

AN INVESTIGATION INTO
PRODUCTIVITY IMPROVEMENT
ON CIVIL ENGINEERING AND
BUILDING CONSTRUCTION SITES

Volume 2: The Compilation and Analysis
of Survey 1 - The Construction
Productivity Questionnaire

The Compilation and Analysis
of Survey 2 - Further Research
Based on the Results of The
Construction Productivity
Questionnaire

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NOTES Volume 2

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TERMS OF REFERENCE. Volume 2.

This thesis was completed to fulfill the requirements of CIV 500Z at the University of Cape Town. It is an investigation into methods of productivity improvement on civil engineering and building construction sites. Volume 2 of the thesis deals with the data collection and analysis procedures.

The main objectives of volume 2 are:

1. To ascertain the areas in the South African construction industry which possess the most opportunity for productivity improvement.
2. To conduct a nation-wide survey to gather the information relating to 1) above.
3. To analyse the survey and to compare the results obtained in similar surveys performed in the United States of America.
4. To further investigate those areas perceived by the South African construction industry as having the most potential for productivity improvement.
5. To analyse the ideas collected as mentioned in 4) above.

The conclusions to the data collection and analysis will be presented in volume 3, "Conclusions", along with the conclusions from volume 1.

SYNOPSIS. Volume 2.

The productivity of the construction industry in the United States fell between the years 1968 and 1979, while that of its European and Japanese counterparts rose. Realizing that the full blame could not be attributed to the energy crisis of that time, research was initiated into finding the areas which possessed the most opportunity for productivity improvement. This research was first aimed at the four hundred largest construction companies in the U.S.A. Later, similar research was conducted on companies which were smaller, and thought to be more representative of the construction industry. The data that was collected from these two surveys has been updated twice to ascertain trends in productivity improvement progress.

Productivity in the South African construction industry is currently very poor. As this industry generates many work opportunities and has an annual turnover of many billions of Rand, it is vitally important to the nation's economy that the industry is efficient. It is obvious that in order to improve productivity, the industry must concentrate its improvement efforts in the areas which need it most, as opposed to spreading improvement efforts over all aspects simultaneously. In order to provide a starting point from which productivity can be improved, research was performed to ascertain the areas possessing the most opportunity for productivity improvement in the local industry. This research was similar to that conducted in the United States.

The necessary information was collected through a national mail survey structured as follows:

The first section of the questionnaire requested information which could be used to categorize the company according to factors such as its annual revenues, size and type of labour force, and equipment usage policies.

The second part of the questionnaire asked the respondents to rate a number of worker motivational factors as to the importance they believed their labourers attached to the factors. The objective of this question was to ascertain the true importance of these factors at a later stage.

The rest of the questionnaire asked the participants to rate a number of factors relevant to the construction industry as to their opportunity for productivity improvement, and to rate their interest in participating in activities aimed at improving productivity.

The survey achieved a return rate of over 27%. The data was analysed according to the financial size of the companies. It was found that the industry was dominated by a few large companies, which generally used their plant more efficiently than did the smaller companies. It was also found that the number of employees were directly related to the annual revenues of the company.

The second part of the questionnaire established that construction management firmly believe that the most important worker motivational factor is good wages, closely followed by financial incentives and job security. A further study was conducted to establish the true importance that workers place in the various motivational factors. Although no specific data was attained from this further research, it was ascertained that good wages did not dominate the other motivational factors.

The third part of the questionnaire listed 37 areas which can affect construction productivity. From the analysis, it was established that six of these factors contributed significantly to the poor productivity currently experienced in the industry. These factors are, in order of importance, labour training, labour quality control, management supervision, cost control, labour relations, and communications.

Further research was pursued into these six areas. Interviews were conducted with personnel in the construction industry to ascertain specific problem areas and their points of view on how to solve these problems. It was found that most companies are acutely aware of the productivity problem, and are trying to solve it mainly through the use of training programs. These programs were studied and found to be well researched and presented. At present, members of the various training boards

are discussing ways in which to improve the training schemes by integrating the best aspects from each scheme.

The conclusions to the surveys and the lessons learned from the subsequent interviews have been set out in volume 3 of the thesis. This arrangement has been used so that the reader can reference the conclusions to the various parts of this study in one place.

VOLUME TITLES

Volume 1: Productivity Improvement in Construction - A Review.

Volume 2: The Compilation and Analysis of Survey 1 - The
Construction Productivity Questionnaire.
The Compilation and Analysis of Survey 2 - Further
Research Based on the Results of The Construction
Productivity Questionnaire.

Volume 3: Conclusions.

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1. INTRODUCTION

It would be naive for one, or a few people, to choose the functions in the construction industry which have the most urgent need for productivity improvement. Further, while the improvement of specific functions must not take place in isolation from, or to the detriment of other functions, one cannot successfully improve every aspect of construction at one time, nor will disparate functions deserve equal attention. In order to ascertain which functions possess the most opportunity for productivity improvement, it is important to appeal to a wide cross-section of the industry to obtain the views expressed by many people with experience of the practicalities and difficulties present in the industry at this time. This volume will develop a national survey aimed at collecting such data, which will be analysed and compared to similar data collected previously in the United States.

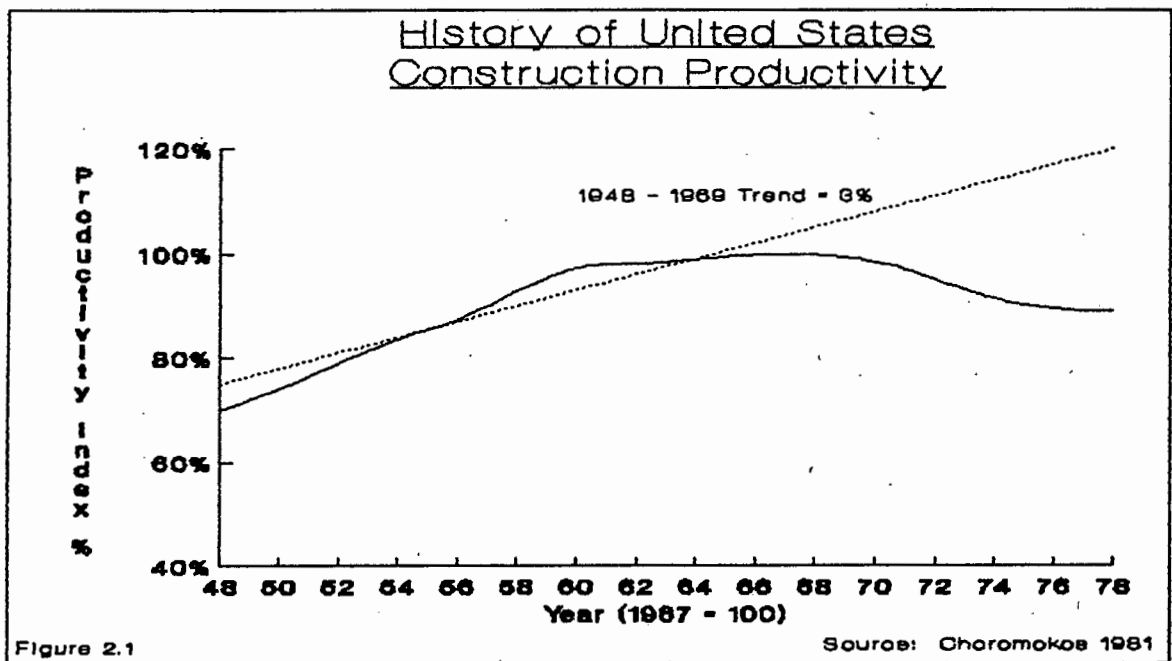
From the analysis of this data, a few areas will emerge as those presenting the most opportunity for productivity improvement. These functions will then be concentrated upon during further research. Here, specific ideas as to how these functions can be improved will be collected.

The data collection methods as discussed in chapter 12 of volume 1 will be used in the information gathering stages of this volume.

From the above discussion, it will be gathered that this volume presents the data collection methods and analysis of a national survey collecting information about the potential for improvement of many functions performed by the construction industry. This survey will be the starting point for further research into improving those specific functions most urgently requiring improvement. Ideas pertaining to this will be collected and presented in this volume, and the resulting conclusions and recommendations will be included in volume 3 of this thesis.

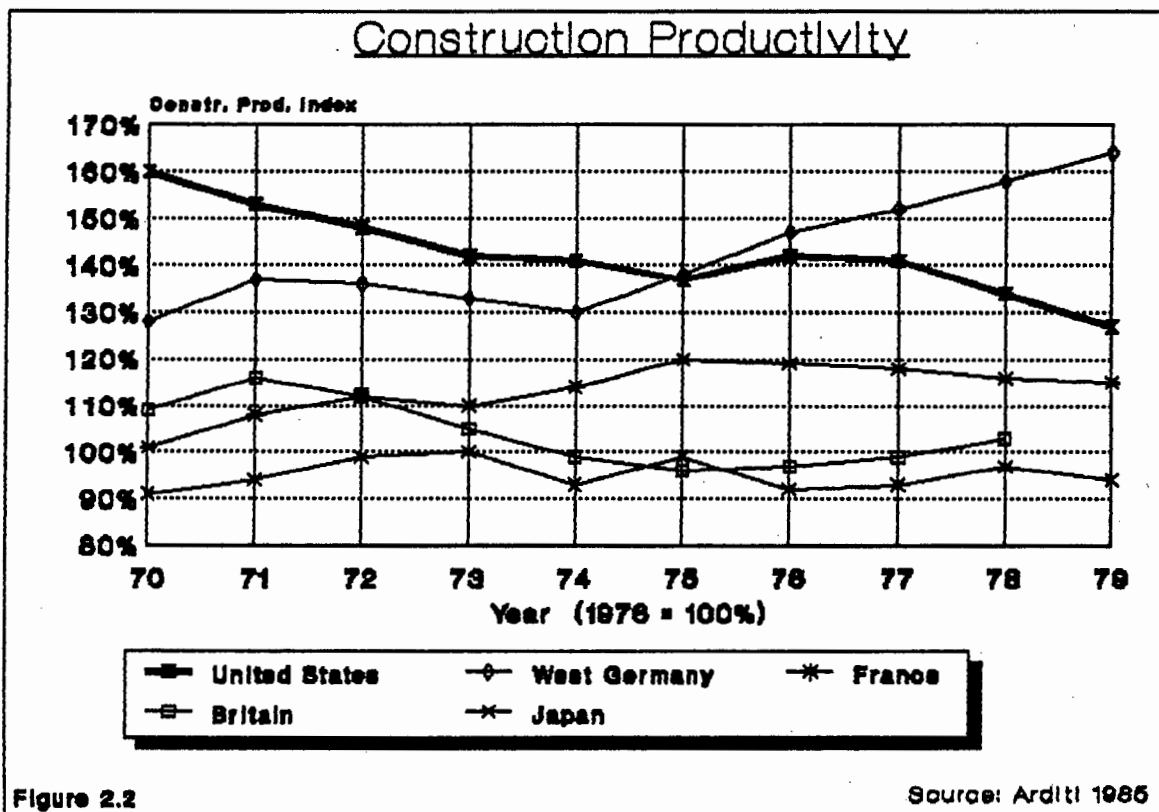
2. THE COMPILATION OF SURVEY 1 - THE CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

