered a reliable measure of supervisory productivity.

- The ratio can readily be improved by reducing the number of supervisors. But this will adversely affect the span of control, performance, and profits.

## 10.2 Contracting Turnover per Employee

The contracting turnover as in the above case includes that generated by sub-contractors.

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- The ratio can readily be improved by reducing the number of supervisors. But this will adversely affect the span of control, performance, and profits.

## 10.2 Contracting Turnover per Employee

The contracting turnover as in the above case includes that generated by sub-contractors.

Only the company's own employees, including staff, are con. dered in calculating this measure.

This, again, is not a meaningful measure, because a variable value is being divided by a fixed number. The labour force can also vary appreciably in total cost, depending on the employee mix in terms of relative skills and rates of pay. This measure, also, does not provide a true comparison of like with like.

### 10.3 Own Turnover/Total Site Payroll Costs

value of subcontract work is excluded in this instance. The turnover figure contains the cost of materials. Materials costs content can vary from one contract to another, depending on design and specification. Thus this measure, while providing a more realistic measure of labour productivity, must still be questioned as it is not necessarily practically meaningful.

### 10.4 Earnings *Before Interest* and Tax (EBIT) *as* a Percentage of Total Payroll Costs

Earnings are, indeed, a product of total resources utilization, but not strictly as a percentage of payroll costs. Consider the following situations.

- A small own turnover content and high sub-contractor turnover content. This can arise in a structure containing sophisticated equipment and services, e.g. a high proportion of steelwork, special glass, air-conditioning, fire prevention equipment, etc.

  Profit on sub-contract supervision is usually guaranteed. In such a case, the company's payroll, in proportion to total turnover will be relatively small.

Hence in these circumstances the EBIT/Payroll cost percentage will be high, without any extraordinary effort or improvements in productivity from the company's own staff.

- On the other hand, where most of the turnover is own work, a comparable EBIT/Payroll cost percentage will require an extraordinary and improved effort by all the employees concerned. This is illustrated in the following table 10.1:

TABLE 10.1

COMPARATIVE EBIT RESULTS

| | Contract A | Contract B |
|---|---|---|
| Own turnover | R 2 000 000 | R 8 000 000 |
| Sub-contract turnover | R 8 000 000 | R 2 000 000 |
| Total turnover | R10 000 000 | R10 000 000 |
| | | |
| EBIT | R 600 000 | R 900 000 |
| Own payroll @ 30% of own turnover | R 600 000 | R 2 400 000 |
| Sub-contract supervision 2% of sub-contractor's turnover | R 160 000 | R 400 000 |
| Total own payroll | R 760 000 | R 2 440 000 |
| | | |
| Ratio | | |
| EBIT/Payroll x 100 | 600000/760000 x 100 | 900000/2440000 x 100 |
| | = 78,9% | = 36,9% |

Thus for the same total contract value, contract B will realize 50% more EBIT than contract A, but the contract A EBIT/Payroll ratio will be more than double that of contract B.

## 10.5 Earnings Before Interest and Tax as a Percentage of Turnover

This is a useful guideline regarding overall earnings and provides an earning indicator relative to total turnover. However, it does not provide a measure of productivity which can be used to compare and evaluate how effectively resources such as manpower, materials, machinery and money have been used on comparable contracts.

## 10.6 Measurement of Contract Performance

The most common measure of contract performance is to compare costs with the contract estimate, which is usually the tender price. Success or failure is measured by the weekly or monthly cost report which compares 'actual costs' with estimated costs relative to income. The assumption is that irrespective of the correctness of the estimate, a comparison with it will indicate whether the job is profitable or not.

There are several serious shortcomings in this hypothesis. Estimates are at best approximate. There are numerous cases where important elements of cost have mistakenly been left out of the tender. To quote but two:

- In the one case the cost of a R20 000 roof was left out by a professional quantity surveyor.

- In the other case the total profit margin was neglectfully omitted from a tender proposal valued at R15 million.

Therefore to focus attention on meeting the estimates rather than minimizing cost and maximizing resources utilization may well be directing supervisory attention in the wrong direction. Often activities which are being done below the allowable cost may be the ones where the greatest cost reduction can still be made.

The excellent performance of management on one job may fall short of estimate, while the estimated profit on another job may be surpassed with less managerial effort.

## 10.7 Management Information Regarding Contract Status

Three of the companies surveyed had not made any changes to the lay-out or information contained in their monthly operating statement in the past fifteen years.

Their statements did not provide a reconciliation of materials usage nor labour cost recoveries. This information had to be obtained from different documents.

All the companies surveyed possessed computer facilities. Computer technology has brought about revolutionary changes in management information capabilities. Experience has proved that if paperwork and information systems have not been reviewed in the past three years then they are out of date, excessively costly, and not optimally effective.

In practice it was found that, using the monthly income and costs reports to evaluate management performance is seldom meaningful, because these reports are often based on unreliable measurements[14], and thus do not provide factual information regarding contract status.

14 So far as profit margins are concerned, site management will apply the philosophy of 'adequate is sufficient'. This can involve the transfer of costs from profitable to marginal contracts, and the carry over of undeclared profits from a profitable to a less profitable contract.

It is of interest to note the observations of Duffy (1985) who conducted a management information study amongst 1354 South African managers. He found that they perceived that 68.5% of their information problems related to information being too late, too little, and of dubious accuracy.

A further shortcoming in the reporting procedures investigated, was found to be the delay in report presentation. The delay varied from six to eight weeks.

This time span in the production of information is, indeed, considerable. Should something go wrong at the beginning of the reporting period then losses could continue to be incurred until the situation is highlighted in the report.

The practice of using the estimate as a standard of performance has introduced undesirable practices which are often used by site management to produce a satisfactory interim report. These practices include under or over measurement and hence under or over claims on the client in order to adjust the contract's income to a satisfactory level.

The ultimate measure of site management performance is how well they use all the resources at their disposal.

It is therefore desirable to be able to apply a composite measure of productivity for this purpose.

## 10.8 Composite (Total) Measure of Economic Productivity

The measures of productivity, as previously discussed, are either discrete measures which apply to physical construction activities or specific financial indicators of contract performance. They do not provide a total measure of economic productivity which can be used to monitor changes in productivity, and evaluate both individual contracts as well as company productivity.

Consideration will now be given to the development and application of an economic measure which will provide an indication of the total utilization of resources inputs, and help to identify changes in productivity.

Perhaps the most important consideration in productivity measurement is that inputs and outputs should match, should be taken from the same universe and relate to the same period.

A universal measure of productivity must therefore be based on a single norm; and that norm is money.

Productivity has been defined as the ratio of output to resources input.

The constructor's output is the sales value of his production; and this is measured in money terms.

The input consists of management, manpower, machinery, plant, materials, supplies and services, and money for working capital.

Rent, rates, taxes, salaries, wages, depreciation on plant and machinery and countless other expenses are also incurred in running a business.

All the foregoing inputs are also measured in money.

Materials purchased are converted by the skill and effort of management, staff and operatives, and by the use of equipment and machinery into saleable products - structures and buildings which represent the sales value mentioned above.

To increase productivity, therefore, requires getting out of a business an ever increasing quantity in terms of money, in relation to that which is being paid in.

## 10.9 The Concept of Production Value and the Development of the Productivity Ratio as a Total Measure of Economic Productivity and Contract Performance

The only productive element is people. They control plant and machinery, use (and misuse) materials and services.

Thus in the course of production three main elements of cost, i.e. input, are incurred.

1) The value of other peoples' production

   This will include :

   - sub-contractors' services
   - materials
   - plant
   - services, powe.:, water, gas, fuel, etc.

2) Salaries and wage costs incurred in one's OWN PRODUCTION

3) Overhead costs - these are fixed costs incurred in the running of the business, and are represented by P & G costs at site level.

Total turnover, or sales value of production, includes the cost of the value of other peoples' production as per (1) above. This cost, including sub-contractors' services and materials can vary widely from contract to contract, and cannot be admitted as a value of the productive effort of the contractor's own manpower.

When the value of other peoples' production is subtracted from contract turnover, then the balance remaining will represent the *PRODUCTION VALUE* i.e. the productive effort of the company's own manpower. This value will have been generated from the productive effort of manpower, plant and machinery in converting materials into a saleable product. This production value is thus the surplus which is available for paying salaries, wages, overhead costs and making a contribution to profits.

It can therefore be seen that the company's own economic output is represented by its *PRODUCTION VALUE* and that its input is the manpower costs i.e. salaries and wages, incurred in the production of this value.

Thus, productivity = Production value/site salaries and wages = Productivity Ratio

It should be noted that capital has not been included as an input, since the companies researched were financed by the parent holding company and interest will have to be paid on the capital employed by the site, from site operational earnings.

The following three financial models developed by the author show how changes in resource utilization and labour productivity are reflected by the *PRODUCTIVITY RATIO*.

**TABLE 10.2**

**FINANCIAL MODELS SHOWING COMPARATIVE PRODUCTIVITY RATIOS**

| | A | | B | | C | |
|---|---|---|---|---|---|---|
| 1. Turnover | | 100 | | 110 | | 120 |
| 2. Materials and services | 45 | | 44 | | 45 | |
| 3. Subcontractors | 25 | | 24 | | 25 | |
| 4. Total outside services (2)+(3) | | 70 | | 68 | | 70 |
| 5. Production value (1)-(4) | | 30 | | 42 | | 50 |
| 6. Site salaries and wages | 23 | | 23 | | 23 | |
| 7. Other salaries | 3 | | 3 | | 3 | |
| 8. Overheads | 4 | | 4 | | 4 | |
| 9. Subtotal (6)+(7)+(8) | 30 | | 30 | | 30 | |
| 10. Earnings before interest and tax (EBIT) (5)-(9) | | Nil | | 12 | | 20 |
| 11. Productivity ratio (5) / (6) | 1,30 | | 1,83 | | 2,17 | |

Model A shows a zero EBIT result, and a productivity ratio of 1,30. This means that for every R1,00 paid in site wages and salaries, a production value of R1,30 was generated.

Model B shows a positive increase in productivity. The same salaries and wages produced an extra 10% in turnover. There was also an improvement in the utilization of outside services, which is represented by lower costs of 68 compared with 70. Materials wastage was reduced and some of the work previously done by sub-contractors was done by own labour. The productivity ratio has increased to 1,83, i.e. for every R1,00 paid in site salaries and wages a production value of R1,83 was obtained, with a resulting EBIT of 12.

Model C shows a further improvement in productivity and improvement in materials

FINANCIAL PERFORMANCE AND PRODUCTIVITY STATISTICS

DEFINITIONS :- 1) PAYROLL = SALARIES + WAGES (Excl. On Costs)
2) MONTH 1 = JULY 83. (MNTH 19 = JAN 85 etc.)
3) YEAR 1 = JUL 83 TO JUN 84
YEAR 2 = JUL 84 TO JUN 85 , etc.
(REFER TO "CALENDAR" FOR FURTHER DETAILS.)

CONTRACT MONTH OF : JUL'85 THIS IS MONTH NUMBER :- 25 THIS IS YEAR No :- 3
START DATE (MNTH NO.) :- 19 EST. TOTAL VALUE IS :- 1531000 PROF DECL AT LAST JUNE:- -8518

| DATA ASSEMBLY : | TO DATE LAST MONTH | THIS MONTH ONLY | TO DATE THIS MONTH | |
|---|---|---|---|---|
| GROSS TURNOVER : | 919371 | 235448 | 1154819 | |
| SUBCONTRACT COSTS : | 174[illegible]7 | 36748 | 211255 | |
| PROFIT : | -8518 | 3285 | -5233 | TO DATE THIS YEAR : 3285 |
| COST OF SALARIES : | 55355 | 14215 | 69570 | |
| COST OF WAGES : | 152297 | 39275 | 191572 | |
| MAN HOURS WORKED : | 79974 | 17847 | 97821 | |
| SUPERVISOR MONTHS : | 19 | 5 | 24 | |
| AVERAGE ASSETS : | 108000 | N.A. | 391000 | |
| CONCRETE POURED : | 1171 | 531 | 1702 | |
| BUDGETTED TURNOVER : | 811000 | 260000 | 1071000 | |

| STATISTICS :: | | AS TENDERED | TO DATE LAST MONTH | THIS MONTH ONLY | TO DATE THIS MONTH |
|---|---|---|---|---|---|
| ( TARGET = 65 ) | %G.P./AV.ASSETS (Annual) | N.A. | 0 | N.A. | 10 |
| ( TARGET = 9 ) | %G.P./TOT.TURNOVER | 7.38 | -0.93 | 1.40 | -0.45 |
| | %SUBCONTRACT COSTS/TOT.TURNOVER | 11 | 19 | 16 | 18 |
| | %SALARIES/PAYROLL | 41 | 27 | 27 | 27 |
| ( TARGET >= 100 ) | %TURNOVER/BUDGET T.OVER | 100 | 113 | 91 | 108 |
| ( TARGET = 1.43 ) | VALUE ADDED PAYROLL | 1.25 | 0.96 | 1.06 | 0.98 |
| | M&R TURNOVER PER MAN HR | 8.24 | 9.31 | 11.13 | 9.65 |
| | TOTAL TURNOVER PER SUPERVISOR MONTH | 34022 | 48388 | 47090 | 48117 |
| (TARGET = 7) | TOTAL TURNOVER / AV.ASSETS (Annual) | N.A. | 17.03 | N.A. | 5.06 |
| | MAN HRS PER C.M. CONC | 60 | 68 | 34 | 57 |
| | PERCENTAGE COMPLETION | N.A. | 60 | 15 | 75 |

**FIGURE 10.1 FINANCIAL PERFORMANCE AND PRODUCTIVITY STATISTICS**

utilization and services. The productivity ratio has increased to 2,17 and EBIT to 20.

It will be seen from the above that the Productivity Ratio is a realistic economic indicator of changes in productivity. The ratio provides a measure of all resources inputs and also takes quality into account. Unacceptable quality will result in rework, reduce turnover, production value, and increase costs. This measure is also valid irrespective of positive or negative EBIT results. This will be shown in the following analyses of company productivity results.

In summary, an optimal productivity ratio will result from : increases in turnover at existing fixed cost levels; reduction in the cost of materials and services; reduction in the cost of sub-contractors.

A turnover increase and reduced costs will provide a higher Production Value; and when this is achieved with lower site salaries and wages, then it is, indeed, an indication of improved productivity.

### 10.9.1 The application of the productivity ratio as a measure of productivity and contract performance

Figure 10.1 shows operational results for a civil contract valued at R1.53 million. This presentation resulted from the foregoing research.

The productivity ratio is listed in the statistics as 'value added payroll', and the target set was 1.43. This means that the contract was required to produce R1.43 of production value (added value) for every R1 spent on wages and salaries. This was a revised figure from the 1.25 which was tendered. The resultant cumulative ratio of 0.98 clearly reflects the overall loss of R5 233.

| SYMSTR | | | MONTH | | | | |
|---|---|---|---|---|---|---|---|
| CUMULATED | OCT | NOV DEC | JAN | FEB | MAR | APR | MAY |
| TURNOVER (a) | 2,458,830 | 2,855,062 | 3,532,932 | 4,085,442 | 4,717,166 | 5,414,882 | 6,264,957 |
| BUDGET T/O (x) | 2,457,000 | 2,853,000 | 3,477,000 | 3,909,000 | 4,700,000 | 5,600,000 | 6,700,000 |
| MARERIALS COST (b) | 843,342 | 1,044,862 | 1,309,541 | 1,502,840 | 1,690,875 | 1,957,745 | 2,274,024 |
| SUBBIES COST (c) | 912,392 | 1,018,140 | 1,319,875 | 1,543,147 | 1,804,252 | 2,110,274 | 2,457,571 |
| LABOUR COST (d) | 479,966 | 554,000 | 633,748 | 743,446 | 891,917 | 1,182,575 | 1,110,349 |
| TOTAL (b)+(c)+(d) | 2,235,700 | 2,617,002 | 3,263,164 | 3,789,433 | 4,387,044 | 5,250,594 | 5,841,944 |
| PRODUCT VALUE ACTUAL (o)=(a)-(b)+(c) | 703,096 | 792,060 | 903,516 | 1,029,455 | 1,222,039 | 1,346,863 | 1,533,362 |
| (M)/TOTAL RATIO (r) =(b)/TOTAL | 0.3772 | 0.3993 | 0.4013 | 0.3966 | 0.3854 | 0.3729 | 0.3893 |
| (S) to TO RATIO (s)= (c)/TOTAL | 0.4081 | 0.3890 | 0.4045 | 0.4072 | 0.4113 | 0.4019 | 0.4207 |
| (L) to TO RATIO (t)= (d)/TOTAL | 0.2147 | 0.2117 | 0.1942 | 0.1962 | 0.2033 | 0.2252 | 0.1901 |
| CUMULATED | | | | | | | |
| RATIO ACTUAL=(o)/(d) | 1.46 | 1.43 | 1.43 | 1.40 | 1.37 | 1.14 | 1.38 |
| REPORTED PROFIT AS %COST | 7.57 | 6.73 | 6.38 | 6.19 | 6.12 | 6.03 | 6.19 |
| MONTHLY | | | | | | | |
| TURNOVER ACTUAL (e) | | 396,232 | 677,870 | 552,510 | 631,724 | 697,716 | 850,075 |
| TURNOVER BUDGET | 460,000 | 396,000 | 624,000 | 432,000 | 791,000 | 900,000 | 1,100,000 |
| ACTUAL | | | | | | | |
| MATERIAL COST (f) | | 201,520 | 264,679 | 193,299 | 188,035 | 266,870 | 316,279 |
| SUBBIE COST (g) | | 105,748 | 301,735 | 223,272 | 261,105 | 306,022 | 347,297 |
| LABOUR COST (h) | | 74,034 | 79,748 | 109,698 | 148,471 | 290,658 | (72,226) |
| TOTAL COST (f)+(g)+(h) | 0 | 381,302 | 646,162 | 526,269 | 597,611 | 863,550 | 591,350 |
| (i)=PRODUCT VALUE (e)-(f)+(g) | | 88,964 | 111,456 | 135,939 | 182,584 | 124,824 | 186,499 |
| (j)=RATIO (M) to TOTAL=(f) TOTAL | | 0.529 | 0.410 | 0.367 | 0.315 | 0.309 | 0.535 |
| (k)=RATIO (S) to TOTAL=(g)/TOTAL | | 0.277 | 0.467 | 0.424 | 0.437 | 0.354 | 0.587 |
| (l)=RATIO (L) to TOTAL=(h) TOTAL | | 0.194 | 0.123 | 0.208 | 0.248 | 0.337 | -0.122 |

**FIGURE 10.2 CONTRACT MONTHLY AND CUMULATIVE OPERATING, AND COMPOSITE PRODUCTIVITY RESULTS**

The current month's operation shows a small profit of R3 285, and this is reflected in the productivity ratio being greater than 1,0, vis 1,06.