During the late 1970's, the United States was facing an economic crisis. The dollar value was low, and inflation and unemployment were rife. The United States construction industry employed about 10% of the national work force, and contributed over 10% of the country's gross national product. It was realized that limited productivity improvement in this industry contributed to the country's economic predicament. Figure 2.1(4) shows a 3% annual increase in United States construction productivity between the years 1948 and 1969. After that, the productivity dropped in less than ten years to a rate equal to that in 1956. (4)



The construction industry could not lay the total blame for their poor productivity on the oil crisis, as other countries were able to recover from the energy price escalation in a short period of time. Another contributing factor was the sparing use of government aid to this industry as opposed to France and Britain where government policy allocated funds towards favored industries. Figure 2.2(s) was prepared by the Japanese

productivity center and shows that the U.S.A. was the only major industrial nation to record a drop in productivity over the years 1970 - 1980. (5)



In the light of this comparatively poor productivity improvement, Choromokos et al.(4) pioneered research into the field early in 1978. They realized that in order to maximize productivity improvement, it was necessary to focus effort on those areas presenting the greatest potential for improvement, rather than trying to improve all areas at the same time. The first task was obviously to identify those areas requiring the most urgent attention. Rather than select the areas themselves, they recognized that a more thorough understanding would be gained through a survey sent to the executives in the industry, pooling their experienced understanding of the situation.

Early in 1978, executives from eighteen large construction companies were interviewed to assess their views concerning the areas that represent the greatest potential for productivity

improvement, and the types of activity they would be willing to participate in so as to improve productivity. A questionnaire, based on these findings, was designed to:

- i) Obtain a brief description of the company for classification purposes.
- ii) Find out which office and site functions the executives thought had high, medium, or low capacity for productivity improvement.
- iii) Determine those activities in which the executives or their companies would take part, such as serving on an advisory board, or contributing funds, in order to improve productivity.

This questionnaire was sent to the ENR top 400^(1.1) companies in April 1979.⁽⁴⁾

The replies were firstly analysed as one group, then again by categorizing the companies based on their annual sales. The results were presented so as to fulfill the requirements in ii) and iii) above.

In 1983, Arditi⁽⁵⁾ duplicated the survey. He justified the repetition by reviewing the current literature, and realizing that conditions in the construction industry had changed considerably since 1979. He reasoned that a duplication would identify important trends in improved and worsened areas, and would provide valuable comparative information. Exactly the same questionnaire was sent to the new ENR top 400 companies, and the results were analysed in the same manner.⁽⁵⁾

The ENR top 400 companies recorded a range of annual sale in U.S. dollars from \$8,620 million to \$43 million in 1986. (Engineering News Record 1986) These companies however, represented a minority portion of the contracting companies in the United States. Koehn and Caplan⁽⁶⁾ were concerned with a larger segment of the population, that being the small to medium size companies,

1.1 The ENR top 400 companies are the 400 largest contracting companies in the United States as listed annually by the Engineering News Record (ENR) periodical.

defined by them to operate in the region from US\$20 million to US\$9 million per annum. Basing their questionnaire on that developed by Chromokos et al in 1978, they hoped to identify those functions in which small to medium sized companies perceived opportunities for productivity improvement. They would also be able to compare these companies' needs to those of the ENR top 400. Although the survey was conducted in 1981, the results were only published in 1987. The data collected was analysed in a similar fashion to that of the previous survey.(6)

Another investigation of the small to medium sized companies was conducted in 1986 by Koehn and Manuel(7) in order to update and complement the previous study. To ensure complete validity of the data, firms from the same contracting organizations were involved. The usual comparative procedures were completed, and the results were published in 1988.

The present investigation will be similar to the previous studies. The main objectives of the study will be to ascertain the areas in the South African construction industry which present the greatest opportunities for productivity improvement, and to compare the findings with those of the United States surveys. The validity of the comparisons and the other secondary objectives will be discussed in section 2.3.

2.1 The Format of the Questionnaire

The document sent to the participants in the current survey consisted of two main parts: the covering letter, and the questionnaire. The questionnaire can be sub-divided into five parts. The full document has been reproduced in Appendix I. Draft forms of the questionnaire were used in a pilot study before the final version was sent out. Four firms participated in the pilot study, three of which are mentioned in the acknowledgements, the other requesting to remain anonymous. These four companies undertook either civils (2 companies), building (1 company), or both civils and building work (1 company). Their annual Rand turnover ranged from R100 million to R5 million. This scope of company size was specifically chosen in

order to cover a wide range of potential respondents. Ambiguities and difficulties uncovered during the pilot study will be mentioned during the detailed discussion of the questionnaire in the following paragraphs. This draft survey was studied by the Statistical Advice Bureau at the University of Cape Town after which certain aspects of the questionnaire were changed to improve the quality of the data, and the ease with which it would be analysed. Advice on the best statistical methods and computer packages with which to analyse the data was also sought and obtained.

The Covering Letter: This included a brief introduction to the topic and stated that further research was to be based on the results of the survey. It identified the convenors of the survey and guaranteed the confidentiality of any data. A self-addressed, stamped envelope was included with the document to enhance returns.

The Questionnaire: This opened by suggesting a "return-by" date. As a result of the pilot study, the instructions requested the participants not to include holding or subsidiary companies registered under names not covered by the address to which the questionnaire had been sent. This was to prevent any misunderstandings the participants might have had as to the scope of company activities their answers should cover. To illustrate this, separate documents were sent to geographically separate divisions of some companies. That is, to Company X (Cape) and to Company X (Natal). These companies can be regarded as completely separate from a contracts, and a contracts managers' point of view, and therefore, for the purposes of ascertaining their areas considered to have high potential for productivity improvement, they should be surveyed separately. Similarly, those companies which have completely separate divisions for different types of work, for example, Company Y (Civils Division) and Company Y (Mining Division), were sent separate questionnaires.

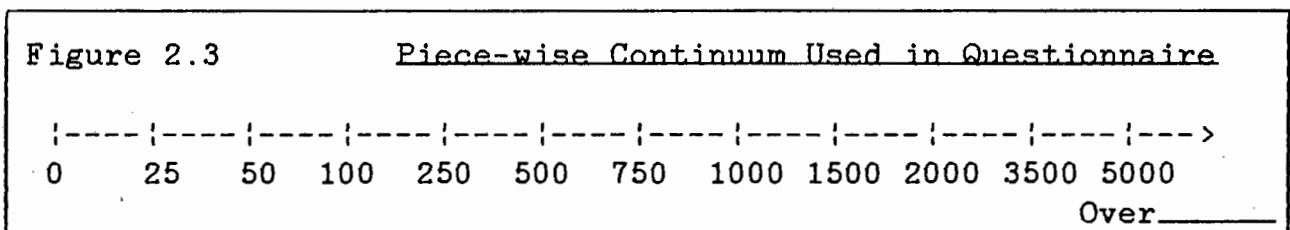
An important difference between the current survey and the original ones, is that *this* questionnaire does not request the company to include their name on the completed form. This is

beneficial in that its omission will enhance initial returns, but it does not allow for a follow up stage reminding participants to return their questionnaire, and it restricts further research in that the particularly interested companies can not be identified. The decision not to request companies to include their names was made after the participants in the pilot study expressed concern that the information supplied in the questionnaire could be of a sensitive nature.

The first part of the questionnaire (questions 1 to 9) was designed to ascertain the size of the company and the type of work it undertook. Contextual information such as Rand turnover, number of persons employed, amount of work subcontracted, equipment and computer usage policies, and geographical dispersion, was gathered. The current survey differed from those it was based on in that in this section the data was gathered over a continuum, rather than in a pre-categorized form. Instead of being asked, for instance, if the number of employees in the company was

- a) Under 100
- b) 100 - 500
- c) 500 - 1000
- etc.

the participants were asked to indicate their position on a line, usually bearing a piece-wise linear scale. See figure 2.3 below.



This form of data collection offers the advantage in that the information can be analysed in a trend form, or in any other desired format rather than just the single preconceived categorization that the previous surveys were limited to. In

this form, the data may be grouped into, for example, quartiles, to allow enhanced statistical significance.

The second part of the questionnaire consists of question 10. This section was not included in the previous surveys, and is based on work done by Kovach.⁽³⁾ It concerns motivational factors and the importance that managers believe their labourers attach to the factors. Data gathered here will be compared to the actual importance the labourers attach to these factors, and to the hypothetical importance as suggested by the various current motivational theories. A significant degree of interest in this question was expressed by the participants of the pilot study, and as a result this question was moved closer to the beginning of the questionnaire in order to maintain the participants' interest in their task.

The third (question 11) and fourth (question 12) parts asked the respondents to rate "headquarter-type" and "site-type" functions respectively for potential with respect to opportunity for productivity improvement. A five point scale was used for improved data quality and usage, as opposed to the "High, Medium, and Low" categories employed in the previous studies. These sections constitute the most important area of the study, and most of the data will emerge from here.

The fifth part of the questionnaire investigates the participants' interest in taking part in various activities for the specific purpose of improving productivity. Again, a five point scale was used instead of the original bipolar "yes / no" answer. Finally, comments relative to productivity problems were requested through an open-ended question.

The problems encountered during the pilot study that have not already been mentioned were mainly concerned with the limits of the line scales. These were modified during the course of the study. One participant suggested that some of the fields defined in questions 11 and 12 were too wide, and therefore could not be accurately perceived. For example, what exactly was meant to be included in "pre-cast"? Unfortunately, a precise definition of

each field would necessarily increase the number of fields, the opportunity for omission, and the length of time required to fill in the questionnaire. Consequently, a reduction in returns would be realized. A knowledge of the use to which the data would be put enabled a balance to be achieved between the precision and the accuracy of the defined fields. Question 13.2 inquired as to whether the company was interested in contributing funds to support programs aimed at productivity improvement. The obvious question "How Much?" was inevitably asked at this point, resulting in the question being re-worded to suggest a nominal contribution. The companies participating in the pilot survey were reluctant to complete this question if their organizations could be connected to the expressed desire to contribute funds.

2.2 Results of Previous Surveys

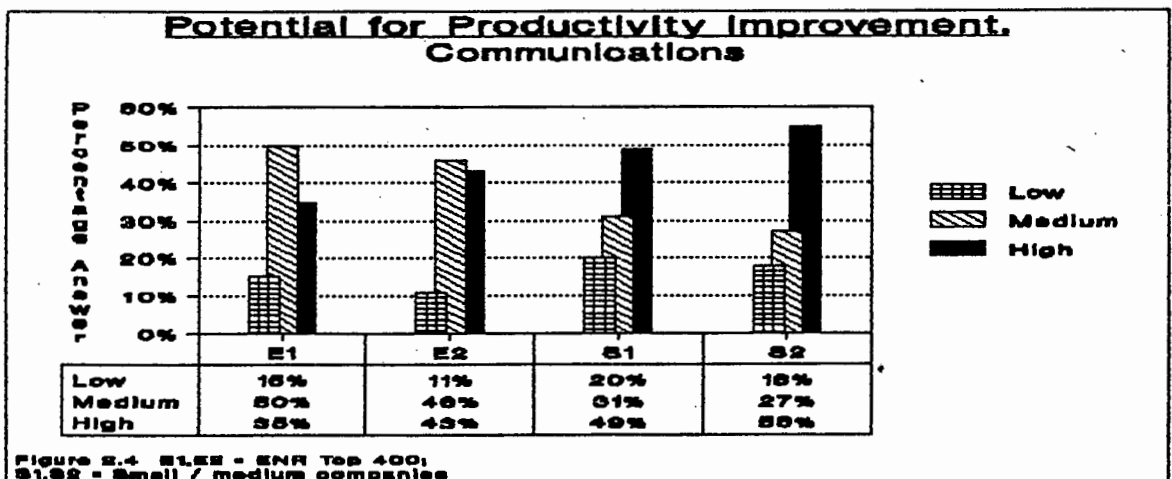
The results of the previous surveys have been summarized in figures 2.5 through 2.16 on the following pages. They have been presented as a graphical illustration in preference to the tabular format used in the aforementioned surveys. The results of the surveys have been rearranged so as to allow them to be compared easily. However, direct comparison must only be made with the statistical limitations of the results clearly understood. The illustrations show the percentage of respondents in each survey who answered high, medium, or low, to each of the questionnaire categories. The key-code is presented in table 2.1 below.

TABLE 2.1

Key-Code for Figures 2.5 - 2.16

CODE	YEAR	POPULATION	CONVENORS	REFERENCE
E1	1979	ENR top 400	Chromokos J. & McKee K.E.	4
E2	1983	ENR top 400	Arditi D.	5
S1	1981	Small/medium	Koehn E. & Caplan S.B.	6
S2	1986	Small/medium	Koehn E. & Manuel J.	7

The following paragraph illustrates the use of the figures, and points out some of the limitations that must be applied when drawing conclusions from the data. As an example, figure 2.4 below refers to the potential for productivity improvement perceived by the participants for the head-quarter function of communications. We can see from the graph that in 1979, only 35% of the ENR top 400 responded "high potential" compared to 43% in 1983. S1 shows that in 1981, 49% of the small/medium company executives perceived communications to rate "high potential", and this increased to 55% in 1986. We can therefore assume that the field of communications has risen in importance for the ENR top 400 companies between the years 1979 and 1983, and also for the small/medium companies over the years 1981 to 1986. We can also assume that the small medium companies in general need to improve their communications more than do the ENR top 400 companies. One must be cautious in assuming a trend of rising communications importance across the four surveys from 1979 to 1986 as E1, E2 and S1, S2 are based on different population groups. Any trends assumed over the four surveys should be based on rearranging the survey order to E1(1979), S1(1981), E2(1983), S2(1986), as this is the order in which the data was gathered.



The detailed discussion of each of these surveys is presented in the papers in which the results of the surveys appear, and shall not be repeated here. However, points of major interest, and

especially those which have not been published previously will be expressed below.

Planning and Scheduling: (Figure 2.5 a,b) These head-quarter functions are both rated "high" in all of the surveys. The small/medium companies, however, suggest that more improvement needs to be made in these areas than do the large companies. This is probably due to the fact that large companies usually have a more formalized and proven system for these functions.

Marketing: (Figure 2.6 b) Notably different are the attitudes towards marketing between the large and small/medium companies. The larger companies are more able to devote specific time and funds towards public relations activities than are the smaller companies. There seems to be a slight across the board increase in the importance of this function.

Drafting: (Figure 2.7 a) This records a very low potential for improvement. This is either due to the established drafting practices combined with formalized education or to the lack of interest in this function typical of contracting companies.

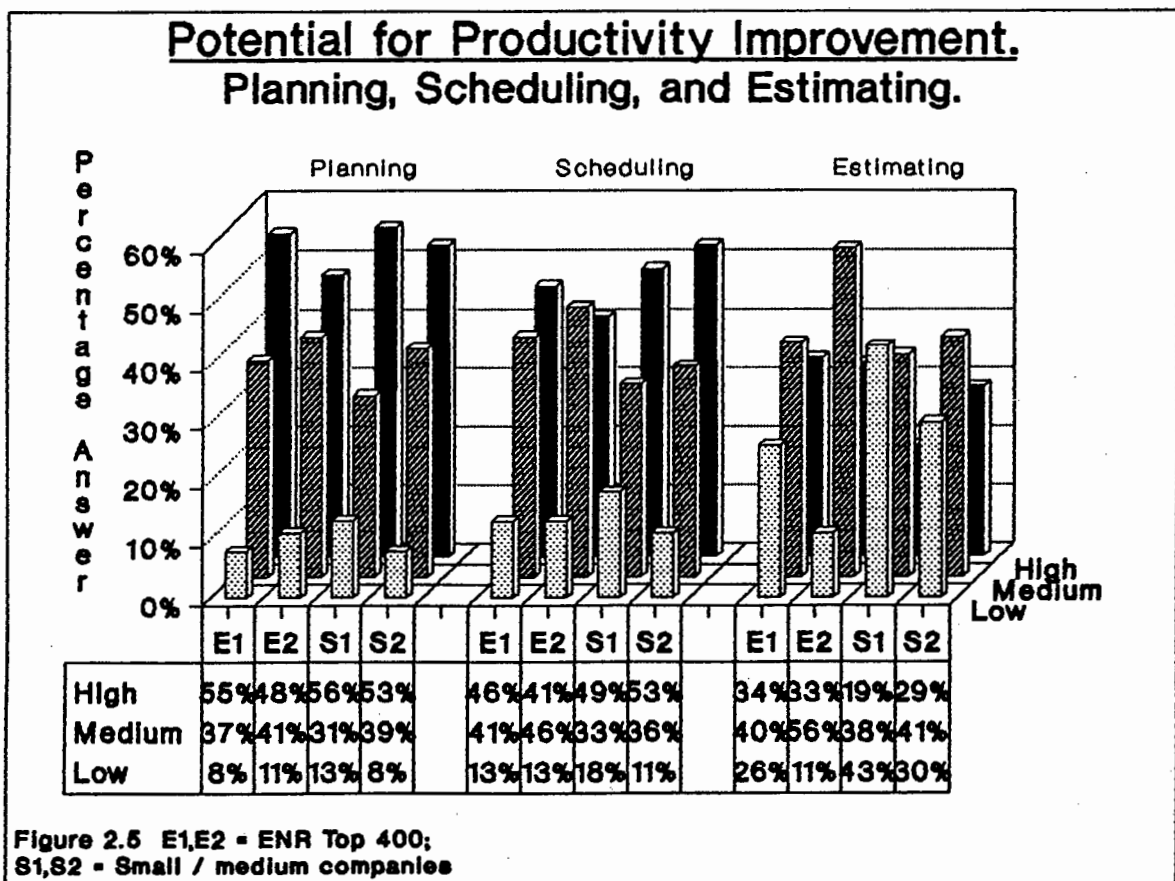
Labour Relations: (Figure 2.8 a) Labour relations need much improvement according to the results of all the surveys. From the graphs, it can be assumed that these relations are deteriorating with time, and this is more noticeable in the smaller companies. Related to this function is that of contract agreements (figure 2.11 a) which show high potential for improvement, and a trend of increasing importance, again especially in the small/medium companies. Although these figures apply specifically to the United States construction industry, it is not difficult to imagine them applying to other industries, and to other countries.

Materials Delivery: (Figure 2.9 a) Small/medium companies need to improve this function to a much larger degree than do the ENR top 400 companies. This is in line with the small companies' slightly poorer planning and scheduling functions illustrated in figure 2.5.

Labour Training: (Figure 2.11 b) There is an expressed interest in improved training throughout the four surveys.

Equipment Maintainability: (Figure 2.13 c) The maintainability of equipment is rapidly becoming more important. This can be seen by the 10%+ rise in the number of respondents marking this function as "high" from E1 to E2 and from S1 to S2.