The conclusion to be derived from the cumulative productivity ratio is that insufficient value was produced for the total resources input, which included sub-contractors' services, materials, equipment and own manpower. Subsequent investigations revealed excess site labour which contributed to poor labour productivity.

The presentation shown in figure 10.1 would have been more meaningful with the addition of materials costs.

The results format was subsequently revised, and the revised lay-out is illustrated for another contract, in figure 10.2. This shows monthly and cumulative results for turnover, the main cost items, production value, and the productivity ratio.

The development and application of the productivity ratio and revised contract format proved to be of value to management in measuring changes in productivity and the effectiveness of resources utilization.

### 10.9.2 Company results as measured by the productivity ratio

Figures 10.3 and 10.4 present productivity results for two different companies over periods from 1975 and 1976 through to 1983 and 1984.

Company A consistently increased turnover in current values, but suffered decreasing productivity and gross profit percentage, which culminated in a loss for the year 1981. This is clearly shown by reference to the productivity ratio which was less than one.

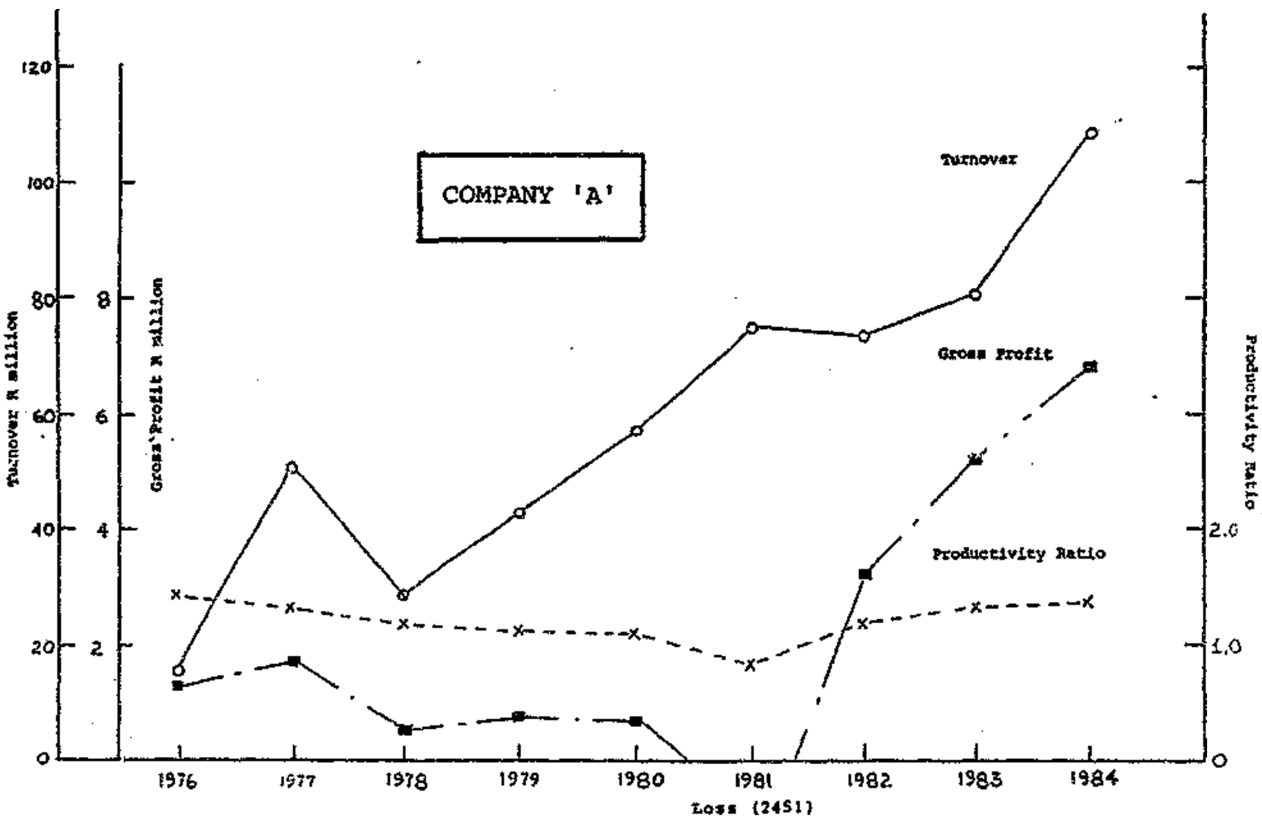



FIGURE 10.3 COMPOSITE COMPANY PRODUCTIVITY RESULTS - A

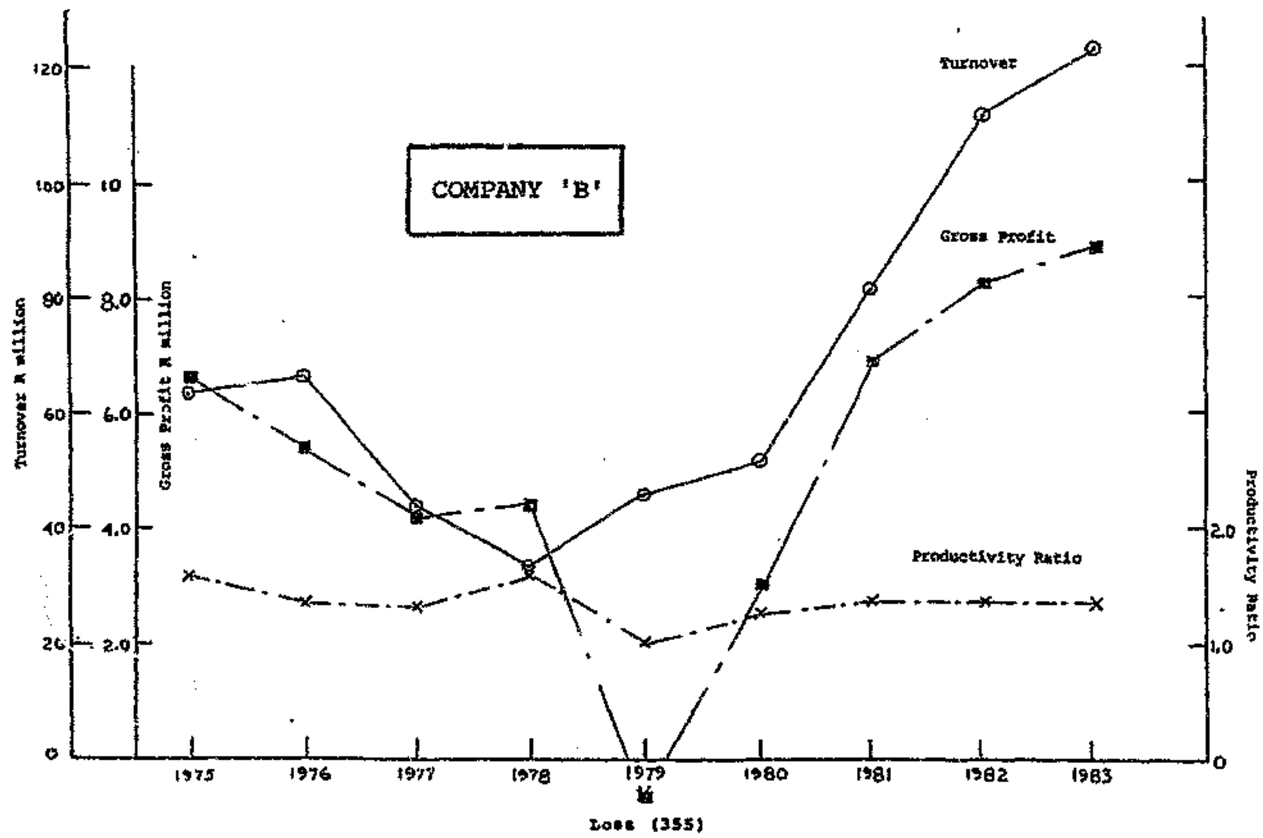



FIGURE 10.4 COMPOSITE COMPANY PRODUCTIVITY RESULTS - B

Company B experienced a drop in turnover for the period 1975 through 1978. However, the gross profit as a percentage of turnover was maintained in 1977, and improved in 1978 as did the productivity ratio. This was followed by a loss year during which the productivity ratio was 0.97. There was an improvement in profits in terms of current values; but this ignores inflation. In terms of economic productivity as represented by the productivity ratio, there had been no improvement in resources utilization during the nine year reference period. This lack of progress in resources utilization and productivity improvement follows the national productivity trend as discussed in chapter 3.

## 10.10 Money - Measurement and Control

An essential financial control element is that concerned with preliminary and general costs (P & G) which accounted for between 10% to 15% of total contract costs in the companies investigated. This category of costs includes site establishment and site clearance, management and supervision, and is usually a repository for any general costs which cannot readily be allocated to a clearly defined cost centre.

P & G costs are, of course, time dependent. If the contract completion time exceeds the original programme then additional supervisory costs will be incurred. Similarly, early contract completion will result in lower total management and plant costs.

TABLE 10.3

**PRELIMINARY AND GENERAL COSTS**

| COMPANY | NUMBER OF CONTRACTS | TOTAL ALLOWABLE COST | ACTUAL vs ALLOWABLE + gain – loss | | % TOTAL COMPANY LOSS |
|---|---|---|---|---|---|
| | | | Number of Contracts | Total for Company | |
| A | 10 | 3 270 000 | – 10 | – 1 518 000 | – 46,4 |
| B | 10 | 2 305 000 | – 7<br>+ 3 | – 386 000 | – 16,7 |
| C | 10 | 2 154 000 | – 8<br>+ 2 | – 931 000 | – 43,2 |

Table 10.3 shows the P & G costs for three different companies, compared with the allowable cost. The figures presented for each company include their most recent ten contracts. Only 5 out of the total 30 contracts involved showed an actual gain on the allowable P & G costs.

Total company actual cost, however, exceeded the allowable in all three companies. The reasons for the excess costs include unrealistic allowables, inadequate cost control, and programme over-runs.

## 10.11 Recommendations

### 10.11.1 Control

Financial and production control during the currency of the programme is imperative to avoid cost over-runs. This can be achieved through the implementation of 'zero base' budgeting and ensuring that the construction programme is complied with.

Both site management and supervision should be involved in setting up the budget. The supervisor (foreman) who will be using P & G resources must put forward a plan of the resources he will require during the different stages of the contract. This plan must include alternatives of providing the service, i.e. whether it be in-company or by sub-contractors, and show a relative cost comparison. P & G general labour must be reviewed critically and considerations must be given to work simplification and labour performance standards.

The separate sectional plans should then be co-ordinated, and discussed by all involved in their development, with cost-benefit evaluations of a" proposed expenditure.

The resultant priced-out operational plan built from a 'zero base', i.e. starting from scratch, will provide a realistic norm against which to control costs. The fact that first line supervision (foremen) have participated in formulating the plan will encourage their commitment to ensure that P & G costs are maintained within the limits of the agreed budget.

The implementation of zero based budgeting required a change in company philosophy and practice. Progress was slow, but the practice proved to be beneficial to those contracts where it was implemented.

### 10.11.2 Inter-Company productivity comparison

The general acceptance by contractors of the production value concept and productivity ratio as a composite measure of productivity, will make possible the introduction of inter-company productivity comparisons.

The results can be submitted in coded form to organizations such as BIFSA, MBA or SAFCEC where they can be categorized by type of structure, and the results published in the form of highest, lowest and mean productivity ratio, per structure category. The contractor can then compare his own results with those published.

The publication of these productivity ratios will provide the industry with a useful guide to productivity standards and stimulate a competitive spirit which will help improve overall resources utilization, and hence raise productivity standards.

The productivity ratio information should be complemented by discrete measures such as have been discussed in Chapters 8 and 9, which relate to the physical me[illegible] of labour productivity, and materials utilization and wastage. The measures [illegible] labour productivity in particular, have become acceptable to management and supervision, and are practically useful for estimating, and checking the performance of labour engaged on specific readily measurable activities such as bricklaying and shuttering.

### 10.11.3 National and regional productivity norms

National and regional labour productivity data are not available; and in their absence contractors tender on the record of their past achievements or on their hopeful future improvements. This often results in a wide disparity of tendered prices as was shown in Section 3.2.

It is of interest to note that a similar situation exists in the U.S.A. - the country with the largest Gross Domestic Product (G.D.P.) in the world. The Business Roundtable Report (A-1, 1982) states : *'construction productivity data for nationwide use is not available. The Bureau of Labour Statistics (B.L.S.) productivity data for construction, unlike the data for other industries, is considered unreliable by B.L.S. and is not published. Moreover, a single measure of productivity, even if accurate, is insufficient for such a diversified industry as construction. Logical segments of the industry should be examined separately and several measures devised for each. This will then enable owners to compare performance on their projects against industry norms'.*

The above recommendations are, indeed, applicable to the South African construction industry.

The presentation of two categories of data should be considered.

First, discrete data relating to manpower performance. This should include :

- Manhours per unit of output
- Rand value of materials per unit of output
- Total Rand value per unit of output
- Project duration.

Regarding the third and fourth elements listed above, the money values, for comparative purposes, over a period of time, will have to be adjusted to an acceptable base in order to allow for cost inflation.

The second set of data should be on a sectorial basis, which will present productivity ratios for a comprehensive range of construction categories. The use of productivity ratios will eliminate the necessity for inflation adjustment since all the data will be measured in money terms during the same time dimension.

These productivity measures will provide a basis for the realistic evaluation of labour productivity; provide guidelines for training workers to produce quality and quantity; permit contractors to measure their performance against industry norms; and provide a basis for labour remuneration and incentive payments.

The collection and collation of data may best be done by a private agency to ensure confidentiality, under the aegis of such organizations as B A, the Master Builder's

Association; and the South African Federation of Civil Engineering Contractors.

## 10.12 Conclusions

The application of the different measures of productivity to construction operations, reveals considerable potential for reduction in the wastage of manpower and materials, and improvement in overall productivity.

Wastage of manpower is revealed by low site activity ratings which have indicated the employment of excess labour. Low effort ratings, further indicate low productivity.

The low levels of performance, excess site labour, and lost time, as discussed, emphasize the importance of measurement, so that the wastage of the most important resource - manpower - can be identified, monitored, quantified, and hence reduced.

The application of the concept of production value and productivity ratio as an overall measure of economic productivity confirms the fact that there has been little improvement in productivity in the construction industry.

Measurement alone will not result in productivity improvement. Improvement will only be achieved when shortfalls in resource utilization, as highlighted by measurement, are identified, evaluated, and action taken for their elimination. This requires management commitment to change (for the better) and reduce aspects such as lost time, low effort ratings and materials wastage. This must be complemented by a general sense of awareness and caring for the resources employed.

The caring for resources, and the commitment to waste reduction and elimination, must apply to every one involved in the construction process - management, supervision and workers. It is only when caring and commitment is part of a company's culture, that productivity improvement will become an ongoing reality.

Measurement provides signals, and improvements in productivity will ultimately depend on the effectiveness of managements' reaction to the information provided.

# CHAPTER 11

## MATERIALS HANDLING

### SYNOPSIS

It has already been shown that the major portion of the site labour force is engaged in materials handling. Improved techniques for materials handling can therefore make a considerable contribution to the improvement of productivity. Such improvement therefore constitutes an important component of the holistic approach to improved resources utilization and overall productivity.

This chapter discusses the importance of materials handling and its effect on construction costs. The factors which affect materials handling are defined and the effect of work simplification and methods improvement are outlined.

Site observations revealed the lack of attention paid to the handling process. Recommendations are made for improvements; and innovations which were introduced to simplify and economize on materials handling are described, and the results analyzed.

# 11. MATERIALS HANDLING

It has already been shown that approximately 80% of construction manpower consists of labourers whose basic work involves excavation, backfilling, moving equipment and materials. Therefore, since most of the manpower is involved in materials handling it may be argued that construction is largely a materials handling exercise. Hence, it is essential that the handling of materials is done at least cost.

Additional handling adds to the cost of the end product (the completed structure), without adding any extra value. There is also the constant danger of damage to the materials and equipment being transported (chipped bricks, spilled concrete, etc.); and the value of material being wasted increases every time it is moved or shaped.

Economic materials handling is dependent on numerous factors, which should be effectively co-ordinated to provide an integrated system that will serve the construction process.

These factors include the following :

- Planning - site lay-out
- Materials management
- Good housekeeping
- Methods - work simplification
- Handling equipment

## 11.1 Site Lay-out

A key factor in reducing handling costs is a well planned site lay-out. It can, and does have a considerable effect on overall construction costs. The lay-out must take into account the location of site offices; labour accommodation; the storage of materials, plant and equipment; location and number of toilets (can reduce lost time); materials and labour flow lines. Effective planning will help to ensure that all facilities are in the right place and avoid having to move them at a later stage.

A well planned site will allow materials to be stored close to where they will be used. Internal transport aisles should as far as is possible, be level, well maintained, and should provide the shortest transportation routes, and ready access to materials, equipment, and working areas.

In practice, for example, the concrete mixing plant and cement silos should be positioned to ensure the shortest possible route between them and the construction areas; materials should be delivered as close to where they will be used as possible, in order to avoid double or multiple handling.