Foreign Technology: (Figure 2.16) The importing of foreign technology to the United States records the least potential for improvement out of all of the functions. This is due to the present availability of foreign technology and the ability of the United States to locally manufacture suitable equipment and to develop new methods.



Potential for Productivity Improvement. Communications, Marketing, Procurement

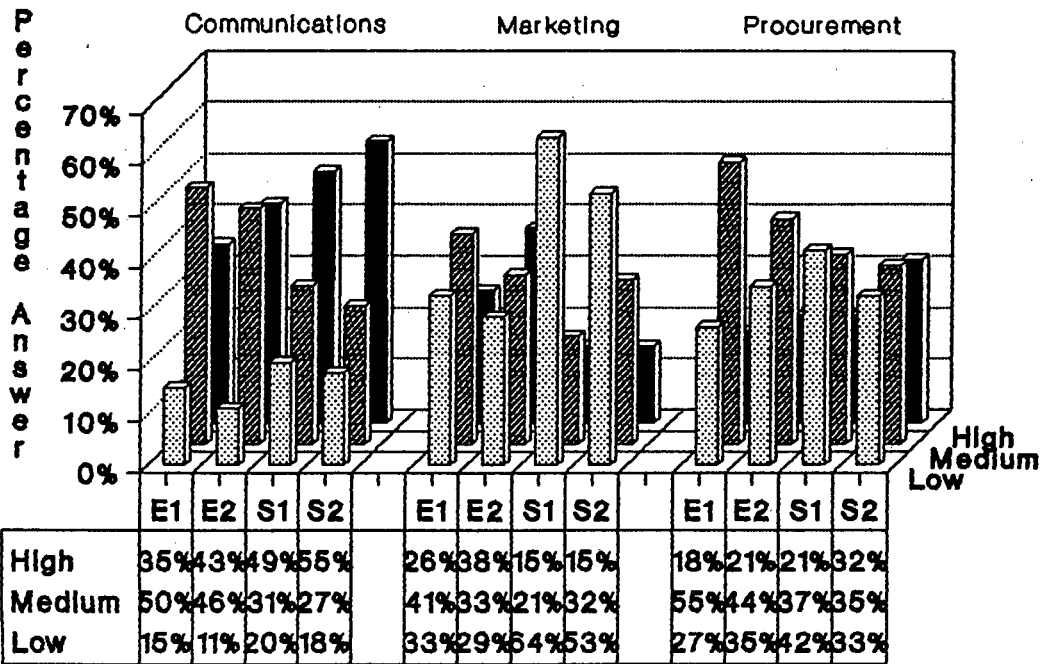


Figure 2.6 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Drafting, Specifications, Engineering

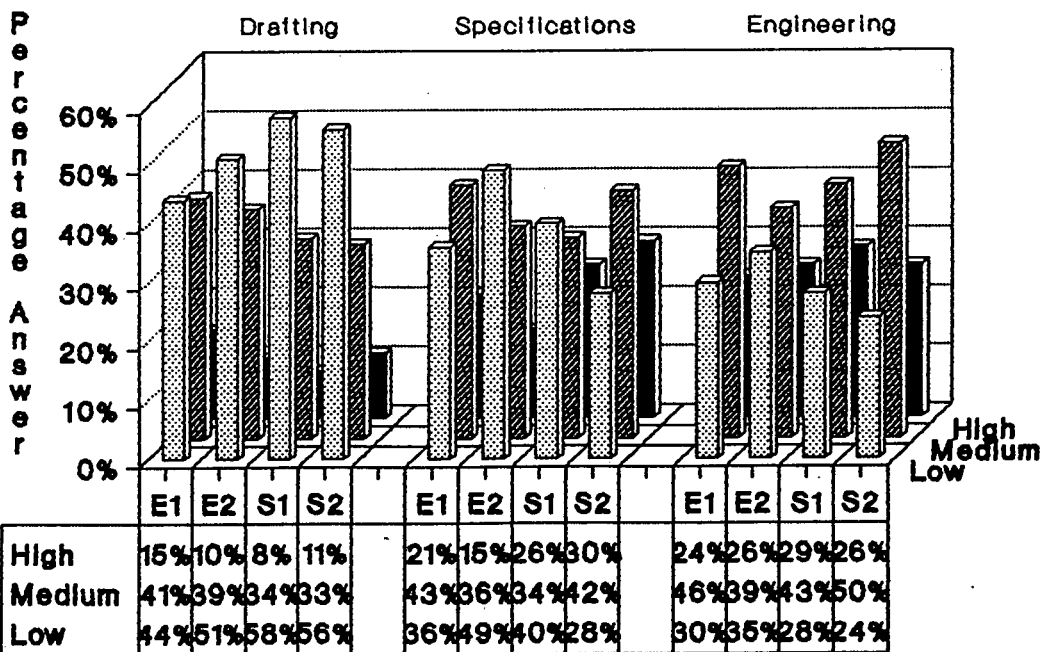


Figure 2.7 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Management - Labor Relations, Cost Control, Supervision.

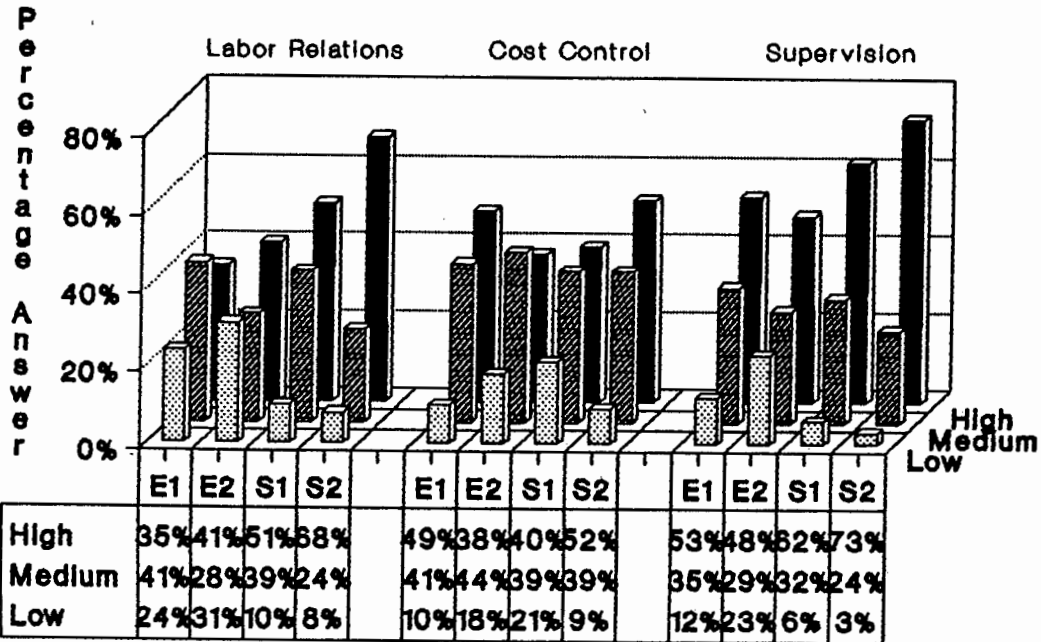


Figure 2.8 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Materials - Delivery, Storage, Packaging

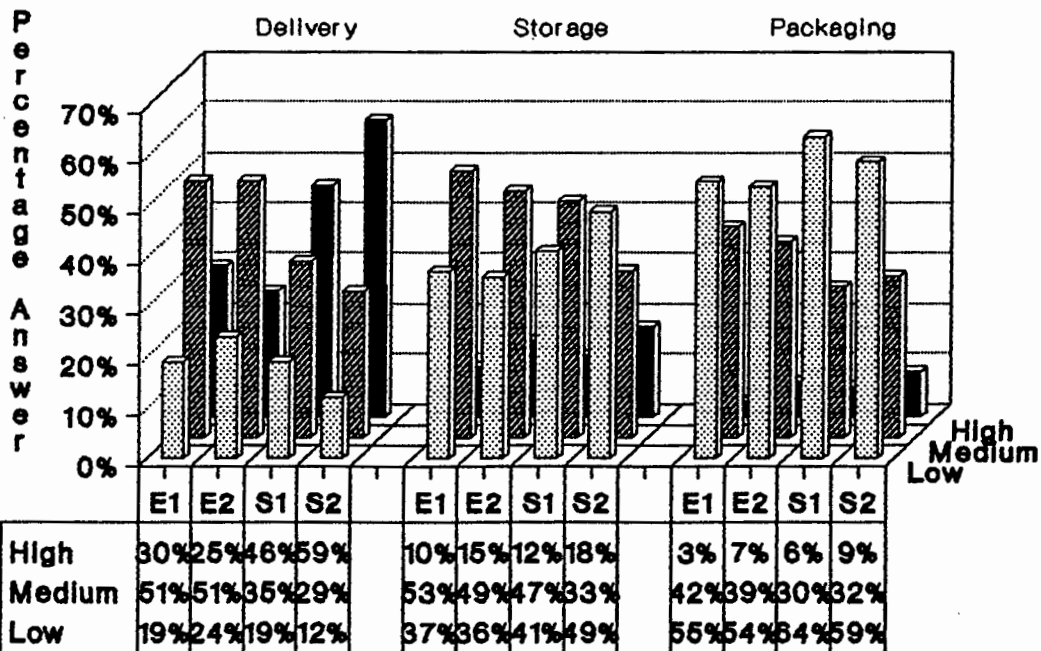


Figure 2.9 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Materials - Prefabrication, Standardization, Availability.

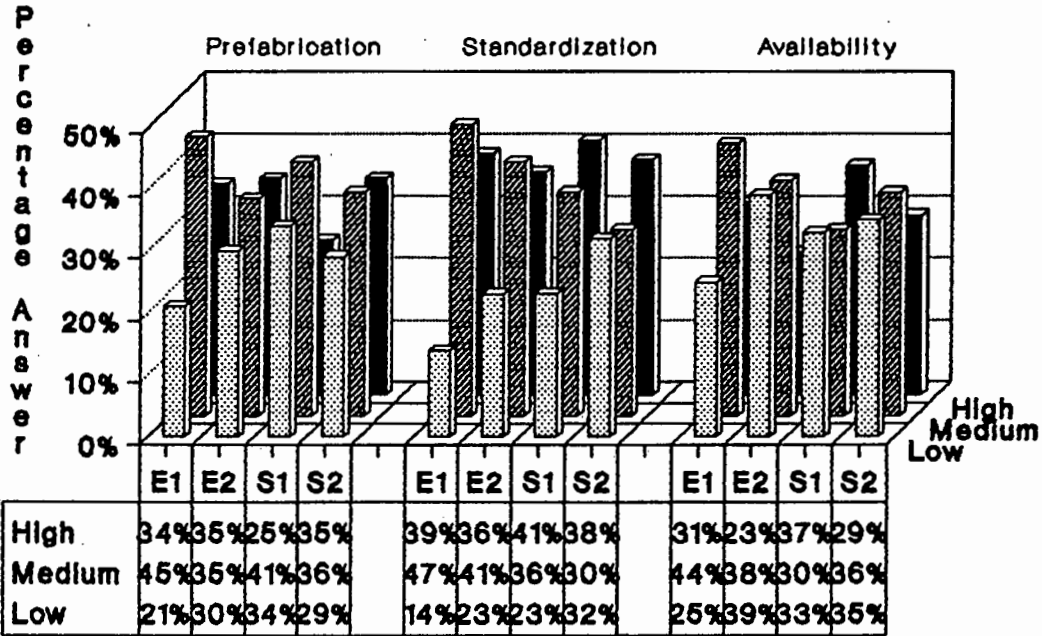


Figure 2.10 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Labor - Contract Agreements, Training, Quality Control.

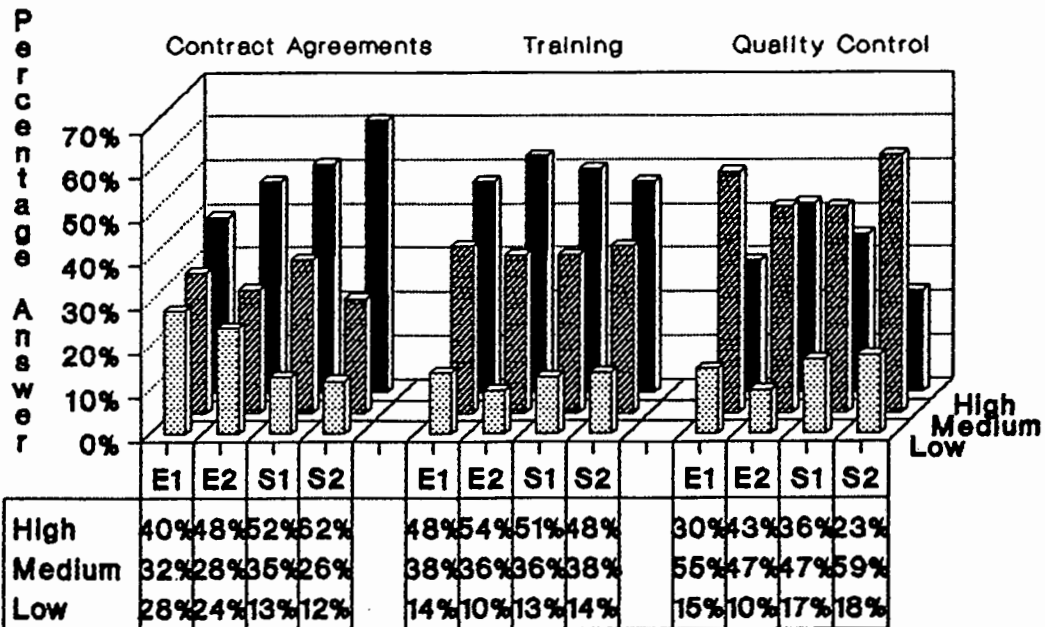


Figure 2.11 E1,E2 - ENR Top 400;
S1,S2 - Small / medium companies

Potential for Productivity Improvement. Labor - Turnover, Availability

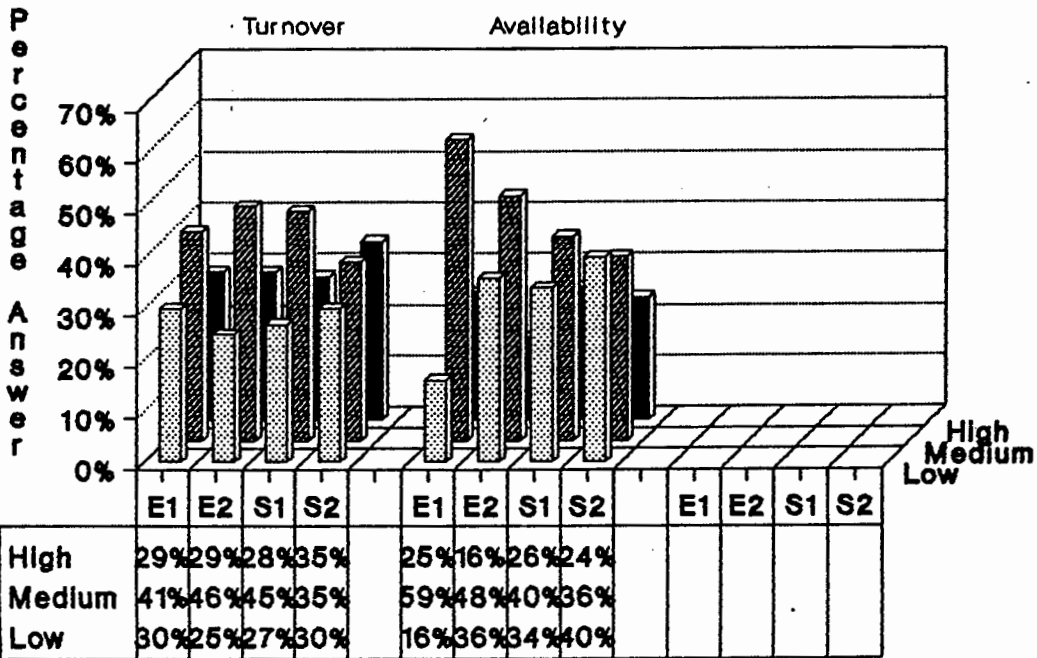


Figure 2.12 E1,E2 = ENR Top 400;
S1,S2 = Small / medium companies

Potential for Productivity Improvement. Equipment - Capacity, Simplicity, Maintainability.

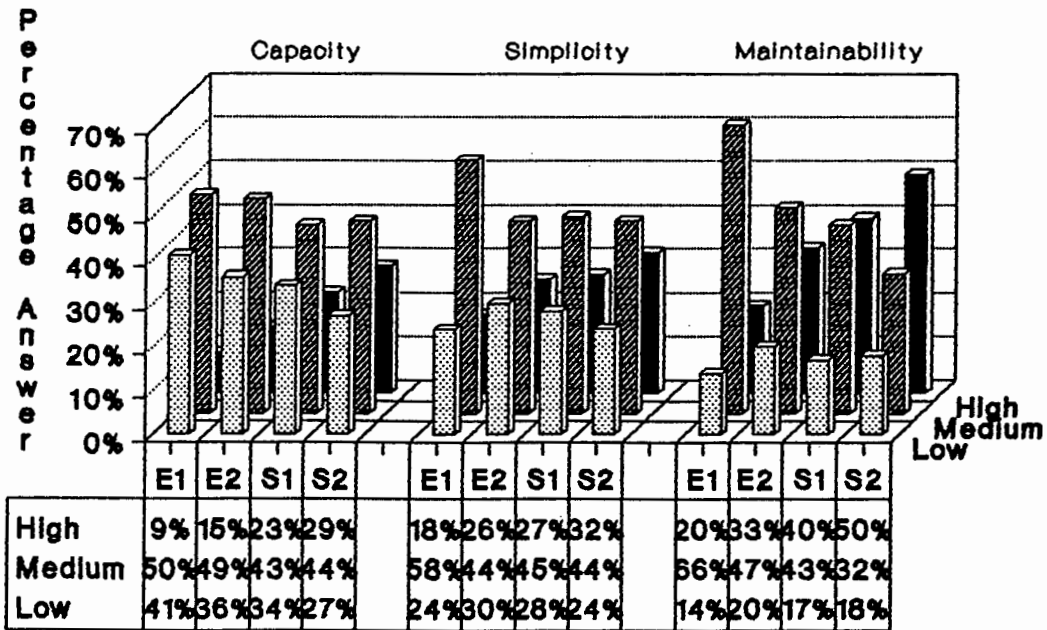


Figure 2.13 E1,E2 = ENR Top 400;
S1,S2 = Small / medium companies

Potential for Productivity Improvement. Equipment - Utilization

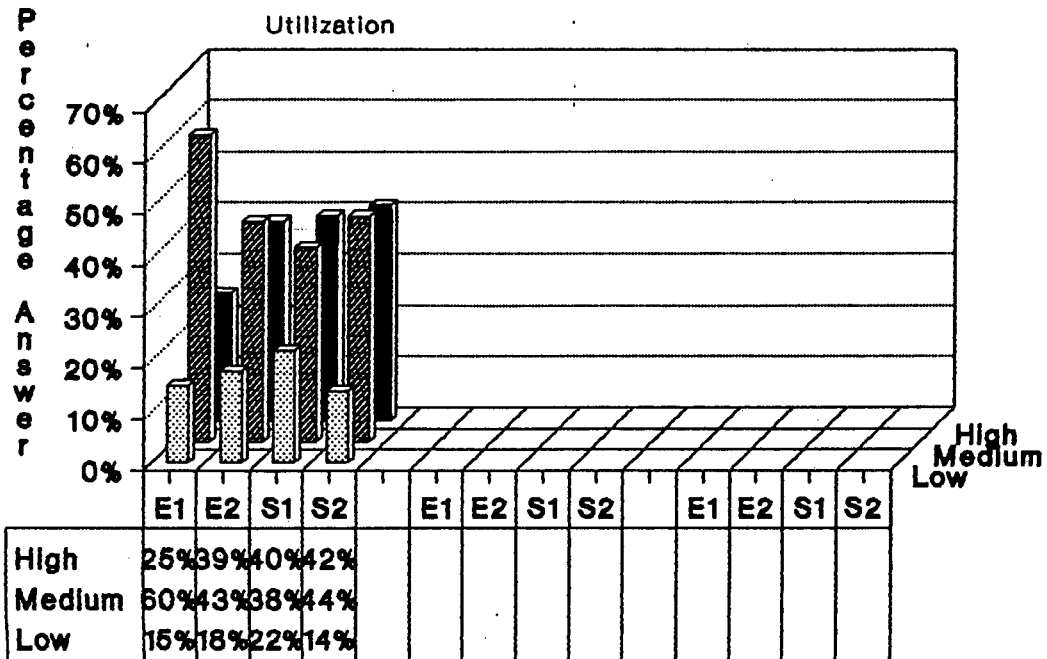


Figure 2.14 E1,E2 = ENR Top 400;
S1,S2 = Small / medium companies

Potential for Productivity Improvement. Engineering - Design Standards, Design Improvement, Standard Specifications.