### 11.1.1 Uniflow

The concept of single directional flow without backtracking, should be practiced wherever possible. This will help to keep people and materials moving, without the congestion and delay which occurs when the same pathways are used for movement in opposite directions.

### 11.1.2 String Diagram

Doubt about the shortest transport routes can readily be resolved using a string diagram.

The scale plan of the site can be mounted on softboard which will allow plastic headed pins to be pressed in along the proposed route. A piece of string is then strung around these pins along the full length of the route. The length of the string will give the route length to the scale of the site plan.

The same procedure is then followed for the alternative routes and the lengths compared to help decide on the shortest route.

## 11.2 Materials Management

Economic handling of materials and equipment is dependent on the implementation of good materials management practices. This involves liaison with suppliers to package materials into unit loads which are readily transportable and can be handled by the equipment available on site.

## 11.3 Housekeeping

Good housekeeping can and does simplify materials handling, and is an important part of materials management. Tidy and accessible storage of materials simplifies materials procural from storage piles and contributes to the expeditious and timely delivery of the necessary materials to the work place.

### 11.3.1 Motivation for good housekeeping

The housekeeping check list, Appendix A, can be used to evaluate the level of site housekeeping. The evaluation is done on a zero defect basis with a score of zero for what is right ('yes' column), one for what is partly right ('part' column), and two for what is wrong ('no' column). Site management can thus monitor housekeeping levels, and strive for improvement. Improvement can also be motivated by introducing an intersector and inter-site house-keeping competition with prizes.

## 11.4 Work Simplification and Methods Improvement

The construction industry differs from the manufacturing sector in that every contract is unique with regard to location, design, and to some extent, methods of construction. It also differs since it is man-driven and not machine-driven, as is the case in highly mechanized industries. This uniqueness provides a challenge to the contractor to be innovative in his use of materials and work methods - with the accent on work simplification and materials handling.

Methods improvement must be a constant challenge to supervision and management. To improve methods involves analyzing the operation, questioning current practices, and hence devising revised procedures which will permit the work to be completed in fewer operations, in less time, and at reduced cost without adversely affecting quality.

Basic questions to be asked in the course of work simplification are :

- Can the operation be eliminated? (The simplest way to solve a problem)
- Can it be combined?
- Can the sequence be changed?
- Can activities be simplified?
- Can they be mechanized?
- Can jigs or fixtures simplify the work?

The foreman should be educated and encouraged to simplify the tasks he is responsible for. He should constantly strive to reduce the labour content in site operations.

It is appreciated that methods improvement - work simplification - involves innovation and creativity. The latter cannot be learned by rote, and a high level of effectiveness requires an innate talent. It can, however, be taught within certain limitations.

Ideally, a specialist member of staff should be appointed to conduct this work, and site personnel should be made aware of the need of simplification.

In all circumstances, however, it is essential that the foreman be involved both at the analytical as well at the creative stages of the work. He should be encouraged to provide as much input as possible, and to develop a commitment to change, and assist in the implementation of 'his' ideas. Experience has shown that to simplify the tasks effectively, the foreman should have sound technical knowledge. A technically competent foreman is better equipped to understand the need for and the possibilities of simplifying the work in his charge.

## 11.5 Site Observations

Of the sites investigated none could produce a current detailed site plan showing space allocation for materials storage nor site transport routes. Batching plants and mortar mixing stations were found to be far from the working sites where the materials would be needed.

No advantage was taken of differences in ground levels to permit gravity loading of wheelbarrows and dumper trucks.

Generally there appeared to be little awareness at site and management levels of the importance of simplifying handling and reducing costs.

Numerous examples were observed of workers engaged in unproductive work or using unproductive methods, in full view of foremen, engineers and site management. The following are but a few glaring examples observed during the course of site visits.

- Workers using 25mm and 100mm wide brushes to apply waterproof paint to 3m x 5m concrete panels. This work could have been speeded up by using 300mm wide rollers.

- Shutters not being hosed down after a concrete pour. The result is that spilt concrete sets on the outside of the shuttering - especially on clamps, ferrules and wedges. The stripping operation consequently necessitates chiselling and chipping. This results in damage to the equipment, additional costly labour, and delay in the construction process.

- Cleaning steel shutter panels by scraping them with clamps, thereby slowing the cleaning operation and causing irreparable damage to the panel face. This cleaning operation could have been done more effectively and quickly with broadfaced scrapers.

- Wheelbarrow pushers queuing at concrete and mortar loading stations. This could have been avoided by providing additional wheelbarrows which could have been filled while the full barrows were being pushed to where the concrete was needed.

- Excavating foundations in the wrong sequence by starting on the outside, results in extra work when removing the earth from the inside trenches. Also, not loading excavated material directly into barrows leads to double handling.

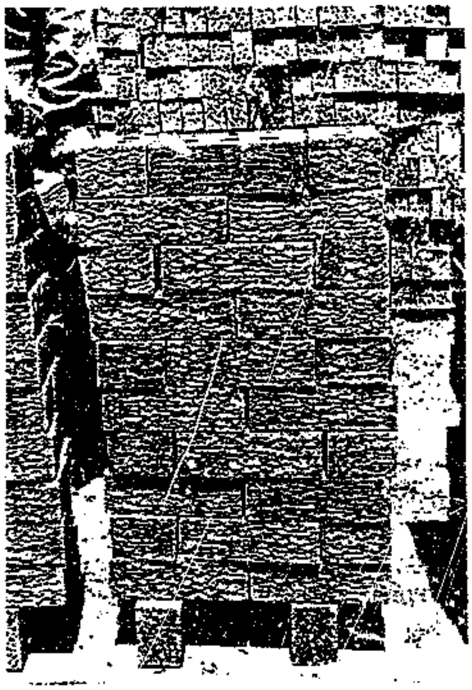
- Inefficient placing of concrete in columns. The common procedure is to build a platform/s (depending on the height of the column) and then to lift the concrete by the shovel load in stages, to the top of the column. This is labour intensive and time consuming. The alternative is to use a wheel mounted bucket lift which is readily portable. The buckets can be filled directly from a barrow and drawn to the top where the concrete is tipped into the column. This procedure is labour saving and will reduce concrete wastage which is inevitable when it is transferred by shovel and stored temporarily in different locations.

- Wasteful use of labour in supplying concrete to a ring beam. Concrete was delivered by wheelbarrow and dumped at the lower end of an inclined bucket conveyor. Two labourers were employed in shovelling the concrete into the bucket. Acting on the writer's suggestion, a small one metre high ramp was built so that the barrows could be discharged directly into the bucket of the conveyor. This permitted the transfer of the two labourers to more productive work, eliminated one handling operation, and the waste of concrete which invariably remains when it is dumped on bare ground.

## 11.6 Innovative Work Simplification and Materials Handling

The challenges in introducing and managing innovation are indeed considerable; and they are discussed by T L Webb in his papers "Barriers to Innovation in Building and Construction" (1981) and "The Management of Innovative Building Technology" (1988).

An economical and practical form of applied research and development is through experimentation on a limited budget. In practice it involves identifying an area of concern and then experimenting with alternative proposed solutions without affecting



Brick Stack

Loading Operation

Advantages: - The stack, once made, does not require any further handling.
- Can be placed in suitable position for bricklayer without further restacking.
- Stacks, and part stacks, can be removed to new locations.
- Trolley has double the capacity of a builder's wheelbarrow.

Transport

FIGURE 11.1 BRICK STACK CONFIGURATION, LOADING AND TRANSPORT, BY SPECIALLY DESIGNE' 'ICK HANDLING TROLLEY the construction process. Once an improvement has been achieved then the new process or technique may be applied in practice.

This methodology was used during the course of this research and the following are some of the innovations which were developed and applied on two of the construction sites which were investigated.

### 11.6.1 Brick Handling

The common practice for transporting bricks from the stockpile to the bricklaying site was to use the standard builder's wheelbarrow which can contain approximately 25 standard size bricks. The bricks are loaded (often thrown) individually into the barrow and then offloaded (often dumped) and stacked for the bricklayer. Breakages occur during this handling procedure, and facebricks in particular, are susceptible to chipping. This wastage is costly and was measured to be in excess of 5%.

A trolley was designed to reduce the handling and attendant damage to the bricks. It is shown in Figure 11.1, and is capable of handling a stack of up to 50 bricks.

The following is a description of the brick stack and the attendant advantages provided by the trolley.

The stack is built on two supporting bricks. This permits the insertion of the trolley forks under the stack. The only manual operation involved is in building the stack as shown in figure 11.1. Thereafter the stack is picked up by means of the trolley, the two supporting bricks placed on top of the stack, which is then transported and placed in a handy position for the brick layer. The stack, or part of the stack which may not have been used, can be picked up again without any further manual brick handling and relocated where required. The two top bricks are then again used to support the brick stack in its new location.

Advantages:

- The trolley can easily be pushed onto a hoist platform to lift the brick load to a higher floor in a multistorey structure.
- Handling the bricks once only and transporting them in bulk eliminates breakage and chipping.
- The trolley is fitted with pneumatic tyres which facilitates traversing rough terrain.
- Maintenance on the trolley is minimal, and limited to tyre wear.

Test results showed a minimum saving of 3% on brick breakage and 40% in labour handling cost. The latter cost saving will, of course, vary with the distance of the work from the stock pile; because of the greater carrying capacity of the trolley vis-a-vis a wheelbarrow.

### 11.6.2 Hollow cement block handling

Hollow cement blocks are not very resistant to impact and site breakages run well in excess of 10%. This percentage far exceeds the average contract's profit margin.

Such blocks were incorporated in the floor slab design on one of the contracts surveyed. Past handling practice involved off loading them manually from the delivery truck and relocated where required. The two top bricks are then again used to support the brick stack in its new location.

Advantages.

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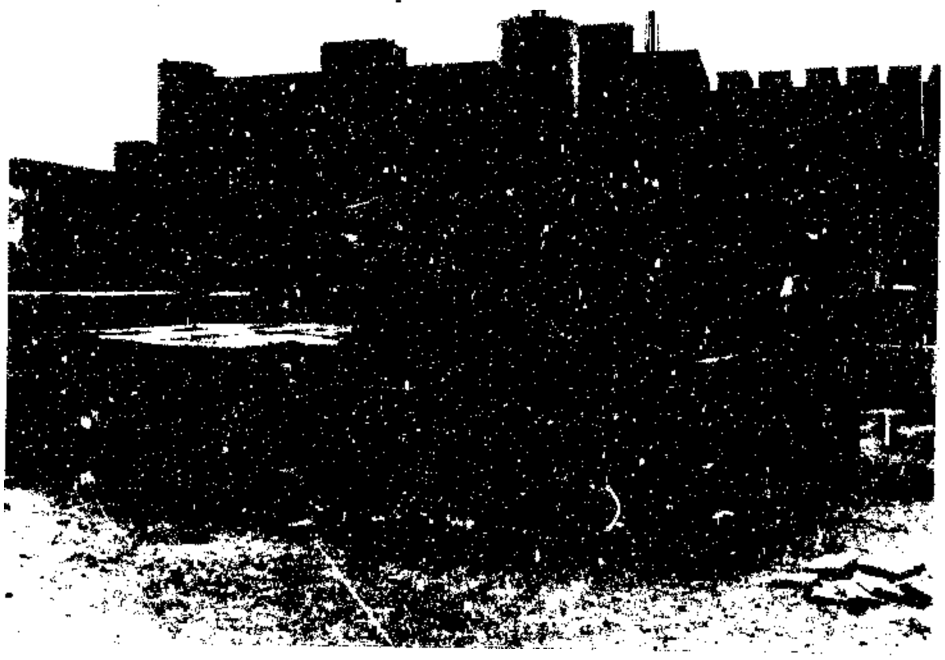


FIGURE 11.2 HOLLOW BRICK STACK WITH JOISTS IN POSITION

stacking them. As and when required, the blocks were loaded onto pallets, lifted by crane onto the floor slab and then manually set out one at a time and lined up as part of the slab construction. It can be appreciated that this handling procedure involved considerable labour, time, breakage and resultant cost.

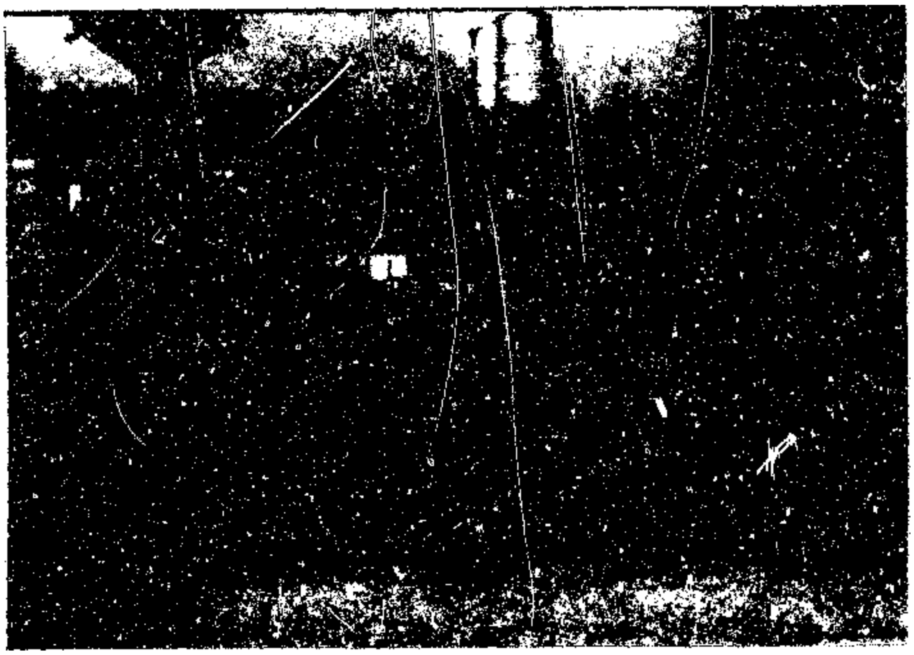
The following innovative procedure was introduced.

- The hollow core of the blocks provided the possibility for handling of up to 20 blocks at a time. This was done by threading a joist through the hollow core, and lifting the blocks by means of a spreader bar attached to a crane.

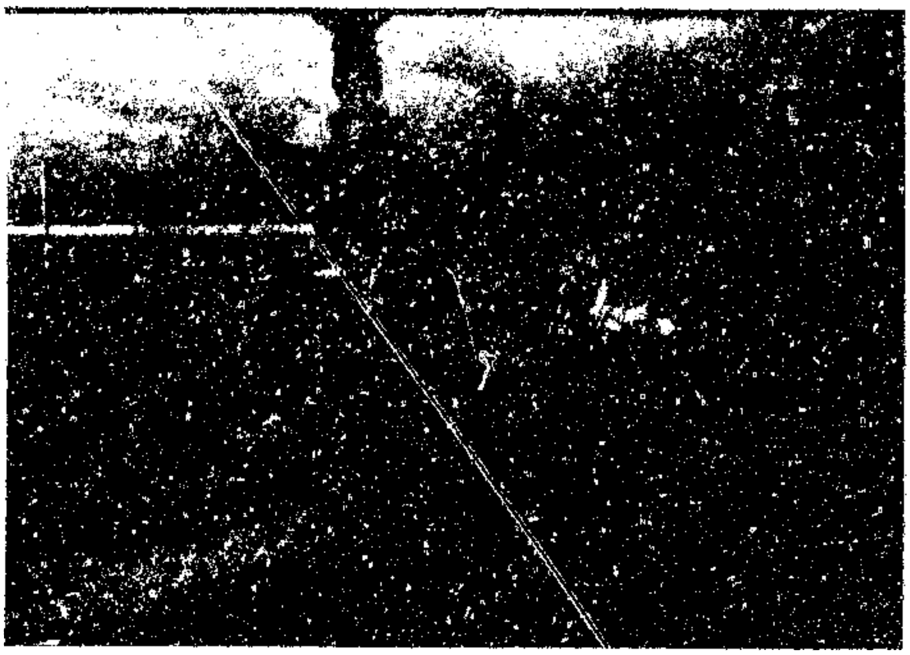
- End plates were designed which fitted over the ends of the joists, and the pitch of the joists in the end plate conformed to the designed spacing of the blocks on the slab. In this way it was possible to place the blocks on the slab simultaneously and avoid individual handling and breakage.

- Arrangements were made with the block suppliers to stack the blocks on their delivery vehicles to permit this method of handling. Figure 11.2 shows a site stack with joists in position and minimal breakage. In the top right background can be seen several rows of blocks which formed part of the cored floor slab.

- This innovation reduced the allowed handling cost for hollow concrete blocks on this site by R27 000 and more than justified the investment in joists, end plates and spreader bar.



TURNTABLE BEING ROTATED



KIBBLE BEING LIFTED

FIGURE 11.3 TURNTABLE USED FOR LOADING CONCRETE INTO KIBBLES

### 11.6.3 Improving crane utilization

One of the contracts surveyed involved the placing of large volumes of concrete. Calculations based on concrete loading times of the kibbles to be used, and the crane cycle times, showed that two cranes would be required, but would not be fully utilized because of the time delay in loading the kibbles from the mixer. Thought was therefore given to reducing the loading and crane cycle time so that one crane would be sufficient to do the job.

A turntable was designed and installed at the concrete mixer delivery end as shown in figure 11.3. The empty kibble was deposited on one end of the turntable, and the full one was picked up from the other end. The turntable was then moved through 180 degrees and the empty kibble filled from the mixer while the crane was transporting the full kibble. This eliminated the crane waiting time for kibble loading and improved the batching plant cycle time.

### 11.6.4 Innovative plant adaptation

Bricks were delivered to one of the contracts on pallets. The site terrain was rough and sloping, and the established method of brick transportation by wheelbarrow was proving to be excessively costly in labour, time and breakages.

The fact that the standard dumper truck has a lift and tilt facility, albeit limited, stimulated the thought that the container might be removed and the dumper converted so that it could handle palletized loads of material. The resultant vehicle is shown in Figure 11.4.