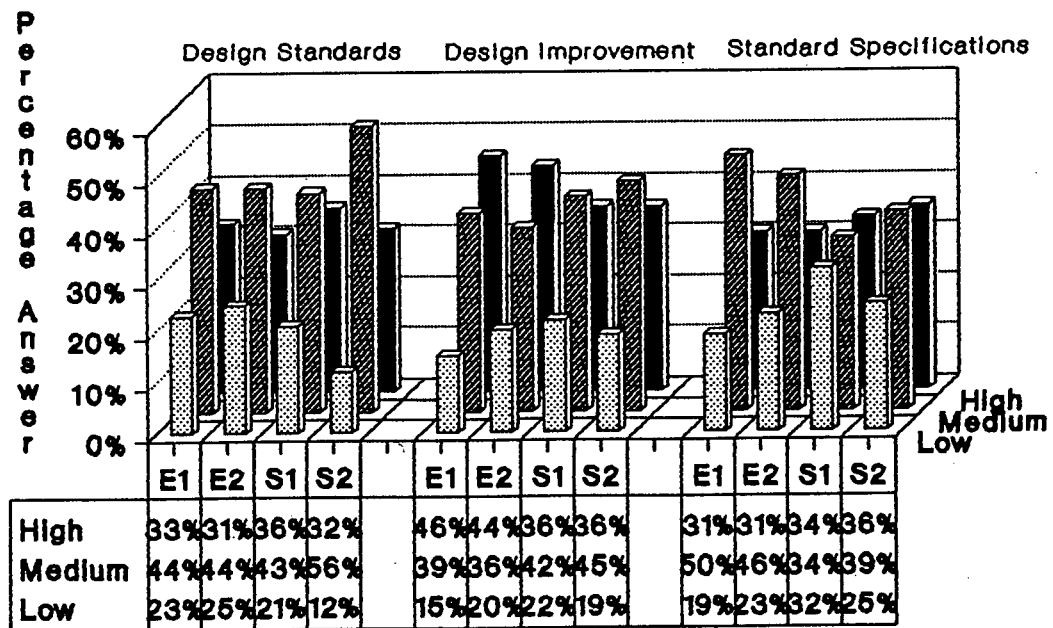


Figure 2.15 E1,E2 = ENR Top 400;
S1,S2 = Small / medium companies

Potential for Productivity Improvement. Construction Techniques - Pre-cast Pre-assembled, Foreign Technology.

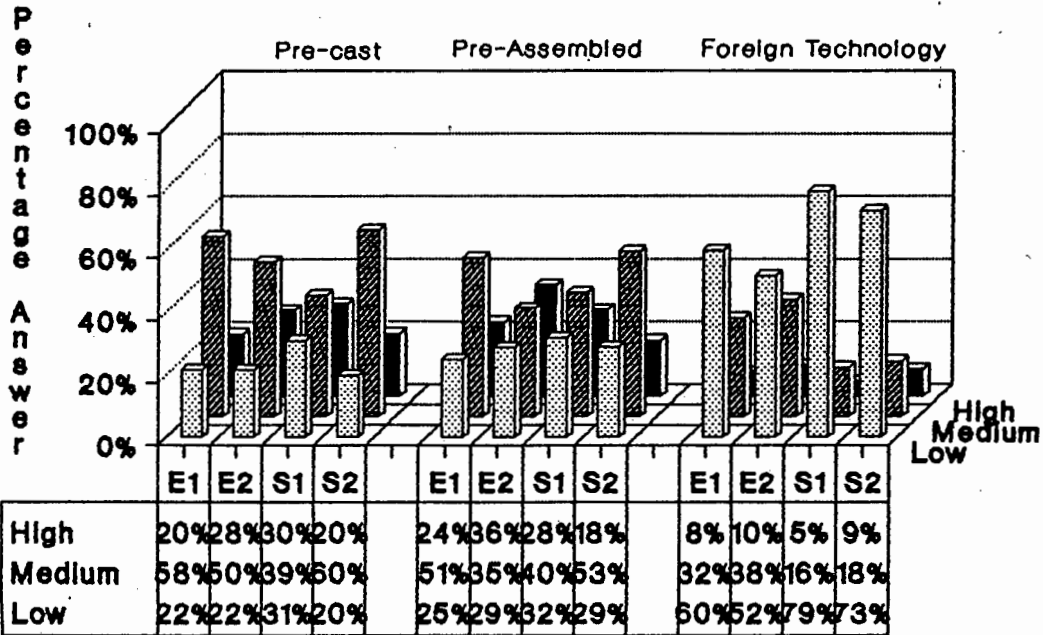


Figure 2.16 E1,E2 = ENR top 400;
S1,S2 = Small / medium companies

2.3 Prelude to the Analysis of Current Survey

The main objective of this survey is to ascertain the areas perceived by the executives in the South African construction industry which have the greatest potential for productivity improvement. Research into improving these areas will be conducted after the results of the survey are known.

Secondary objectives include:

- i) Determining the proportion of contractors who responded to the survey which engage mainly in either building, civils, or industrial construction, and those which are engaged in two or all of these categories.
- ii) Determining the ratio of temporary employees to permanent employees for various suitable company categories.
- iii) To correlate the proportion and value of owned and hired equipment to the size and type of company.
- iv) To ascertain the percentage of work (by Rand value) subcontracted on the average job, subject to the size of company.
- v) To examine the types of computer usage prevalent in the industry.
- vi) To determine the proportion of construction by type and Rand value, located in each geographical section of the country.
- vii) To evaluate and rate the importance that executives believe their labourers attach to certain motivational factors.
- viii) To determine which head-office and site functions are deemed to be most important concerning potential for productivity improvement for small, medium, and large companies.
- ix) To establish general interest expressed in participating in activities designed specifically to improve productivity in the construction industry.

The data will be analysed in a group format, taking the population as a single entity. Analysis to ascertain trends will then be performed, and finally, the total sample will be divided into smaller representative groups by the value of annual sales, and each group will be analysed as separate entities. This last step is necessary to enable the findings to be compared to the

results obtained in the United States. The comparison will not be of a direct Dollar / Rand-value nature due to the time elapsed between the U.S. surveys, and the present one. The differing rates of inflation, different population groups, and the incomparable changes in the strengths of the two currencies also reduce the value of such an analysis. Dividing the total population into small, medium, and large sized companies will provide a much more meaningful comparison, although there will still be many important limitations.

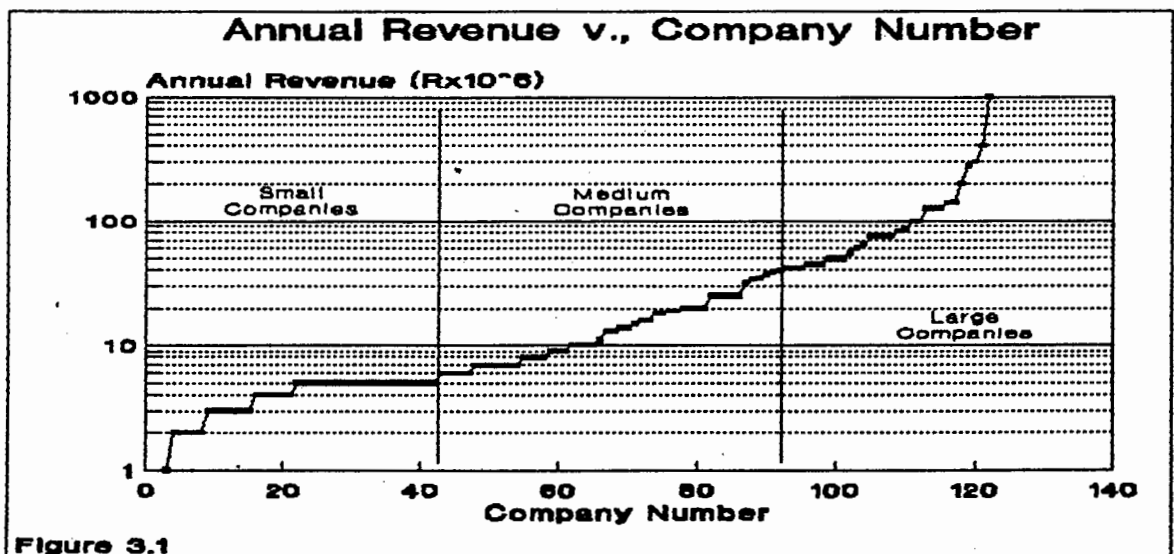
3. ANALYSIS OF SURVEY 1 - THE CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

The data will be analysed in four groups: (i) taken as one population, and then to enable comparison to the previous surveys, taken as groups of (i) large, (ii) medium, and (iii) small.

The number of surveys sent out was: 455 No.
The number undelivered: 10 No.
The number of spoilt returns: 3 No.
The number of useable returns: 122 No.
This is a percentage useable return of: $122/(455-10) = 27.4\%$

3.1 Analysis of Part 1. Questions 1 to 9.

The unprocessed data is presented in Appendix II. From there, it can be seen that the five largest companies have at least twice the annual revenues of their closest competition, bar one. This is illustrated in figure 3.1 below. A logarithmic scale was used to show more clearly the almost exponential increase in company size. The "company number" is used to identify specific questionnaires and was allocated according to the size of the company by their annual revenues. As the inclusion of the top five companies skews the data, the same information for companies 0 - 99 has been re-plotted using a linear scale in figure 3.2.