This vehicle proved to be very versatile. It had the unique advantages of having a low

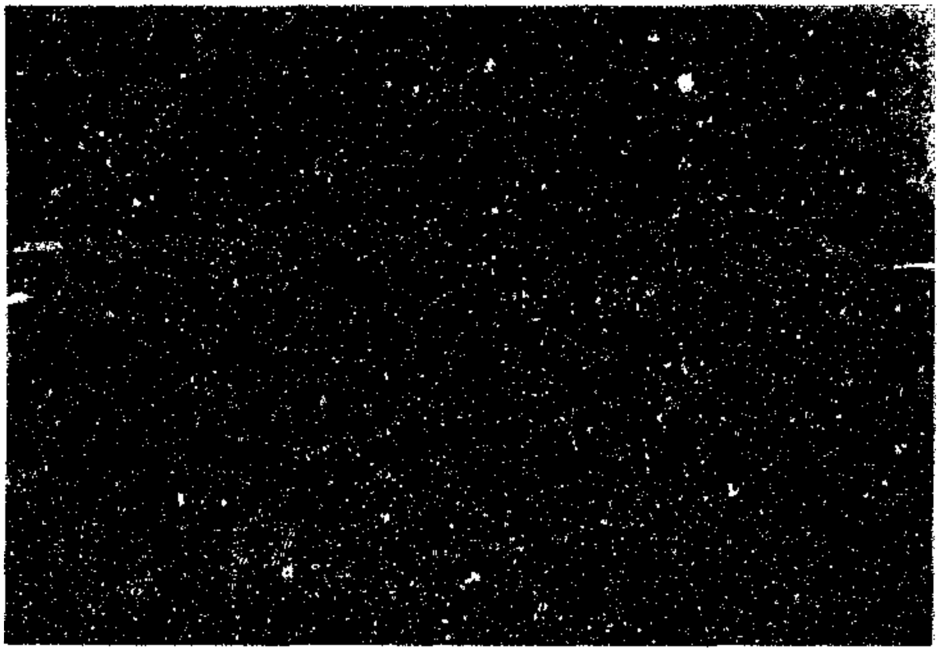


FIGURE 11.4 CONVERTED DUMPER TRUCK TRANSPORTING BRICK STACK

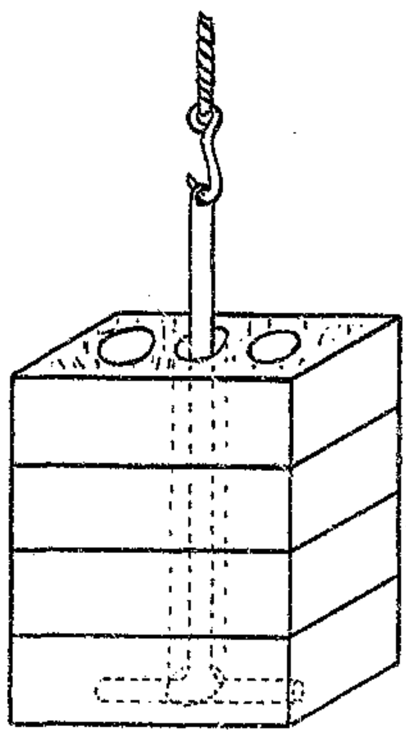


FIGURE 11.5 "T" BAR FOR LIFTING HOLLOW BRICKS

profile, being able to travel cross country, and it served the following purposes:

- Transportation of palletized loads of bricks, stacked trays of mortar, and drums containing small items of equipment.

- It was fitted with a towbolt to pro ide a tow facility for a trailer on which were transported scaffolding, reinforcing steel and equipment.

The economies resulting from its use which permitted the bulk handling of a variety of materials, and ... ed breakage and spillage, far exceeded the cost of modification which was considered to be a capital investment.

### 11.6.5 A 'Third World' innovation

The old established ... of throwing bricks up to a higher floor in the absence of a hoist or ramp ... ch part of the South African building scene, that it seldom commands any notice. Brief observation of this practice immediately reveals that it is dangerous, fatiguing, and costly.

Many of the bricks in current use have hollow cores. This prompted the design of a simple inverted 'T' bar which can be used to lift a number of bricks to any required height by means of a rope and pulley system. The application of the method is shown in Figure 11.5.

### 11.6.6 Transport and storage bins

None of the sites visited had suitable and sufficient storage bins for small but costly items such as clamps, wedges and connectors. This provided a security risk, and

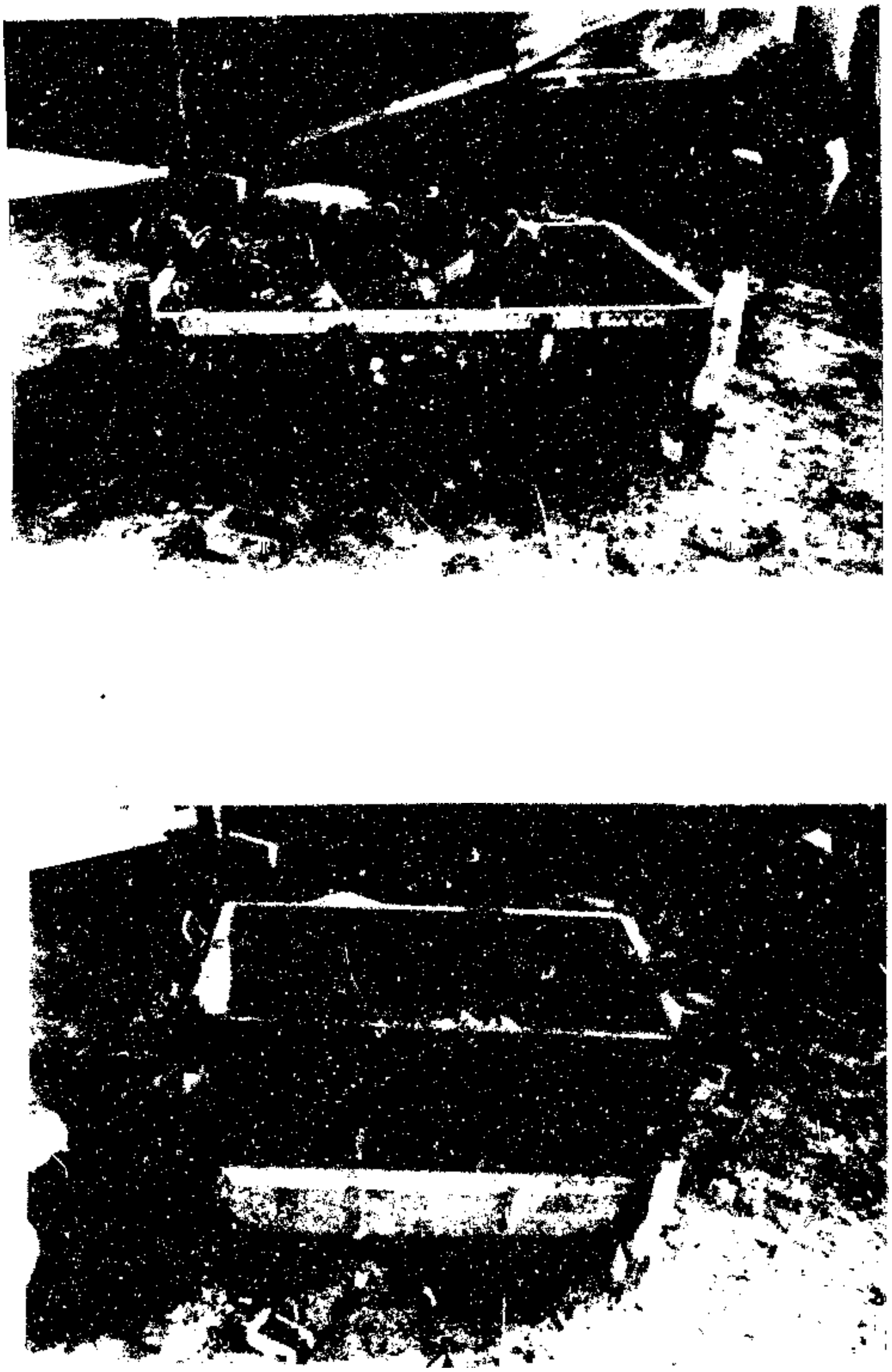


FIGURE 11.6 STORAGE BINS WITH VERTICAL STACKING FACILITY

resulted in costly losses of equipment during the assembly and dismantling of shuttering.

This equipment is usually stored in empty oil drums or half drums cut across their width. The drums which were seen on sites are difficult to transport, and the materials stored in them are not easily accessible because of the container's depth.

Figure 11.6 shows a storage bin made from an empty oil drum, which is far more functional than the half drum commonly found on sites. Materials stored in these containers are readily accessible, and the containers can be stacked one on top of the other to provide economic storage and transportation.

Scrap angle iron was used to line and reinforce the top edges and corners. Construction of these bins involved approximately two hours welding time per bin.

### 11.6.7 Transport trolleys, storage and transport fixtures

Workers were often seen carrying single items of equipment such as a scaffold pole, a scaffold plank (usually by two people), a trestle, or a bunch of clamps tied together with wire.

The introduction of wheeled platforms facilitated the transportation of bulk loads of support material, cement and reinforcing.

The platforms had two rear wheels and front supporting legs. The front end was fitted with the female portion of a tow bolt. A tow bar fitted with the male portion of the tow bolt, and swivelling wheels, was used to lift the front portion of the platform and get it mobile and steer it.

Special bulk storage and racks were designed for steel shuttering and support materials. These are shown in figure 11.7. It will be noted that the shutter plates are stored on end and face to face. This storage method makes for easy retrieval, and safeguards the shutter face from damage. These racks can be lifted by crane and transported by the converted dumper truck.

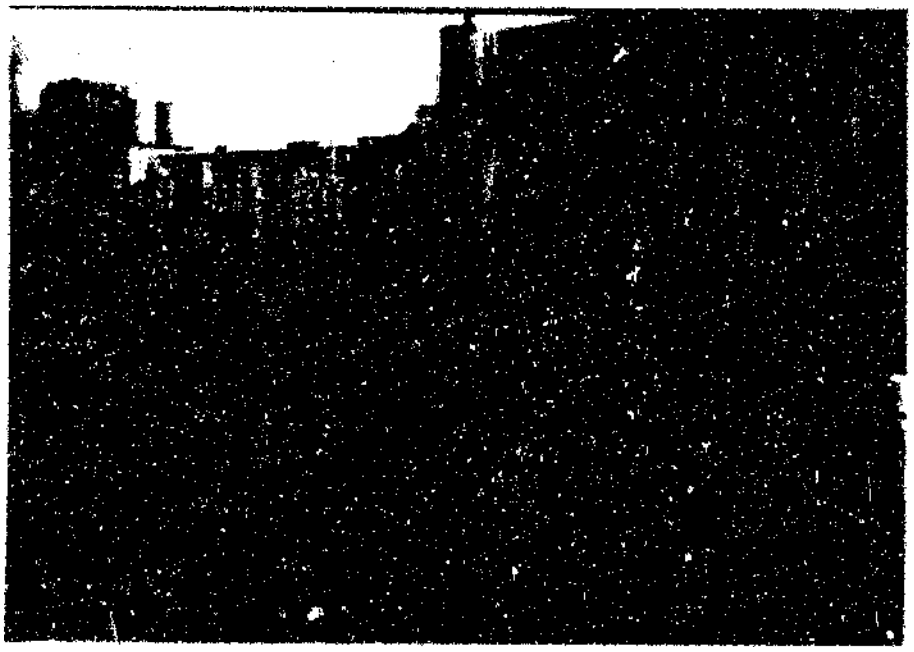


FIGURE 11.7 EQUIPMENT STORAGE AND TRANSPORT FIXTURES

## 11.7 Conclusions

Materials handling is a major cost factor in the construction process. It is therefore incumbent upon management and supervision to reduce this cost as far as is possible. This can be achieved through improved planning of the site lay-out and the location of essential services and materials.

Work simplification and methods improvement are important factors in improved materials handling practices; and site managements should be encouraged to develop the necessary skills in this area of operation.

The potential for reducing cost by viewing the construction process as a materials handling exercise is, indeed, considerable. It therefore behoves the industry to research and improve materials handling methods.

The necessary research could be initiated at a conference under the auspices of the CSIR or the South African Institute of Building, with the participation of all interested parties - particularly the contractors' associations and the universities and technikons. Such an occasion will provide the opportunity to define the scope and terms of reference of the necessary research. The different areas of research could then be allocated to the relevant universities that teach building science. This research would be valuable in engendering a sense of awareness at both undergraduate and graduate level regarding the importance of materials handling, and provide the construction industry with valuable developments in this field.

# CHAPTER 12

## VARIOUS IDENTIFIED PRODUCTIVITY LOSSES

### SYNOPSIS

The holistic approach encompasses the reduction and elimination, if possible, of all resource losses.

Various examples of and reasons for the loss of productivity were identified during the course of the research. These losses included those caused by late starts and early finishes; month end absenteeism following the monthly payment of wages; avoidable overtime; and the wastage of unidentified skills. Other losses concerned the non working supervisor, and the adversarial relationship which often exists between the contractor and consultant/architect. Since these all contribute to deficient resource utilization, it is important that they be minimized in accordance with the proposed holistic approach to improved productivity.

This chapter discusses these losses. The time losses were quantified, and economic solutions were developed to reduce the time lost, and hence improve production and productivity. The solutions developed and implemented to overcome these losses are described, as are the results obtained.

## 12.1 Lost Time

### 12.1.1 Late starts; early finishes

An opinion survey conducted amongst supervisors in one of the construction companies investigated, and confirmed by site observations, indicated that late starts and early finishes accounted for approximately 11% of working time. This translated into an effective excess labour cost of R1.4 million per annum, which exceeded the net profit of the company concerned.

The incidence of late starts and early finishes is not unique to the company surveyed. Similar practices were observed in other companies, though not evaluated.

Some solutions for reducing this lost time were proposed during the course of the cybernetic discussion sessions described in Chapter 14 and implemented on some contracts with a consequent improvement in the situation.

The solutions proposed and implemented included the following :

- Stricter control by supervision regarding starting and stopping times. This was assisted by sounding a warning five minutes before starting time.

- Strict control by supervision on absenteeism during working hours : especially on large urban sites. Workers often leave the worksite to do shopping or wander off the site.

- Extending the morning tea break to twenty minutes, and reducing the lunch break to twenty minutes. The morning tea break is in practice, breakfast, when

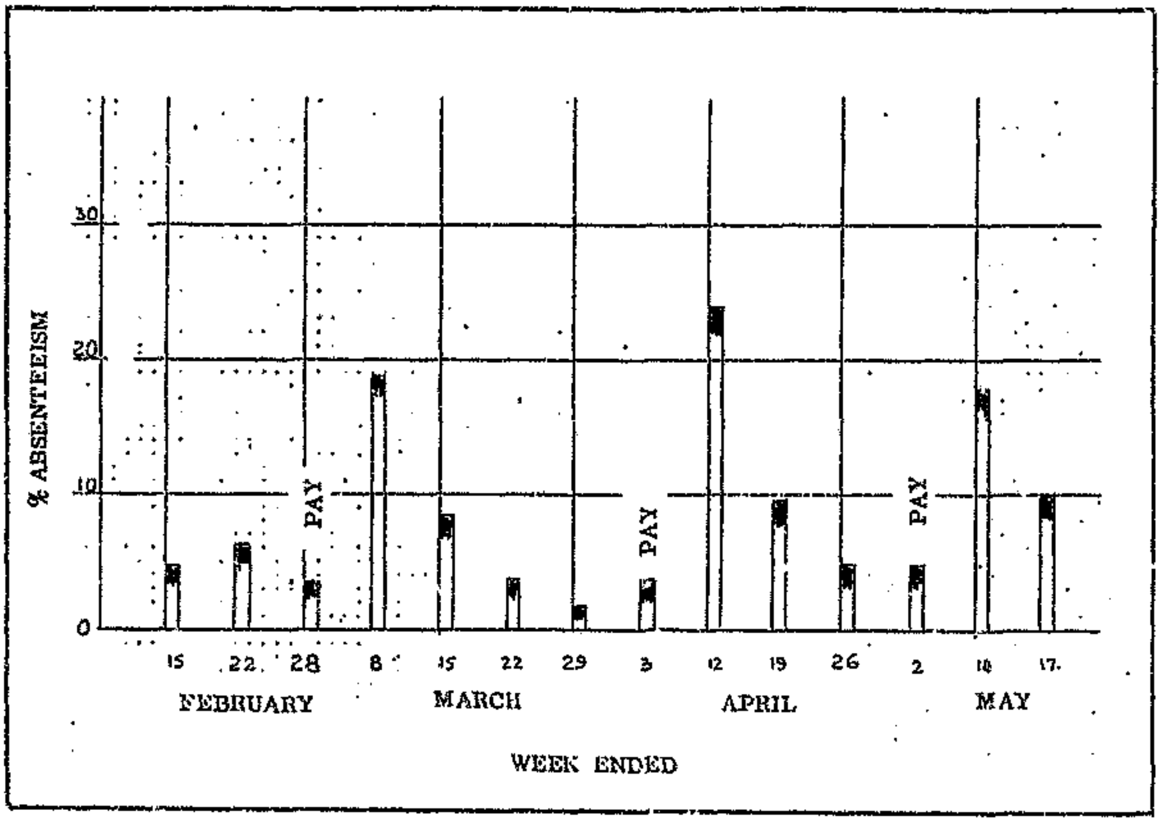



**FIGURE 12.1 WEEKLY ABSENTEE RECORD**

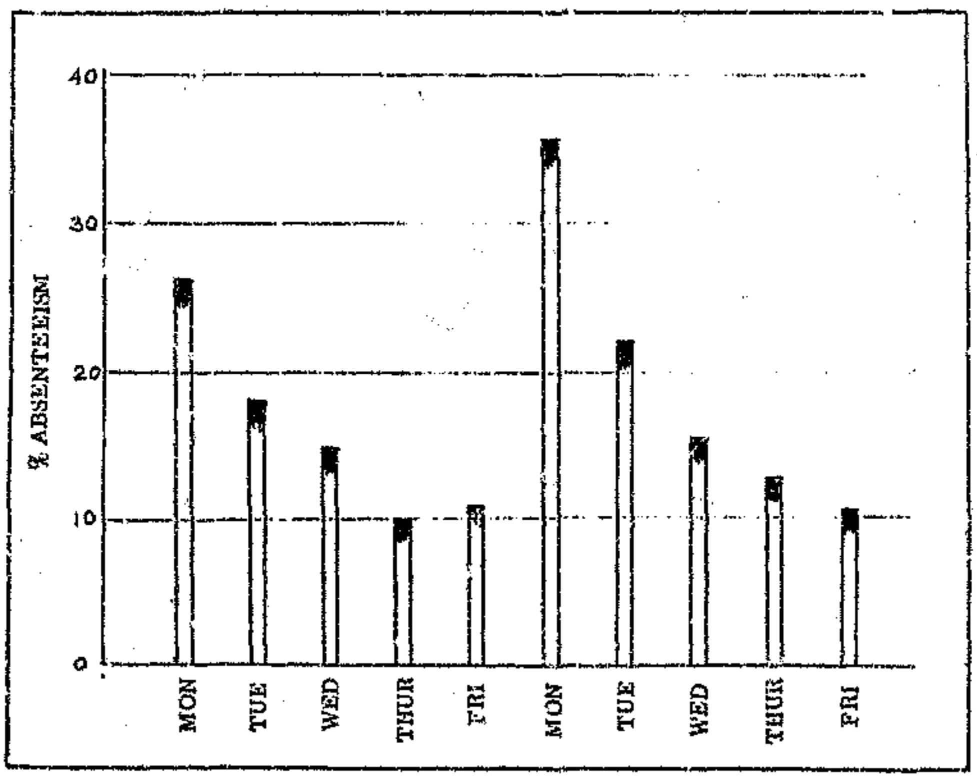



**FIGURE 12.2 DAILY ABSENTEE RECORD FOLLOWING PAY WEEKEND AVERAGE MID-MONTH ABSENTEE RATE ± 3%**

some workers cook a meal because they leave home without having eaten.

- Preparing materials at work places late in the afternoon in readiness for an immediate start the next morning. This particularly applies to artisan's requirements.

- Staggering the mortar mixing team's working time so that they start half an hour earlier and stop half an hour earlier. This will permit brick layers to start work timeously. The same principle should apply to concrete mixing and the supply of 'Readymix' concrete to ensure that the concrete placing teams do not stand idle at start up time.

### 12.1.2 Month end absenteeism

Three of the companies surveyed paid their hourly employed workers monthly. Most of these workers lived away from their permanent homes in the rural areas, and were provided with hostel accommodation by their employers.

The monthly pay-out in contract A was made on a Thursday, and the site was closed down until the following Monday. This long weekend afforded the employees - particularly those who were married - the opportunity to return home to their families with their earnings. Many of the unmarried workers remained in the hostels.

The rate of absenteeism during the week following pay-day was approximately 20% (refer to Figure 12.1). Absenteeism on the Monday was exceptionally high being at times in excess of 30% (refer to 12.2). Many of the absentees were employed in critical activities such as batching plant operations and shuttering. In practice therefore the site seldom resumed full production before the Wednesday following the pay weekend. Thus

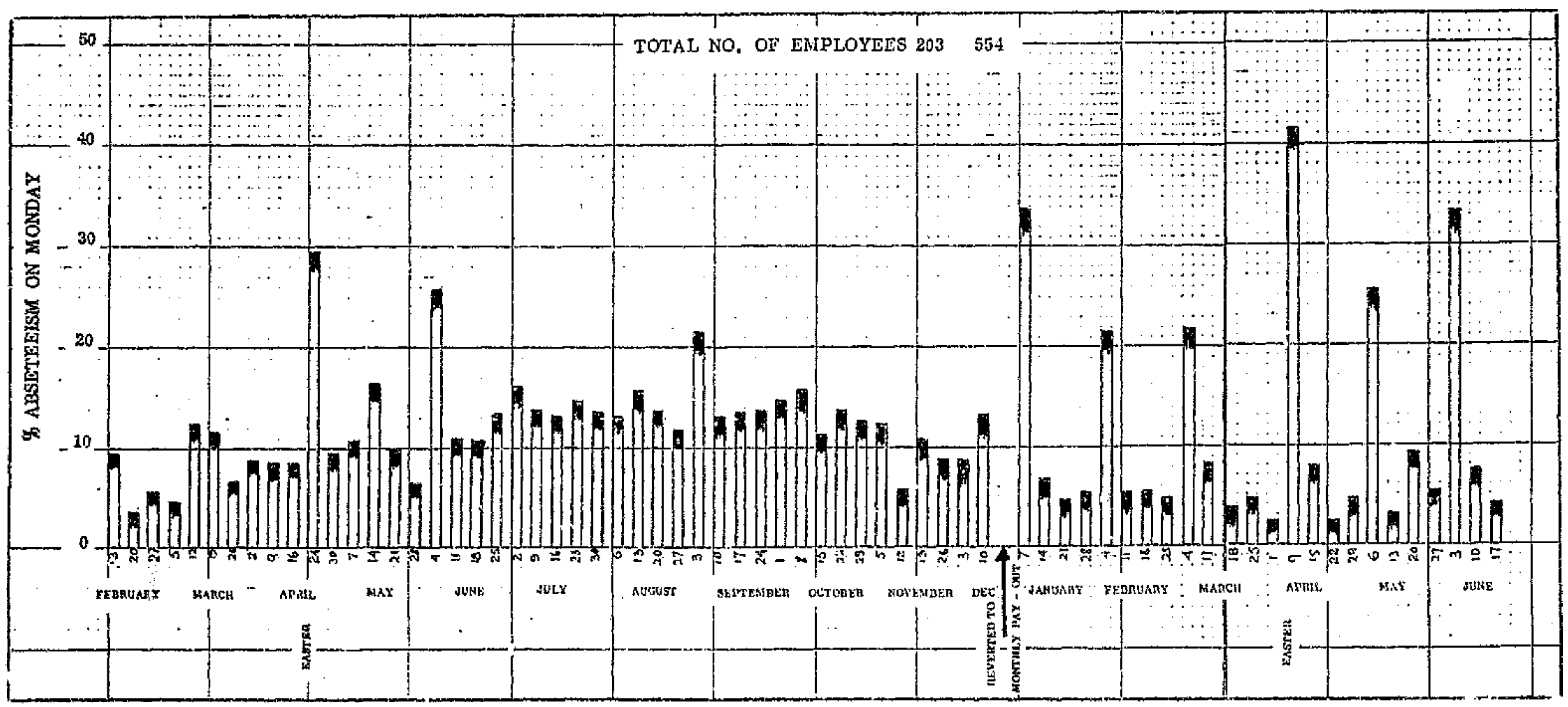



**FIGURE 12.3 PERCENTAGE ABSENTEEISM ON MONDAY**

three production days were lost per month.

Many of the sites worked a 07h00 to 14h00 shift on a Saturday. Therefore, if a 26 working day month is considered then the three days' loss of production represented 11.5% of total available working time. This meant a delay of 11.5% in contract completion time with a resultant loss to the owners in beneficial occupation. It also meant additional costs in site overheads, i.e., Preliminary and General cost (P&G), as well as the hire costs of plant and equipment during the non-productive site time.

P & G costs amounted to approximately 10% of contract value.

Contract B included both Civil and conventional building work. The total number of employees varied between 203 and 554, depending on the construction stage of the contract.

The monthly pay-out was made on the last Friday morning of the calendar month. Friday for all practical purposes was thus not a productive working day. The following Monday, as can be seen from Figure 12.3, showed an absentee peak of over 30 % compared with an average of less than 10% for the interim Mondays.

#### 12.1.2.1 Staggered pay days

In an effort to reduce the month end production time lost, the practice of staggered pay was introduced. This involved different groups of employees getting their month's pay on different days of the month. It has been proved that if the number of employees receiving their pay at any one time is relatively small, then the absentee rate is also very low.

Method

It was recommended that the employees be divided into eight pay groups, so that there would be two pay-outs per week during the course of the month. At the time of this recommendation the site layout complement was approximately 60. In these circumstances it was agreed to limit the pay groups to four and the weekly pay-outs to one. This now meant that even with a 50% absentee rate on the Monday following pay Friday, amongst those who received pay, the total site absenteeism was limited to 12.5%. This was a level at which the site could maintain production, providing critical activities such as concrete mixing and placement were catered for.

In the third and fourth month following the introduction of staggered pay the Monday absentee rate was as follows :

| Week Commencing | MONDAY | Percentage Absenteeism |
|---|---|---|
| WEEK NO. | | |
| August | 1 | 1.6 |
| | 2 | 13.1 |
| | 3 | 11.5 |
| | 4 | 5.2 |
| | 5 | 6.9 |
| September | 1 | 5.4 |
| | 2 | 9.0 |
| | 3 | 5.7 |
| | 4 | 10.0 |
| October | 1 | 9.7 |

It is noteworthy that the month-end absenteeism peaks following the pay week end are considerably reduced from almost 40% to 7% and 10%.

Deducting the average daily mid-month absentee rate of approximately 3%, shows that the absentee rate following the pay week end has only increased by from 2 to 10%.

It was found that the pay-out, because of the relatively small numbers, was of short duration, and did not therefore disrupt production. Employees preferred the procedure because of the added security against robbery which the interim pay-outs provided, and the limited demand on off-site transport facilities which workers used to return to their homes. The pay office administrative load was also spread more evenly throughout the month.

A year later the site discontinued the staggered pay practice. The reason prompting the decision was that the sub-contract labour, which at this stage of the contract had increased appreciably, was being paid monthly and leaving the site on pay-day. This had an unsettling effect on the main contractor's labour, and it was therefore decided to revert to one payment per month for all employees. The Monday absentee rate then increased to over 30%. The early Friday stoppage (pay-out at 11h00) and Monday absentee rate once more resulted in a minimum of two days' lost production per month. The discontinuation was thus economically unjustified and could have been avoided by firmer management.

**Conclusions**

The annual turnover of the three companies concerned, amounted to R292 million. The elimination of the production time loss resulting from absenteeism (3 days per month out of 26), would permit these companies to increase their turnover by 11.5%, representing an additional R 33 580 000 of construction value. To this must be added the earlier beneficial occupation by the owners, and hence a saving on capital charges and an earlier return on capital invested.

The conclusions to be drawn are that :

- staggered pay days can help to maintain uninterrupted production.
- The greater the number of employees, the greater must be the number of pay groups.
- The pay groups must be constituted in such a way as to ensure the continuity of critical operations such as batching plant, cranage, brick handling, etc.

## 12.2 Waste Resulting from Scheduled Overtime

Ineffective planning, excessive down time, and poor manpower utilization contribute to contracts falling behind the programmed completion schedules. Late completion often involves penalties payable by the contractor.

In order to make up for lost time, site management will often schedule overtime. This practice is usually counter-productive. The Business Roundtable in their summary Report (1983 : p. 22) state : *"in terms of efficiency, it (overtime) is enormously counterproductive. It is also a frightful waste of the owner's money, and from the stand point of the industry as a whole, it usually amounts to irresponsible behaviour."*

A U.S. Labour Department Study, quoted in the above report, concludes that :

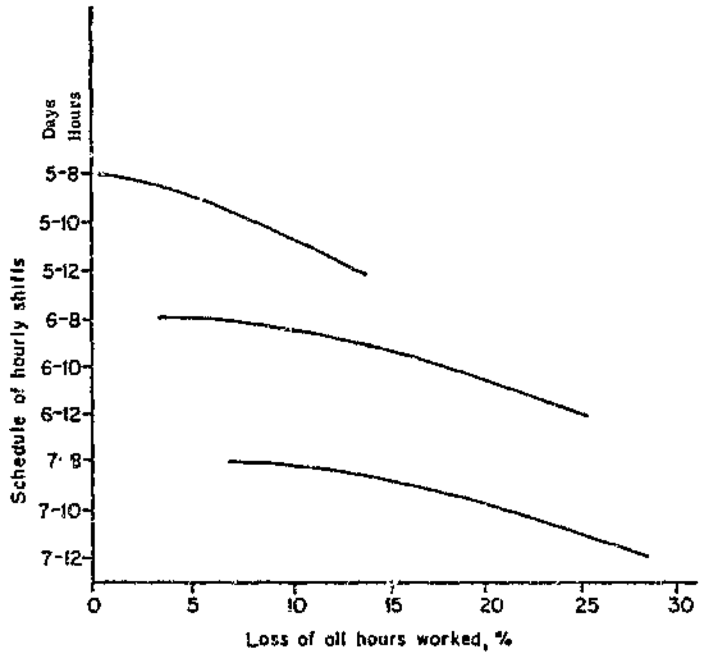



**FIGURE 12.4 OVERTIME VS PRODUCTIVITY**

(Data compiled from NECA summary, MCAA studies, statistics from U.S. Department of Labor Bulletin, no. 917 and other similar data.)

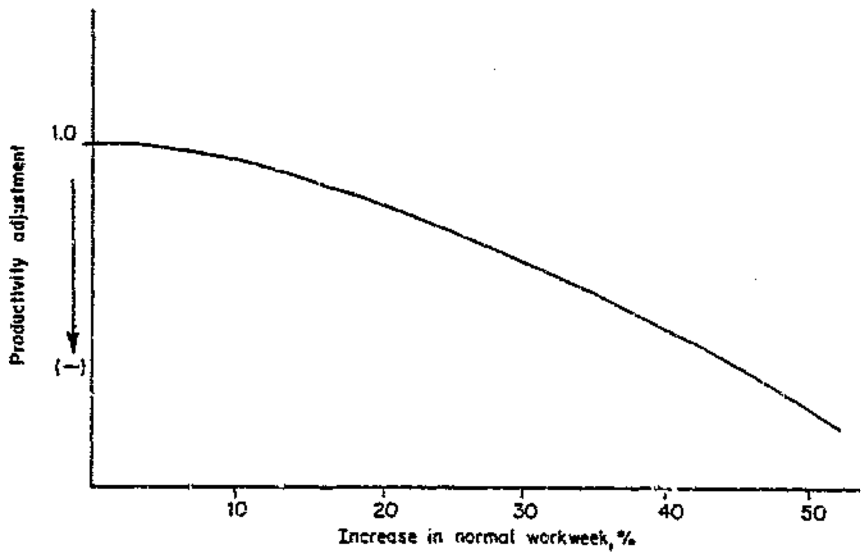



**FIGURE 12.5 OVERTIME VS PRODUCTIVITY PERFORMANCE**

- *The longer the hours the more scheduled (normal) work time is lost to absenteeism.*

- *As hours increase, so do injuries - not only in absolute numbers but also per hour of work.*

- *On a sustained basis, after a workman has completed eight hours of work a day and 48 hours per week, it usually takes an additional three hours of work to produce an additional normal two hours of output, provided the work is light. If the work is heavy, it takes two hours of extra work to do a normal hour of work.*

### 12.2.1 Loss of time due to overtime

The foregoing is supported by statistics from the U.S. Department of Labour.

Figure 12.4 illustrates the loss of productivity as both the numbers of hours, and the number of days worked per week, increase.

This same loss is shown in Figure 12.5 but here the loss is expressed as an adjustment factor to productivity performance during normal work hours. It will be seen that this adjustment factor which is negative, indicates reduced productivity with increases in the length of the normal work week.

There is little reason to suppose that South African labour output is more efficient during overtime work than that in the U.S.A.

Construction is, indeed, heavy work. If it takes two extra hours to do one hour of normal work, and overtime work is paid at one and one-third of normal time, then the overtime cost of completing the equivalent of one hour's normal production is in the ratio of 2.7:1.

According to the Central Statistical Services, the overtime worked in the construction industry amounted to 8.2% in 1985 and 7.3% in 1986. Taking the lower of the two figures, and multiplying that by the differential cost related to productivity and normal time (2.667), the additional cost of overtime amounted to 19.5%.

The labour component is acknowledged to be approximately 30% of total construction cost.

Thus scheduled overtime, which is usually avoidable, added approximately 6% to national construction costs in 1985 and 1986. The additional cost has been paid by the end user, and has added grist to the inflation mill.

### 12.2.2 Multi-shift work

If a contract is to be accelerated then consideration should be given to working two shifts per day : 06h00 to 14h00 and 14h00 to 22h00. This concept was introduced on a tunnelling contract that was investigated in the course of this research.

It was noted that the multi-shift operation demanded stricter planning disciplines and tighter scheduling of materials and resources, as well as additional first line supervision. The latter, however, was economically justified.

The operation, however, yielded the following benefits :

EMPLOYMENT RECORD

NAME: ______________________ I.D. NO. [ ] COMPANY NO [ ]

| SITE | FROM / TO | ACTIVITY | GRADE* | DATE | REMARKS | R/HR |
|---|---|---|---|---|---|---|
| | | | | | | |

*GRADE - MONTHLY ASSESSMENT 0 - NOT EMPLOYABLE 1 SATISFACTORY + GOOD/VERY GOOD

**FIGURE 12.6 EMPLOYMENT RECORD**

- Better return on fixed costs such as site establishment and management.
- Better utilization of plant and equipment : doubling the time usage for the same hire charges.
- Earlier completion of contract : thus establishing potential for increased turnover.
- Earlier beneficial usage for owner.
- No necessity for overtime work.

## 12.3 Skills Wastage due to Employee Transfers

Skills that have been acquired by general workers are often wasted when they are transferred to new contracts or re-employed after a break in their employment. The difficulty in communications because site management cannot speak the ethnic language involved, can and does result in the worker being employed in a capacity where he cannot practice his acquired industrial skills, and is thus under-employed.