The data must be divided into three groups to enable comparison to the large, medium, and small groups in the previous surveys. In order to ensure that the three groups are statistically representative and comparable, it was decided to aim for three equally sized groups. The divisions have been shown in figure 3.2. The definitions are as follows:

Small: annual revenue < R5,500,000

Medium: ann. rev. > R5,500,000 and < R24,500,000

Large companies : annual sales > R24,500,000

The frequency of companies with particular annual sales is shown in figure 3.3. It can be seen that the majority of companies have sales less than R10,000,000.

In the following analysis, ordinates are usually plotted against the Rand annual revenues. As can be seen from figure 3.3, there are many companies having, for example, R5 million annual Rand revenues. For analysis purposes, the average ordinate as quoted by all companies having equal annual sales is plotted. For example, if 3 companies each having an annual revenue of R9 million record that their number of permanent employees are 175, 160, and 45 respectively, then the ordinate plotted against R9 million will be $(175 + 160 + 45) / 3 = 127$. For this reason, care must be

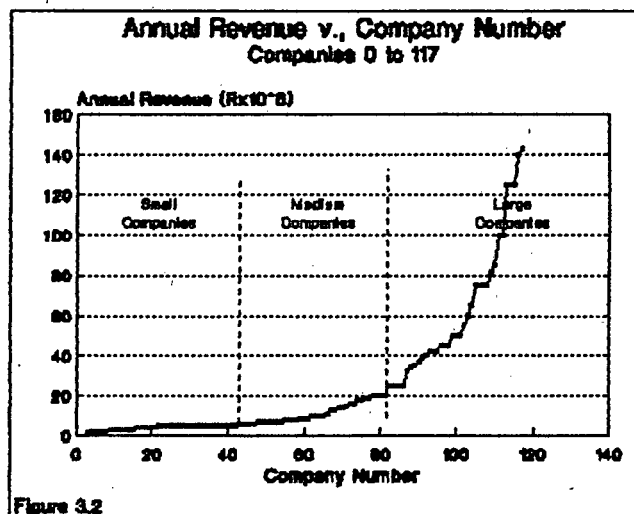


Figure 3.2

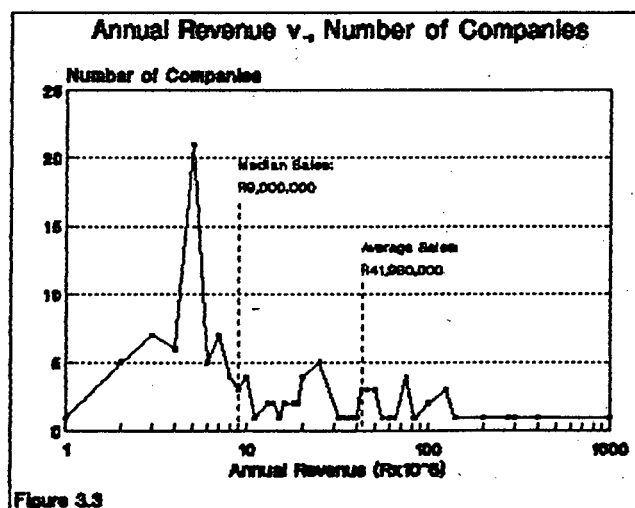


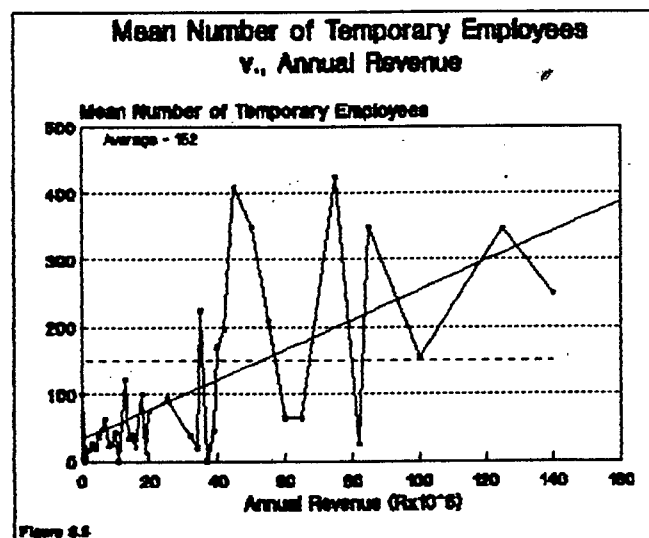
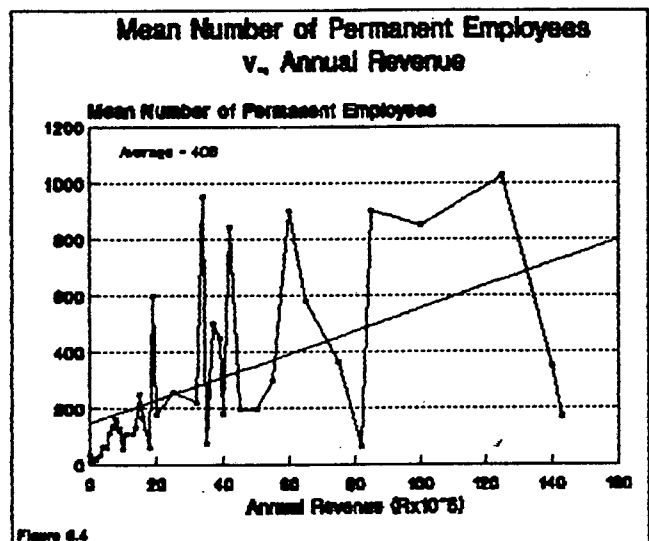
Figure 3.3

taken when drawing conclusions from the data presented in the following analysis. For example, the average ordinate of the 21 companies with an annual revenue of R5 million will be much more significant than the ordinate plotted against the single company with an annual revenue of R300 million. Figure 3.3 will give the reader a feel for the significance of data according to the number of companies represented by a particular annual revenue. In the analysis of sections 3.3 and 3.4, the ordinates of the companies with annual sales over R150 million have been grouped and averaged so as to achieve more meaningful results.

3.1.1 Number of Employees

The graphs showing mean number of employees against annual revenues (see figures 3.4 - 3.6) were plotted by averaging the number of employees in companies having equal annual revenues. As is intuitively obvious, the larger the company, the more people are employed. The mean number of total employees was calculated by summing the number of permanent and temporary employees.

The coefficient of linear regression (R^2) is closer to 1 for the data representing total employee number than it is for either permanent or temporary employees. This shows that the total number of employees for a particular sized company is almost directly related to that



company's annual revenues, while the company's employment policies influence the number of temporary and permanent employees.

More important however, is the relationship between employee productivity and the size of the company. The productivity has been measured in terms of the number of employees per million Rand annual turnover. (See figure 3.7) Provided that all companies undertake the same type of work with similar capital intensity, it can be seen that productivity reaches a maximum when annual turnover is R90 million. Productivity, measured in these terms, is lowest in the small to medium sized companies, that is, those with an annual turnover of less than R10 million.

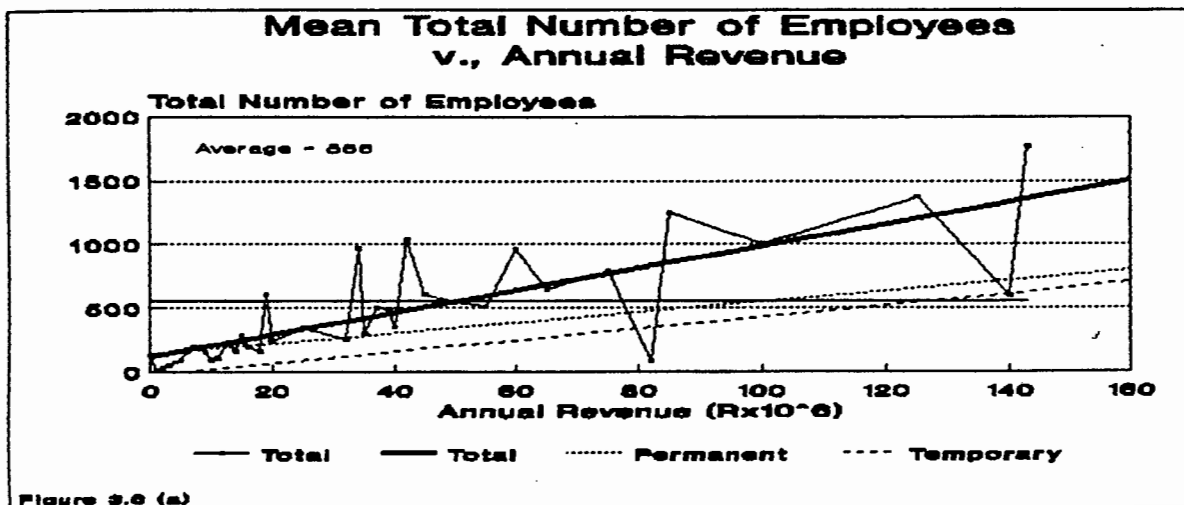


Figure 3.6 (a)