In order to avoid this situation an employment record card was designed and introduced, at company level, as shown in Fig. 12.6. The card contains the worker's name, identity number and company number. Place is provided for recording the site on which he has been employed; the period of employment; and the activity in which he was employed. The grade column provides for the monthly assessment by site management of the worker's value to the company. The remarks column is used to record details of the worker's training and qualifications. His hourly rate of pay is recorded in the last column. The record card is kept on the site, and sent to the next site when the worker is transferred. The record thus provides information to the new site's management which will assist them to employ the worker productively.

Should the worker have been dismissed or left the company of his own accord, then the card was sent to the central personnel office where it was filed in employee number order. This record was backed up by a computer file record.

The introduction of the employment record proved to be practical and useful in employing and promoting employee skills and experience.

## 12.4 The White Supervisory Syndrome

The South African social and industrial culture has spawned a practice wherein the most important qualification for appointment to a supervising post is the possession of a white skin. Furthermore, the position of supervisor as exercised on sites in the RSA invariably involves the issuing of instructions and observing of operations; but doing little if any physically productive work.

This is in contrast to the practice in first world countries where the foreman - except for the general foreman who is equivalent to the South African site agent - is productively and physically involved in the construction process, assisting and working with his crew.

A particularly bad aspect of the local non-working supervisor practice is that it is now being extended to black first level supervisors, i.e. team Leaders, who are copying the industrial behaviour of their white mentors.

The resultant loss of productivity is readily illustrated and quantified in the following example of a 'non-working' supervisor in charge of a team of six workers.

The first line supervisor is usually promoted because of his depth of experience, technical competence, and physically productive capacity. In terms of production potential and capability, this supervisor can often produce twice as much as the average worker in the team. Thus the potential productive capacity of the team, including the supervisor, is at least seven man units. With the supervisor not working the team is reduced to six man units. Hence the practice of using a non-working supervisor results in the loss of at least 15% of the team's productive capacity.

A further manifestation of this syndrome is the practice of truck drivers sitting inactive in the truck cab while their crew are loading and off-loading. This results in the need for an additional truck crew member and unnecessary increases in transportation costs.

The concept of a non-working supervisor, has other negative effects in the black cultural environment. The black culture traditionally tends towards an egalitarian society without the numerous social stratifications which exist in white society. In the physical work situation all are considered equal. In these circumstances it is difficult, if not impossible, for the non-working supervisor to encourage or exhort his team to greater productive effort. The team attitude is: 'if he doesn't work, why should we?' The foregoing is reinforced by the comment of a black non-working supervisor when asked by a white foreman why he was not pulling up the slackers in his team. ' When I go back to the hostel tonight they will kill me'.

The most conservative estimate indicates that direct labour could be reduced by 10% by eliminating the non working first line supervisor. The foregoing are some observed examples of the losses that occur as a result of lost time, overtime, and the under-utilization of people resources. Their cumulative effect in reducing productivity is, indeed, substantial, and it behoves the industry to pay urgent attention to the elimination of the practices concerned.

## 12.5 Construction Management/Consultant Relationships

The construction management team can neither exist nor operate in isolation from the owner, architect, engineers and other consultants. Frequently, however, there is an adversarial relationship between the contractor and the architect and/or consultant. The reasons for this state of affairs are diverse, ranging from personality clashes to perception of professional incompetence.

In all cases of disagreement it is well to bear in mind the words of Tolstoy in his classic 'War and Peace' : 'When two people argue or quarrel, both are always in the wrong'.

ofessional incompetence amongst the contractors leads to deficiencies in planning and setting out, to unacceptable quality and the inability to meet completion dates.

Architects and engineers have in numerous cases been responsible for delays in the provision of drawings; for incomplete and faulty design; and for drawing alterations, which have delayed production and increased cost. There is also an increasing incidence of a lack of detailed construction drawings from architects, who rely on the contractor's experience to complete the necessary details.

The following are some illustrations of productivity losses resulting from professional incompetence.

The first is the case of a contract consisting of four separate buildings each designed to contain 20 different columns which differed in cross-section and shape. No structural or aesthetic reason could be found for the difference. It can only be assumed that the structures were designed by different individuals without any thought for standardization and overall co-ordination.

The resultant cost of the formwork material on this contract was R10.00/m2, instead of a possible R1.20/m2 for uniform columns.

The second case relates to a housing project. Seven weeks after the completion of the project the architects called for a retaining wall and sub-soil drains. This work involved site re-establishment, extra supervision and extra cost for the resultant day-works.

One hundred and twenty houses were completed without the installation of air bricks which were required by the building authority, in spite of the contractor's timely warning to the architects. This omission had to be rectified after the tenants had moved in with resultant damage to carpets and furniture. Additionally, there was the extra cost of repainting.

Other cases include variation orders for additional reinforcing steel (under-design); impractical design of beams which do not fit the overall structure; and the condemnation of specified fill material, which had to be replaced.

The contractor finds himself in a very difficult position. If he takes the consultant/architect to task, he risks possible reprisal in the form of hypercritical inspection of his own work, possible rejection of completed work, rework, and insistence of a presence on site beyond the contracted time. All this can amount to a cost which far exceeds the delay suffered by the contractor as a result of professional incompetence on the part of the consultant/architect.

### 12.5.1 Recommendations and conclusions

During informal site discussions, architects expressed a desire to co-operate more closely with contractors in the construction process, particularly in aspects such as planning and work sequence.

Considerable benefits are to be derived from improved co-operation between those involved in the construction project. This can lead to standardization in structure, materials, sizes, less costly labour involvement and improved planning and more expedient activity sequences.

Thought should be given to convening a meeting of representatives of BIFSA, the Master Builders' Association, SAFCEC, the Institute of Architects, the Institution of Civil Engineers, the Institution of Structural Engineers, the Association of Quantity Surveyors and all other professional bodies and owners involved in the construction industry, with the purpose of establishing guidelines and a code for co-operation.

The national cost of mistakes, and less than professional competence at engineer and consultant architect level, is a matter of concern not only to the construction industry but to the national economy. It is, indeed, a matter which affects productivity adversely, and should form the subject for future research.

## 12.6 Job Size *versus* Productivity

Job size, in terms of the estimated number of man-hours required to complete the project, can have a significant impact on labour productivity. Clark and Lorenzoni (1978) have indicated that as projects become larger, they become more complex. Key supervisors are spread thin, the lines of communications become longer, the logistics of keeping men and materials at the proper level at the proper times becomes more difficult. The net result is a less efficient and less productive work force.

This is particularly applicable to the local construction industry, taking into consideration the excessive span of control at foreman level and the available quality of supervision.

The reverse is true as the job becomes smaller, simpler, and more easily managed.

The awareness of this relationship between job size and productivity will encourage management to plan labour requirements with greater care in relationship to work load, and subscribe to the policy of working with minimal necessary labour complements.

## 12.7 Conclusions

The successful reduction of lost time is dependent on effective supervision; a critical awareness of costs by management, and a commitment to reduce wastage wherever possible. This requires a constant critical review of all operations, methods and practices, and it is this critical awareness which will stimulate the development of solutions, improved practices and loss reduction.

The examples described are but a few of the diverse losses that occur on all sites. Constant attention to loss reduction will help to improve productivity and create a climate wherein it (loss reduction) becomes part of the working culture and the company's philosophy and practices.

# CHAPTER 13

## THE MANAGEMENT FUNCTIONS OF ORGANIZATION, PLANNING AND CONTROL

### SYNOPSIS

This chapter, and those following, discuss the management functions which are featured in the model presented in figure 2.2, their effect on productivity, and how they can be improved. The practice of these functions is an integral part of the holistic approach.

An analytical method is presented for identifying functional responsibilities.

The basic principles of planning are discussed. and a practical method of activity planning and control is described.

The relevant aspects of management control are discussed and a method for the reliable recording of labour attendance and labour cost allocation are described.

# 13. THE MANAGEMENT FUNCTIONS

The management functions relating to the construction site can be categorized under the following five headings :

- Organization
- Planning
- Control
- Communication and participation
- Motivation

This chapter will deal with organization, planning, and control. The function of communication and participation, and of motivation, will be discussed in chapters 14 and 15 respectively.

## 13.1 Organization

Organization is a framework which defines a set of relationships and activities which is recognized by all the individuals in the group, with the objective of attaining specific goals. Organization encompasses the people in the company; their range of authority and responsibility; their relationship with one another; their method of communication; and their co-operation and the co-ordination of their activities to achieve a common task.

## 13.2 Definition of Management Responsibilities and Functions

One of the productivity inhibitors the author identified on sites he investigated was the absence of a clear definition of responsibility and functions of site supervisory personnel.

FUNCTIONAL RESPONSIBILITIES

CONTRACT: Techtrain

DATE: March 1987

LEGEND: MODEL O

ACTUAL X

| ACTION / RESPONSIBILITY | PLANNING – LABOUR – SUPERVISORY | PLANNING – LABOUR – HOURLY PAID | PLANNING – MANAGEMENT – PROJECT | PLANNING – MANAGEMENT – SECTION | PLANNING – MANAGEMENT – ACTIVITY DETAIL | PLANNING – OPERATION – SECTION PROGRAMME | PLANNING – OPERATION – TEAM ACTIVITY | RESOURCE CONTROL – LABOUR – SUPERVISORY | RESOURCE CONTROL – LABOUR – HOURLY PAID | RESOURCE CONTROL – SUB-CONTRACTORS | RESOURCE CONTROL – MATERIALS – PERMANENT – BULK | RESOURCE CONTROL – MATERIALS – PERMANENT – STANDARD | RESOURCE CONTROL – MATERIALS – PERMANENT – ENGINEERED | RESOURCE CONTROL – MATERIALS – CONSUMABLE | RESOURCE CONTROL – EQUIPMENT – SMALL | RESOURCE CONTROL – EQUIPMENT – LARGE | RESOURCE CONTROL – TOOLS – SPECIAL | RESOURCE CONTROL – TOOLS – INDIVIDUAL | INFORMATION – PROJECT | INFORMATION – SECTION | INFORMATION – TEAM ACTIVITY | MEASUREMENT | MOTIVATION | EDUCATION / TRAINING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contract Manager | ⊗ | | ⊗ | ⊗ | | | | X | | | | | X | | | ⊗ | X | | ⊗ | ⊗ | | | O | O |
| Site Agent | ⊗ | X | O | ⊗ | X | O | X | ⊗ | X | ⊗ | X | X | X | X | ⊗ | ⊗ | ⊗ | X | ⊗ | ⊗ | X | | O | O |
| Ass. to Site Agent | | | | ⊗ | | | | | | X | O | O | O | | | | | | | ⊗ | | | | |
| Gen. Foreman | | ⊗ | | | ⊗ | | ⊗ | | ⊗ | | X | X | | ⊗ | X | | | ⊗ | | ⊗ | ⊗ | | ⊗ | O |
| Finishing Foreman | | ⊗ | | | ⊗ | | ⊗ | | ⊗ | ⊗ | | | | ⊗ | X | | | ⊗ | | ⊗ | ⊗ | | O | O |
| Site Quant. Surv. | | O | | | | | | | | ⊗ | X | X | X | X | | | | | O | O | O | ⊗ | | |
| Ass. Quant. Surv. | | | | | | | | | | | ⊗ | ⊗ | ⊗ | ⊗ | | | | | | | O | ⊗ | | |
| Chargehand | | ⊗ | | | | | X | | ⊗ | | X | X | | ⊗ | ⊗ | X | ⊗ | ⊗ | | | ⊗ | | ⊗ | O |
| Cost Clerk | | | | | | | | | | | | | | | | | | | | | ⊗ | | | |
| Storeman | | | | | | | | | | | | X | | ⊗ | ⊗ | | ⊗ | | | | | | | |
| Time Clerk | | | | | | | | | | | | | | | | | | | | | ⊗ | | | |
| MEDIUM, FREQUENCY, ETC. | Site organogram | Weekly activity production plan | Computer programme | ditto | | | Weekly activity Production plan | | Production targets | | Purchasing & scheduling | ditto | ditto | | | | | | Daily foremen meeting | ditto | Daily production targets | Actual vs allowables | Incentives | |

FIGURE 13.1 FUNCTIONAL RESPONSIBILITIES

This can and does result in the duplication of some and neglect of other important functions. These functions include planning, control, purchasing, scheduling, and communication. The latter applies to information regarding construction activities to be completed, and feedback information regarding the progress of these activities.

Several projects were investigated to establish the organization and management patterns practiced; and their efficacy was evaluated by using a functional analysis charting technique.

### 13.2.1 Functional analysis

Figure 13.1 shows a Functional Responsibility Chart which was used to survey a building contract involving concrete structures, brickwork and specialized engineering sub-contract services.

The chart was used in the following manner :

The name of the responsible person is written in the left hand column under the heading *'RESPONSIBILITY'*. A vertical column is provided for each of the main functional contract responsibilities.

The circles on the chart indicate the responsibilities which should be discharged by the different levels of supervisors and site administrative personnel. This is a management decision. The bottom of the chart provides space for notes on the medium and source of information to be used, and frequency of action. Crosses on the chart indicate the actual active responsibility exercised by the person concerned. Thus a cross superimposed on a circle shows that the responsibility is being exercised at the level identified by management as being appropriate. A cross without a circle indicates that the responsibility is being exercised by the wrong person; and an empty circle indicates that the function is not being attended to.

A review of the completed chart shows:

- whether the responsibility is being exercised at the correct level
- duplications in functional responsibilities
- essential functions for which no one is taking responsibility.

### 13.2.2 Discussion of site observations

A comparison of the actual and model functions in figure 5-2 shows a bad case of "control from above"; with the site agent trying to do everything himself, and not delegating sufficiently to his assistant and staff. It is noteworthy that he complained about having too much to do, and too little time to get out onto the site. There is also a multiplicity of functional duplication, and a complete neglect of the education/training function. Paradoxically, but not surprisingly, there were numerous delays because of a lack of resources, - timely supply of materials and equipment.

In these circumstances it is therefore not surprising that this particular contract was underperforming and recording a low productivity ratio and an unsatisfactory profit margin.

During discussion with site management it was agreed to bring functional responsibilities more in line with the model situation. This resulted in improved planning, better labour control and hence productivity, and a reduction in waiting time due to the more timeous supplies of materials and equipment.

A review of the functional responsibilities on two other contracts, using the foregoing functional responsibility charting method, resulted in a reduction of managerial personnel (not supervisors), more direct lines of supervisory and managerial communications, and the more effective discharge of managerial contractual functions.

The use of the Functional Responsibility Chart thus provides a means of ensuring that the responsibilities for the important functions of planning, resources control and communication, are clearly defined and their exercise monitored.

### 13.3 The Planning and Control Functions

*PLANNING* is deciding what to do.
*CONTROL* is assuring that desired results are obtained.

Anthony (1965:11) suggests that planning and control are part of an inter-related function, and quotes the example of budgetary control to support his thesis.

*'This process involves a recurring cycle of activities. The cycle starts with the preparation and approval of a budget which clearly is a planning activity. But the budget is also used as a basis for control; indeed, many contend that the budget preparation activity is a principal means of achieving control. During the budget year, many activities occur that clearly fit the definition of control but, simultaneously and as part of the same process, there may occur an activity called budget revision, which is planning. In short, planning and control activities are so closely intertwined in the budgeting process that to describe each of them separately is not only difficult but pointless'.*

Figure 7.1, Chapter 7 showed that the planning function is the starting point in a control system which facilitates decision making, and is the essential precursor to effective action and the avoidance of resources wastage.

Planning must be viewed as an all embracing discipline, and not one which is merely the responsibility of senior management. For a company to succeed, planning must be understood and believed in at grass roots levels where it must be implemented; and these levels must include foremen, chargehands, team leaders and artisans.

Developments in computer technology and the introduction of micro-computers have facilitated the on site use of critical path planning and PERT (programme evaluation and review techniques). It was found, however, that the use of the computer seldom extended to the operational level of planning labour activities and requirements, and the scheduling of materials.

The Business Roundtable (1983) emphasizes that lack of adequate planning has been identified as a demotivator and a cause of delays.

Initially the delays may be frustrating, but it does not take long before the delays are accepted as the norm. The workers may thereafter resent having to improve their performance when the delays are eliminated. An adjustment period follows, and this can prove to be very costly.

Koontz (1958: 49, 51-57) emphasizes the creative and innovative possibilities in planning in his Principle of Alternatives *'...In every course of action alternatives exist, and planning involves the selection of the alternative course of action which will best enable the enterprise to realize its goals'.*

This is, indeed, applicable to construction activities. No plan is finite. All plans must be reviewed regularly and, if needs be, updated to meet current construction

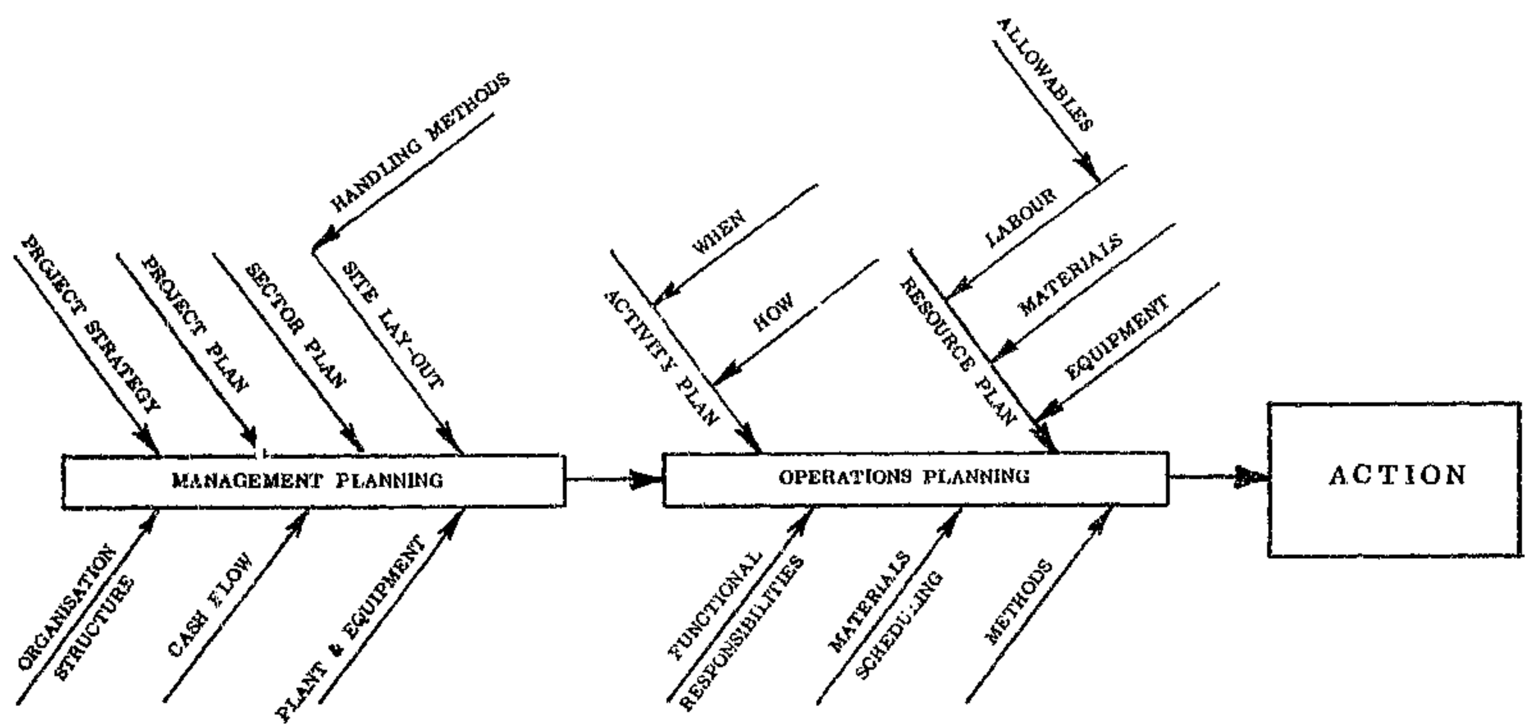



FIGURE 13.2 PLANNING ELEMENTS OF THE CONSTRUCTION PROCESS

requirements.

### 13.3.1 Planning elements of the construction process

Figure 13.2 has been designed to illustrate the main planning elements of the construction process.

Planning can be subdivided into two main categories :

- Management Planning
- Operations Planning

#### 13.3.1.1 Management planning

The most important management planning function is to decide upon a clear direction for the organization. This is done through the medium of strategic planning. Strategic planning is the process of defining objectives, deciding on the resources required to achieve the desired objectives, and developing a strategy to acquire and effectively utilize these resources.

Applied to the construction project it involves the development of a construction strategy, and determining the resources required to complete the project on time, within allowed costs, and to the specified quality standards.

The planning includes the establishment of a suitable organizational structure, a project plan, cash flow projection, sector plans, site lay-out and materials handling methods, and establishing the plant and materials requirements.

This work is usually the responsibility of the contracts manager and site agent, who may consult with his foremen and Quantity Surveyor on the details of the different plans and programmes. These will now be discussed.

#### 13.3.1.2 Overall project plan

The overall project plan requires the setting out of the sequence of the required activities; their commencement and completion dates, and hence the overall duration of the construction programme. This plan then provides the basis for the sector plans and the resourcing of the project with regard to plant and equipment, labour and materials.

Site observations revealed that the overall project plans used on the various sites varied from simple bar charts showing the duration of the different phases of construction, to sophisticated computer print-outs which presented the overall plan schedule in both graphical and tabular form. The computer generated plans showed the earliest and latest starting and finishing dates for the individual phases as well as the overall project. The latter is a standard requirement by managing architects/consultants in the industry. The extent and quality of the planning regarding other aspects such as cash flow, activity details, resources requirements, and materials procural and scheduling, varied from sketchy to non-existent.

#### 13.3.1.3 Sector plan

The overall project plan (depending on project size) is subdivided into sector plans, and the sam methodology is applied to establish the necessary time dimensions for the plan's fulfillment. In practice it was found that this planning was done on an ad hoc basis, with the result that some sector activities were found to be behind the

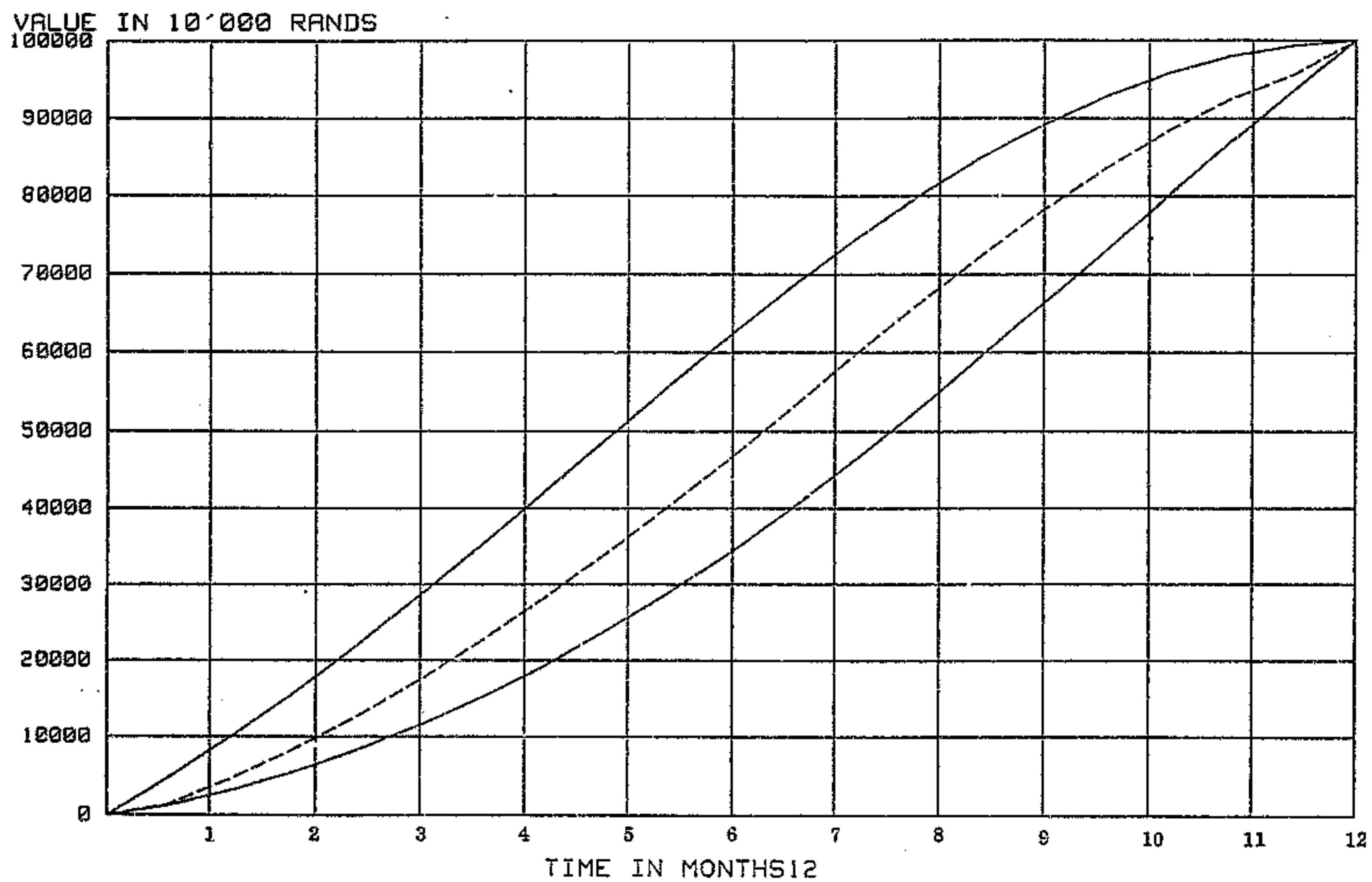



FIGURE 13.3 CASH FLOW PLAN "S" CURVE

scheduled programme. The main cause of delays was found to be the timely procural of materials and equipment. A further contributory factor was the absence of architects/consultants instructions.

#### 13.3.1.4 Site lay-out planning

The importance of site lay-out in controlling and avoiding wastage, and facilitating materials handling, has been discussed in Chapter 11.

#### 13.3.1.5 Materials handling

The principles involved in materials handling, and some recommended methods, are discussed in Chapter 11.

#### 13.3.1.6 Cash (income) plan

The programme derived from the overall project plan provides the basis for the cash flow plan. This is best done by projecting income in terms of the value of completed work for both the earliest and latest allowable completion dates for the different phases of the project. The resultant two 'S' curves with a common starting and ending point (refer to figure 13.3) show the boundaries of value and time within which it is planned to receive cash for completed work.

The actual progressive cash flow is plotted during the course of the project, and if the plot is within the perimeter of the curves, then the project is within the planned completion time. If the plot is above the top line then it is an indication that the contract is ahead of schedule; whilst a plot below the bottom curve will indicate that insufficient work has been completed for the contract time elapsed.

Only one of the companies surveyed used this method of cash flow planning and control. Two companies used a straight line graph showing planned cash flow on a time base, and plotted the actual against it. Another company budgeted turnover and readjusted this budget quarterly on the basis of actual turnover achieved. The results were maintained at head office, and site information was limited to overall contract progress against programme. The straight line method of projecting cash flow does not show the limiting parameters as does the above 'S' curve.

### 13.3.1.7 Operations planning

Operations planning involves the translation of the overall plan into specific activities to which labour, materials and plant resources are allocated. The planning time scale is of a relatively short duration, extending over a two weekly period, and being updated weekly, and if needs be, revised daily.

It is essentially a site activity which involves the site agent, engineer, foremen and first line supervisors. The involvement of the lower echelons of supervision is most important since it affords them participation in the planning process and encourages a sense of commitment to the plans formulated.

It was found that the foreman was seldom involved in activity planning and particularly in the planning and procural of the resources required to accomplish these activities. Generally, he relied on instructions from the site agent.

The duration of an activity is dictated by the overall programme, and the duration, in turn, dictates the quantum of resources which must be applied to meet the time discipline involved.

Effective operational planning cannot be done without premeasuring the work planned. Premeasurement provides information regarding work content, and this is essential for the economical resourcing of the activity in terms of labour, materials, plant, machinery and services.

On the sites investigated, there was a reluctance amongst site agents, engineers and quantity surveyors to premeasure work, and advise foremen and lower level supervisors of the time allowed to complete a specific activity. One foreman commented: *'I must beg for the allowables so that I can tell my workers when to finish'.*

The reasons for the reluctance can be attributed to inertia, and a lack of awareness of the importance of ensuring the effective utilization of manpower.

#### 13.3.1.8 Site manpower planning

Analyses of site hourly wages and monthly salaries, excluding sub-contractors, have shown that these amount to approximately 30% of contract value. These substantial costs can and should be monitored and controlled, and the basis of control must be careful planning for the better use of manpower.

##### 13.3.1.8.1 Site observations

Generally, site manpower requirements were planned on a macro basis relative to the project programme and anticipated turnover. The planning was usually recorded in the form of a histogram, the peaks of which formed a Gaussian curve.

Investigation of a number of projects showed that little if any detailed planning was done to ensure the availability of adequate site personnel of the required technical disciplines and the appropriate ratios of skilled to unskilled workers. In these circumstances employee complements often related to anticipated peak work loads which seldom materialized, and resu[illegible] in excess site labour.

Thus, little appears to have changed since the report by Cortis et al (1962), which stated: '*Builders are generous in their assessment of th: size of the labour force which is really necessary to complete building projects.*'

An example of the foregoing relates to a contract which included the laying of 2 000 000 bricks. Brickwork, in this case, was not a critical activity. Thirty-two bricklayers were employed. At an average production level of only 300 face bricks per day, the work programme could have been completed in time by 22 bricklayers. Yet the foreman insisted on the larger complement 'to cope with the additional work WHEN IT WAS AVAILABLE!'.

When asked how many bricklayers he would employ in his personal capacity as a sub-contractor, he replied : '22'. This is but one example of the lack of caring for company resources which the author came across on some of the sites which were investigated.

**13.3.1.9 Establishing economic labour complements**

The following actions must be taken to establish and monitor economic labour complements.

- Define the activity and premeasure the work to be done in terms of skilled and unskilled labour.

ACTIVITY PRODUCTION PLAN

CONTRACT: Klooftar
SECTION: Culverts
FOREMAN: H. Le Roux

FROM: 11 Aug 1987
TO: 22 Aug 1987

| ACTIVITY | COST CENTRE | ALLOWABLE UNITS PER MAN/DAY: TOTAL QTY. | | MON. | TUES. | WED. | THUR. | FRID. | SAT. | LABOUR ALLOWED: TEAM SIZE | TEAM HRS | MON | TUES | WED | THUR | FRID | SAT | LABOUR ALLOWED: TEAM SIZE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavation 20-34 | 0146 | $90^{m^3}$ | 1 | | | | | | 486 | 9 | 405 | | | | | | | |
| Shuttering 1-15 | 0381 | $90^{m^2}$ | 2.5 | | | | | | 90 | 4 | 72 | | | | | | | |
| Concrete | 0672 | $25^{m^3}$ | 2.7 | | | | | | 30 | 3 | 30 | | | | | | | |
| Brick lay manhole 3-6 | 0214 | 1800 | 450 | | | | | | 63 | 2 | 72 | | | | | | | |
| Brick lay manhole 7-10 | 0214 | 1800 | 450 | | | | | | | | | | | | | | | |
| | | | | completed work | | | week's productive hrs | | | | | | | | | | | |
| RESOURCE REQUIREMENTS: LABOUR | | | | | | | | | Total | 18 | | | | | | | | |
| MATERIALS | | | | F. UP Steel Fix | | | | | | | | | | | | | | |
| EQUIPMENT | | | | | Check Shutters | | | | | | | | | | | | | |
| SERVICES | | | | | | | alert Redenux | | | | | | | | | | | |

FIGURE 13.4 ACTIVITY PRODUCTION PLAN

COMMITTED H. LeRoux

DATE: 7 Aug 1987

COST RECONCILIATION

| | | RATE | | |
|---|---|---|---|---|
| PRODUCTIVE HOURS WORKED | 669 | 2·50 | CONSTRUCTION VALUE | 1672·50 |
| CLOCK HOURS | 576 | 2·50 | LABOUR COST | 1440·00 |
| | | | GAIN/(LOSS) | 233.50 |

REMARKS
new bricklayer underperforming on manholes.

- Establish labour allowables per unit of work to be done.

- Establish the time allowed for the activity.

- On the basis of the foregoing, establish the size of team, i.e., number of skilled and unskilled workers to ensure that the team's work is balanced with minimum, if any, idle time amongst team members.

The resultant planned team complement, completing the activity in the allotted time, or sooner, will ensure full labour cost recovery - and possibly a labour gain.

The practical application of this planning discipline is described in the activity production plan, section 13.3.1.10.

The labour complements established provide a basis for control and, as will be shown, also provide a production norm for the application of a monetary production incentive plan which is discussed in section 15.8.2.

The foreman is the person who, in practice, has most influence on the size of the labour force, but he seldom resources activities according to labour allowable standards. The reasons for the absence of detailed labour planning are that it is seldom a set company practice, and that labour allowables are not readily available to the foreman.

A further contributory factor to the employment of excess labour is the acceptance by white supervision of low levels of performance from black workers (part of the South African paradigm); especially in view of the fact that while they (foremen) are responsible for the completion of the work, they are not personally accountable for paying the workers' wages. In these circumstances they have no real incentive to reduce labour.

The additional labour thus increases costs and the supervisory span of control, to the detriment of supervisory effectiveness and profits.

**13.3.1.10 Activity production plan**

The activity production plan is a practical extension of the overall management project plan, and sets out the activities and time span in which they should be completed.

The absence of effective activity production plans on sites, prompted the author to design and apply a suitable planning sheet to simplify the required planning function. This form is shown in figure 13.4. It provides for a fortnightly production plan, which is revised weekly, a week in advance. The planning was done at foreman level, and checked and approved by the site agent or engineer. It was completed in duplicate, with the original being retained by the foreman and a copy kept by the site engineer/agent.

The planning sheet provides for activity description, cost centre identification or computer reference, the labour allowable and completion time. Provision is also made for resource requirements. These may include any special labour, materials, equipment and services. The latter may concern cranage, shuttering and support equipment which can be planned for provision on the days required.

The allowed time for every activity is shown in the form of a bar chart. The extent of the completed work is shown in the same way. Allowed labour team size and team hours are established per activity as discussed in section 12.3.1.9.

As soon as the weekly production plan has been agreed to (this is to be on a specific week day) the foreman advises the team leader of the activities that are to be completed during the following week.

The team leader records the details and time schedule of these activities in his diary, preferably on the back of the day's page. Should there be a fixed time discipline for the start of any activity, then he will record it on the front of the page against the relevant time. Thus the diary provides a medium of communication and control.

Site management control is exercised during the daily inspections by the site agent/engineer. Progress is reviewed in consultation with the foreman and both mark on their copy of the planning sheet the extent of completed work.

This practice provides an ongoing check on production progress and permits positive action within hours of an activity falling behind schedule.

Daily site inspection, plus the information obtained from the supervisors' production diaries (refer to Section 8.7.1) permits site management to MAKE THINGS HAPPEN more effectively.

This practice subscribes to the concept of proactive 'Guidance Management' as opposed to reactive 'Corrective Management'. The latter is the only recourse where information regarding under-performance is only available retrospectively.

The form also provides for a weekly labour cost reconciliation.

Thus the one form, without any transcription, provides for;

- Planning
- Work Progress Control
- Labour Cost Reconciliation and, above all,
- The development at foreman level of a greater sense of awareness and commitment to contract progress and resources utilization.

The Business Roundtable Report (A-6, 1982) estimates that model planning and scheduling can help reduce construction time by 10% with a 3%[15] saving to the owners. It will be instructive to quantify the applicable savings which can be achieved in the South African construction industry from the more effective application of planning and scheduling procedures. The savings should be substantial, and will justify a detailed study.

#### 13.3.1.11 Materials planning and scheduling

An essential contributory element to the maintenance of high productivity is the timeous supply of the necessary materials and equipment.

The Business Roundtable (A-6, 1982 : 4) surveys have concluded that 6% of labour costs could be saved if all materials and equipment were available at work sites when needed.

It was found that the scheduling of suppliers' deliveries is an often neglected function. All too often it is left to a head office buyer who, at best, can only follow up orders in accordance with the original requested delivery date.

Construction programmes must be flexible to accommodate any changes which may

15 This was the level of contract profits during the period of this research.

occur resulting in possible delays, or advances in progress. The follow up and monitoring of supplies must therefore be able to cater for changes in the rate of progress. Hence following up and scheduling of deliveries should be the responsibility of the site.

## 13.4 Control

The primary function of control is to achieve operational objectives. These will include the contract programme, costs, and quality. Management systems provide a necessary adjunct in exercising control, but they cannot supplant the function of decision making which is the responsibility of site management and which is essential in exercising control. Control must be positive, flexible and encourage initiative and creativity. Rigid control can stifle participation and act as a productivity inhibitor.

### 13.4.1 Managerial control

Management's most demanding responsibility is to implement decisions taken and agreed upon; in other words, TO MAKE THINGS HAPPEN.

This can generally be achieved by management in two separate ways.

- Management by exception - Reactive: corrective action
- Guidance management - Proactive: creative and preventive action

### 13.4.2 Management by exception

Management by exception involves concentrating on the deficient operations while paying little attention to the operations that are going according to plan. This, in fact, means waiting for things to go wrong.

This is a reactive and consequently negative philosophy. When something has gone wrong two elements of loss will result.

The first loss will involve the cost of rectification, the lost time, and the spoilt materials.

The second loss element is the loss of potential gain resulting from not optimizing the operation through positive guidance management to ensure best results.

### 13.4.3 Guidance management

It has become clear that on the basis of these investigations improvements in productivity stem from a positive, proactive, approach. Such an approach and philosophy is the concept of GUIDANCE MANAGEMENT, and the writer's approach to finding solutions to the problems encountered is based on this.

Guidance management means making things happen effectively.

It includes creating the conditions in which people can optimize their efforts. It means:

- Effective planning
- The removal of all demotivators
- The provision of the necessary resources to get the job done effectively and expeditiously. This includes the timeous provision of information, materials, tools, plant and services and manpower.

Guidance management involves positive leadership. It involves CARING: caring for the resources entrusted to one; their effective utilization; the quality of the end product; and service to the customer and all associates.

However, we live in an imperfect world and things will, from time to time, go wrong. When they do it is an occasion to ask 'hard questions' and to PERSIST UNTIL ANSWERS AND NOT EXCUSES ARE FORTHCOMING. It is important to establish the cause of the error - to go back to the point of deviation from the planned course. Rectification means getting it right, and it cannot be right if errors are retained in the course of rectification.

### 13.4.4 Labour control

The larger sites surveyed employed full time labour cost allocation clerks, whose function it was to visit the working areas twice daily, check attendance by counting heads, and record the numbers working against the cost centres concerned. On the smaller contracts this work was done by the time clerk. The reliability of the resultant information was questionable. There was a considerable amount of mobility on the sites by those engaged in materials handling and provision of services; and cases of collusion between absentees and time clerks who falsified attendance records were brought to the author's attention.

The production diary discussed in section 8.7.1 provides a facility for establishing reliable attendance records and labour cost allocation. Each diary has an 'attendance record' sheet as shown in figure 8.5. This is completed daily by the team leader who records:

- the presence or absence of his team members
- the cost reference number of the activity they are working on.

The team's bonus which is discussed in chapter 15 is affected by the number of workers, and it is in their interest to complete the work in the shortest time with the lowest labour input. It is therefore most unlikely that attendance records will be falsified. This method of labour control has proved to be reliable and has resulted in the elimination of the cost allocation clerks and reduction of administrative work on the contracts where it was implemented.

### 13.4.5 Administrative control

There are continuing and accelerating advances in computer technology and applications to the functions of planning and control.

During July 1987, the Institute of S.A. Architects, the S.A. Institution of Civil Engineers, the National Building Research Institute, the S.A. Federation of Civil Engineering Contractors, the Institute of Land Surveyors of the Transvaal, the Association of Quantity Surveyors, the S.A. Institute of Building, the S.A. Institution of Electrical Engineers, jointly convened the PACE conference. The conference theme was "New horizons through the use of computers", and some 64 papers were presented. Their content was exciting and innovative, and provided a state of the art presentation in the RSA.

Professor T L Webb in his review of the proceedings states :

*"In the South African context, and indeed in any third world developing country, the selective and rational use of computers will be particularly pertinent and valid because of the responsibilities that have to be borne by a relatively small group of technologically competent professionals needed to meet the growing and otherwise unattainable skilled manpower requirements of these communities."*

Computer programmes are currently available for :

- Quantity surveying
- Project planning and progress control
- Cost recording and project status reporting
- Labour resource allocation.

The reductions in the cost of hardware makes the application of computer technology at site level increasingly feasible. This now presents an educational challenge to site management to become computer literate so that they can put the available programmes to effective use in the quest for productivity improvement.

## 13.5 Conclusions

Site investigations revealed the absence of a clear definition of site responsibilities for the functions of planning, control and communications. A review of functional responsibilities and their definition resulted in greater managerial effectiveness with fewer site staff.

The planning elements of the construction process were defined, and it was found that site activity planning was done on an ad hoc basis, as was the allocation of labour to construction activities.

An activity production plan was introduced which involved the discipline of labour allocation based on work values. The planning sheet provided information regarding progress control, labour cost reconciliation, and provision for the timeous follow up on materials, equipment and services requirements. The introduction of this planning

discipline focussed the attention of foremen on the timeous completion of activities. It also stimulated a sense of awareness of the cost of labour and the importance of the provision of the required materials and equipment to avoid production delays.
The principles of control were discussed, and the importance of the application of guidance - proactive - management was stressed in finding solutions to problems and achieving objections.

Labour control was facilitated by the use of the production diary. The recorded attendances of workers proved to be reliable, and the procedures employed helped to reduce the cost of employing allocation clerks.

# CHAPTER 14

## COMMUNICATION AND PARTICIPATION

### SYNOPSIS

Effective communications and real participation are important components of the holistic approach to resources utilization - in this instance, manpower.

This chapter discusses the practical aspects of communication and participation; and the contributions which employees can make towards eliminating inhibitors and developing and introducing innovation.

The benefits of introducing a mission statement are set out. Employees perceptions of their position in the industry are discussed; and two practical methods for improving communications are described.

The concept of the cybernetic discussion session is introduced and illustrated, and the results of the discussion sessions are presented in the form of a "Building and Construction Site Vade Mecum", ref. appendix C.

# 14. COMMUNICATION AND PAR~~CIPATION

The operations within an enterprise such as construction involve the application of different technical disciplines. Thus there is a high degree of interdependence and the consequent necessity for effective communication between all concerned. Without this there cannot be effective and productive participation by the individuals who are involved in the project.

The author believes that if you cannot communicate with the worker, then you cannot do much to change his work attitudes or your own.

One of the basic conditions for the success of group endeavour is the subscription of the individuals involved to a common objective.

This chapter reflects an investigation of this statement and proposes more effective means to stimulate the individual's participation in, and contribution to group endeavour.

## 14.1 The Mission Statement

None of the five companies investigated had a published credo or mission statement. In these circumstances it is likely that the employee's prime objective will be his earnings, with little concern for matters such as :

- quality
- the client's interests
- an awareness of the fact that the construction industry provides a service to the community

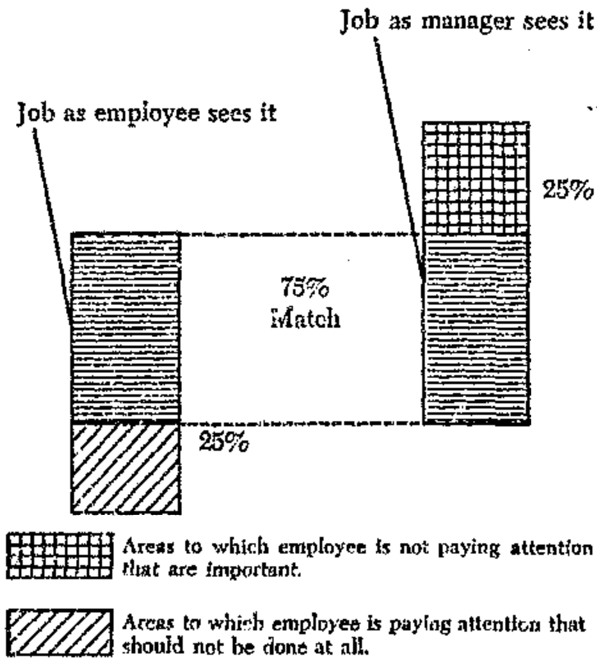



**FIGURE 14.1 DISCREPANCIES IN THE JOB PERCEPTIONS OF MANAGERS AND EMPLOYEES**

Source: Martin, Rober A. and Quick, James C.
MSU Busines Topics Winter 1981 p46

- caring for the company's resources.

The writer consequently drafted a mission statement for one particular company, (see Appendix B) to define (and in some cases to remind employees of) the business the company is in; the philosophies to which it subscribes; and the desirable attitudes which will assist the enterprise to achieve its mission. This statement was accepted by management and circulated to all staff.

The publication of the document had a salutary effect on senior staff. It promoted a discussion which provided clarity, and heightened their awareness regarding their relationship to the company, and the company's relationship to the industry and the community which it serves.

This greater understanding of the company's raison d'etre filtered down to the lower echelons, and the feedback received indicated some changes for the better in site management attitudes towards their responsibilities and the utilization of the company's resources.

## 14.2 Discrepancies in Job Perceptions of Supervisors and Employees

Successful communications result in a consensus between managers and their employees regarding their perceptions and understanding of the job to be done. American studies by George Odiorne (1981) and his associates based on 1800 patterned interviews showed that there was only about 75% agreement between manager and employee regarding the employee's job content. This discrepancy is illustrated in Figure 14.1. The American situation, when compared with that which applies in the South African construction industry, has two distinct advantages:

- Firstly, the average level of education discussed in Chapter 6 is considerably higher in the U.S. than it is amongst employees in the construction industry in S.A. who are predominantly black.

- Secondly, the U.S., for practical purposes, enjoys a common language. The majority of the South African black construction workers, as has been shown, are hardly literate, and possess only a fragmentary understanding of English and/or Afrikaans, while management has little or no knowledge of the black languages in use on site.

In these circumstances it is essential for management to make every endeavour to improve communications and the job perceptions of supervisors and employees. This involves an awareness by management and supervision of the problems involved, understanding, patience, and continuing education of both supervisor and employee in the mastery of language and the transfer of technical skills.

## 14.3 Black Employee Perceptions of their Position in Industry, and Formulae for Achieving Improved Productivity

The perceptions by employees of their employers, the industry and free enterprise are important factors to be considered when developing programmes for participation and motivation.

The University of South Africa (UNISA) School of Business Leadership conducted an investigation entitled Project Free Enterprise (1984) which was published in July 1984, and dealt with black employee perceptions of the free enterprise system.

Table 14.1 sets out the perceptions of the different income groups as to how productivity can be improved.

TABLE 14.1

FORMULAE FOR ACHIEVING IMPROVED PRODUCTIVITY ACCORDING TO INCOME

| FACTOR | LESS THAN R200 PER MONTH | R200 — R399 | R400 — R699 | R700 — R999 | R1 000 — R1 499 | R1 500 — R2 000 | R2 000+ |
|---|---|---|---|---|---|---|---|
| Better training | 42% | 42% | 46% | 40% | 36% | 30% | 28% |
| More machines | 7% | 7% | 5% | 10% | 10% | 19% | 22% |
| Longer hours | 9% | 13% | 8% | 15% | 9% | 8% | 8% |
| Improved salaries | 39% | 36% | 37% | 29% | 27% | 25% | 21% |
| Staff motivation | 3% | 2% | 4% | 6% | 18% | 18% | 21% |

*SOURCE: Project Free Enterprise (1984)*

It is noteworthy that there is considerable consensus regarding the importance of improved training. The proposal for improved salaries which ranks second in importance is understandable. Experience has shown, however, that increased salaries do not result in improved productivity, unless they relate to improved performance.

Katzell (1975 : 35) in reporting on the NYV project records :

*'The managers also recognize that pay increases are not likely to affect productivity unless they are linked to performance. In addition, research has shown that satisfaction with pay is greatest when the pay is tied to performance. And not surprisingly, workers who are more highly paid generally like their pay and their jobs better, and so are less likely to be absent, to strike and to quit'.*

It is significant that the lower income brackets do not attach much importance to motivation, and do not correlate salaries with motivation as does the upper income group. The UNISA report emphasizes this point as follows :

*'A substantial perceptual gap exists between the various income levels. This gap is particularly obvious when comparing the managerial vis- -vis the non-managerial staff. This problem in itself is cause for concern if organizations are to improve knowledge with regard to the factors relating to improved productivity'.*

It is also noteworthy that employees in the construction industry do not relate income to increased output. This particularly applies to unskilled workers who believe that improved wages can best be achieved through financial loans and the redistribution of pay between black and white. This is highlighted in the following table 14.2 which reflects the views of the unskilled workers in the listed industries.

TABLE 14.2

SOURCES FOR OBTAINING IMPROVED WAGES
ACCORDING TO ECONOMIC SECTOR

| FACTOR | AGRICULTURE & FORESTRY | CONSTRUCTION | FINANCE AND INSURANCE | MANUFACTURING | MINING | RETAILING AND HOTELS | TRANSPORT |
|---|---|---|---|---|---|---|---|
| Improved sales/ Production output | 21% | 12% | 55% | 20% | 16% | 30% | 15% |
| Increased price of products/services | 38% | 8% | 31% | 27% | 26% | 32% | 37% |
| Financial loans | 28% | 37% | 7% | 21% | 31% | 17% | 32% |
| Pay Whites less | 13% | 39% | 8% | 30% | 27% | 17% | 14% |
| Employ fewer people | 0% | 4% | 19% | 2% | 0% | 4% | 2% |

*SOURCE: Project Free Enterprise (1984)*

The foregoing would indicate that a great deal of work is required to be done to educate workers, managers and policy makers in the construction industry on the facts regarding sources of income and the distribution of wealth; particularly with regard to the relationship between performance and reward. Indeed, this should be part of the induction programme in every company. More advanced courses and explanations, particularly with regard to the generation of value through resource utilization should be an ongoing part of the employees' continuing education programme.

It is noteworthy to record the conclusions of this Project Free Enterprise report:

*'It would appear that a great deal of ignorance about business and Free Enterprise exists among corporate employees in South Africa. Such ignorance is particularly predominant amongst the less educated, unskilled and semi-skilled workers. These workers regard themselves as grossly discriminated against in terms of remuneration and perceive the Free Enterprise system as a system which is beneficial solely to the white managerial staff. Such perceptions of gross inequality - whether correct or incorrect - do not augur well for the future of industrial relations in this country. Companies must, therefore, take stock of this situation and attempt to move towards the creation of greater commitment to, and involvement in, their structures by their non-managerial work-forces. Such involvement and commitment can, however, only be achieved via an increased comprehension of business and Free Enterprise concepts amongst corporate employees and a fairer distribution of rewards within the corporate setting. In other words, the removal of discrimination should not only be seen as part of an on-going corporate philosophy but should rather be recognized as an immediate corporate action priority. Such a sense of urgency will ensure the type of corporate climate which makes for high levels of commitment to corporate objectives and will consequently ensure the continued survival and growth of a genuine Free Enterprise in Southern Africa'.*

The writer believes that the 'fairer distribution of rewards within the corpo... setting' recommended by the authors of the project can best be achieved by the implementation of incentive schemes and gain-sharing plans for all levels of employees. This will not only promote the distribution of wealth, but also the creation of wealth. These plans must, of necessity, be educational in essence. An employee must be aware of the fact that improved resources utilization which includes his own time and efforts will lead to the creation of greater value ... that he will share in that increased value pro-rata to his effort and performance.

## 14.4 Participation

Participation is more than a ... trend in managing. It is the only method by which we can be sure that employees ... care for and improve a growing network of complex systems and equipment.

Ouchi (1981) has developed his theory Z on the basis of participation. He draws a distinction between the A-type organization which he categorizes as authoritarian and autocratic, and the Z-type which is personified by the Japanese style of participative management. The application of quality circles in Japanese industry has proved the benefits to be derived from worker participation in improving their own operations, and those of the company.

This fact is highlighted by Pascale et al (1981 : 55) who, in discussing the management philosophy of Matsushita, Japanese founder of 'National' electrical/electronic products, states :

*'He believes that a great many little people, paying attention each day to how to improve their jobs, can accomplish more than a whole headquarter full of production engineers and*

*planners'*.

In similar vein, the *'Big Bang'* theory does not apply to the construction industry. Overall improvement can only be derived from doing a lot of little things right which ultimately adds up to a LOT, and this particularly includes the elimination of demotivators. In practice this requires management commitment to operational effectiveness in all the areas of operation, as illustrated in figure 2.2.

### 14.4.1 Encouraging participation

The authoritarian and autocratic style of management is very prevalent in the construction industry, and in these circumstances lower echelons of supervision seldom have the opportunity to discuss their problems with senior management, or submit ideas for improvements in operations.

This is confirmed by the findings published in the Project Free Enterprise report, to the effect that the generally totalitarian and autocratic management styles practiced in the Republic of South Africa negate the meaningful participation of workers in areas such as performance improvement, productivity enhancement and decision-making.

In practice, there is a natural reticence at lower levels to bring problems or productivity inhibitors to the attention of management. There are two main reasons for this reticence.

- Firstly, no-one cares to be the harbinger of bad news, and it is hoped that by not mentioning the problem it will go away.

- Secondly, the person concerned may believe that it is his sole responsibility