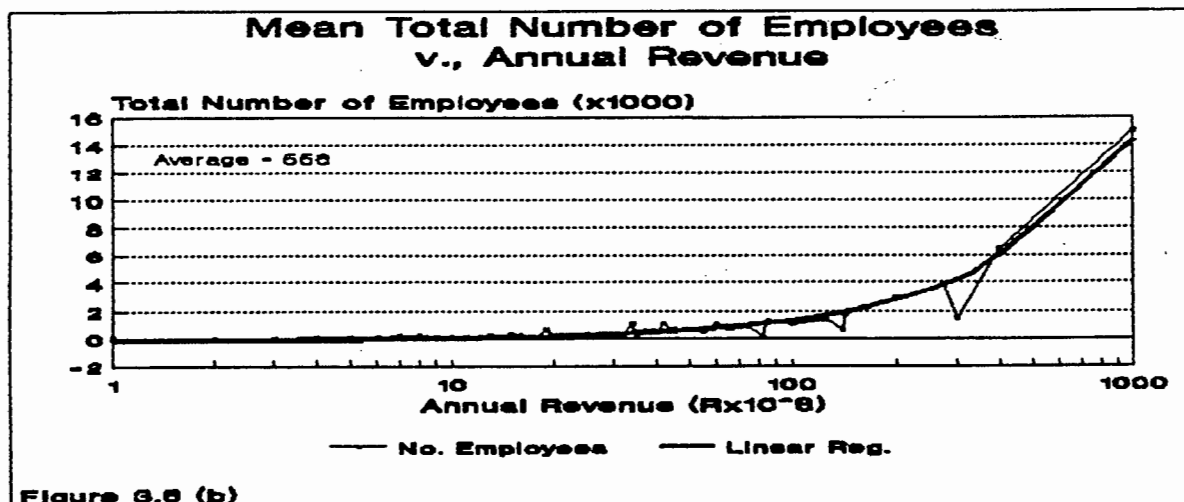


Figure 3.6 (b)

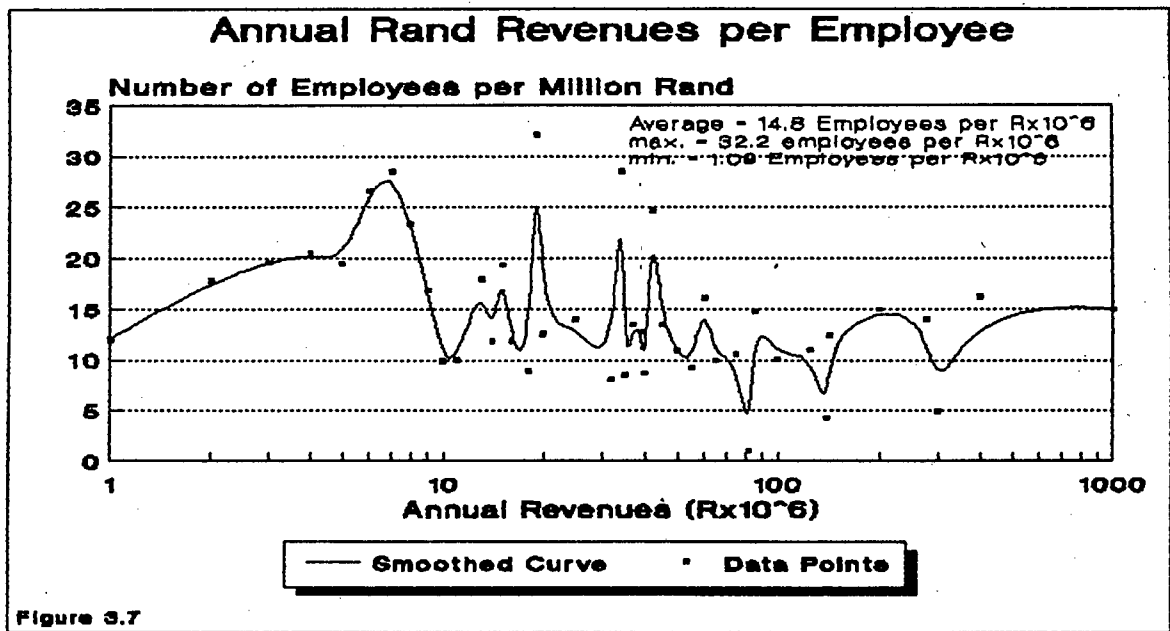


Figure 3.7

3.1.2 Types of Work

Question 1 of the survey requested the respondents to indicate the types of work they undertook. The types were classified as (i) Building (Educational, Commercial, etc.), (ii) Civils (Highways, Dams, Bridges), and (iii) Industrial (Power Plants, Refineries, etc.). As can be seen from figure 3.8 below, most companies concentrate on one type of work.

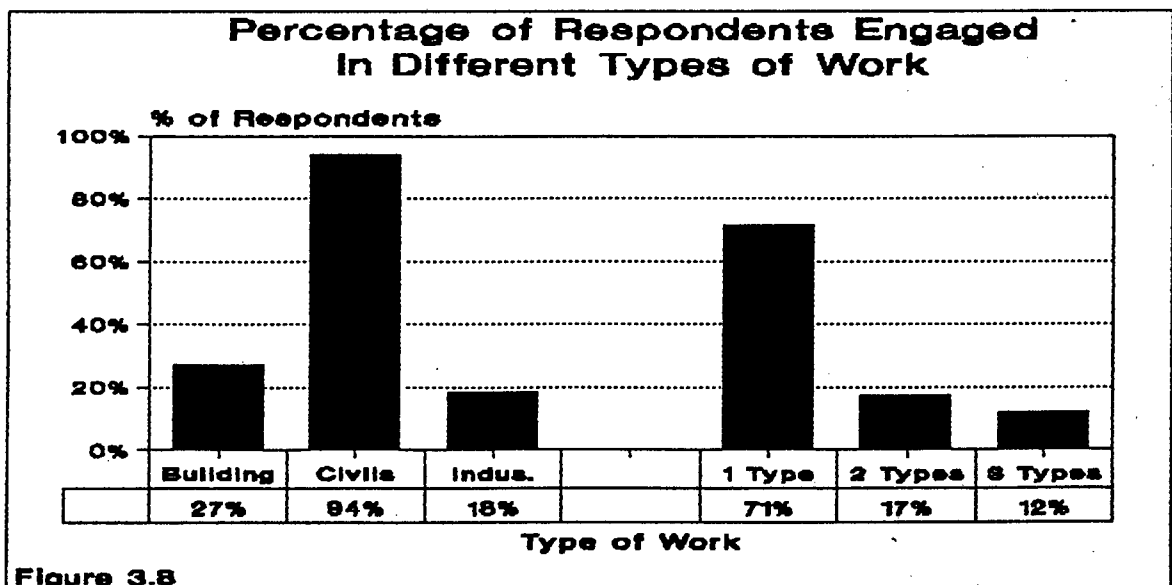


Figure 3.8

3.1.3 Replacement Rand Value of Construction Equipment

Figure 3.9 shows the relationship between the replacement Rand value of equipment owned by companies exhibiting different annual turnovers. As is expected, the large companies have more equipment than the smaller companies. The thick line shows the value of equipment per million Rand annual revenues. From here, it is seen that the larger companies have proportionally less equipment than the small companies.

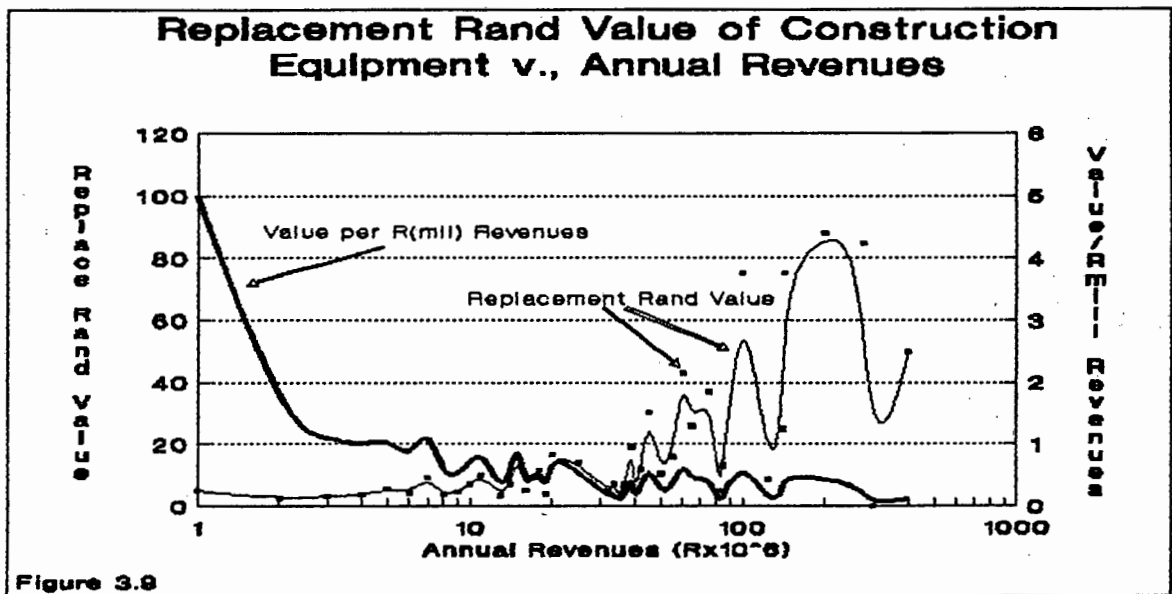


Figure 3.9

3.1.4 Mean Percentage of Equipment Hired

Question 6. sought information about the percentage of construction equipment hired from outside sources. This information is presented in figure 3.10. Most of the companies hire about 20% of their plant regardless of their size.

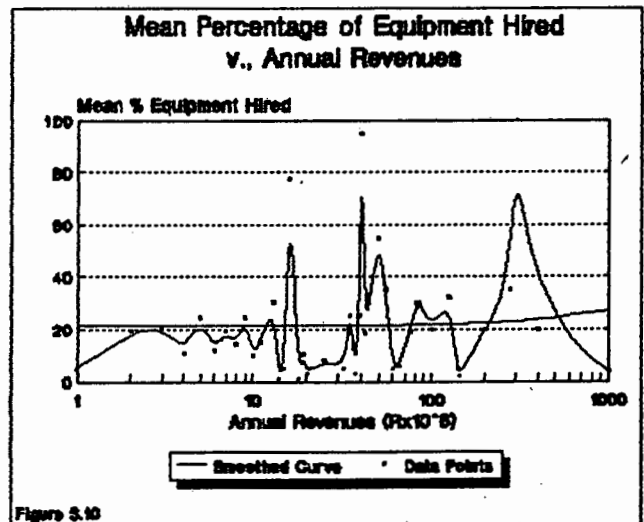
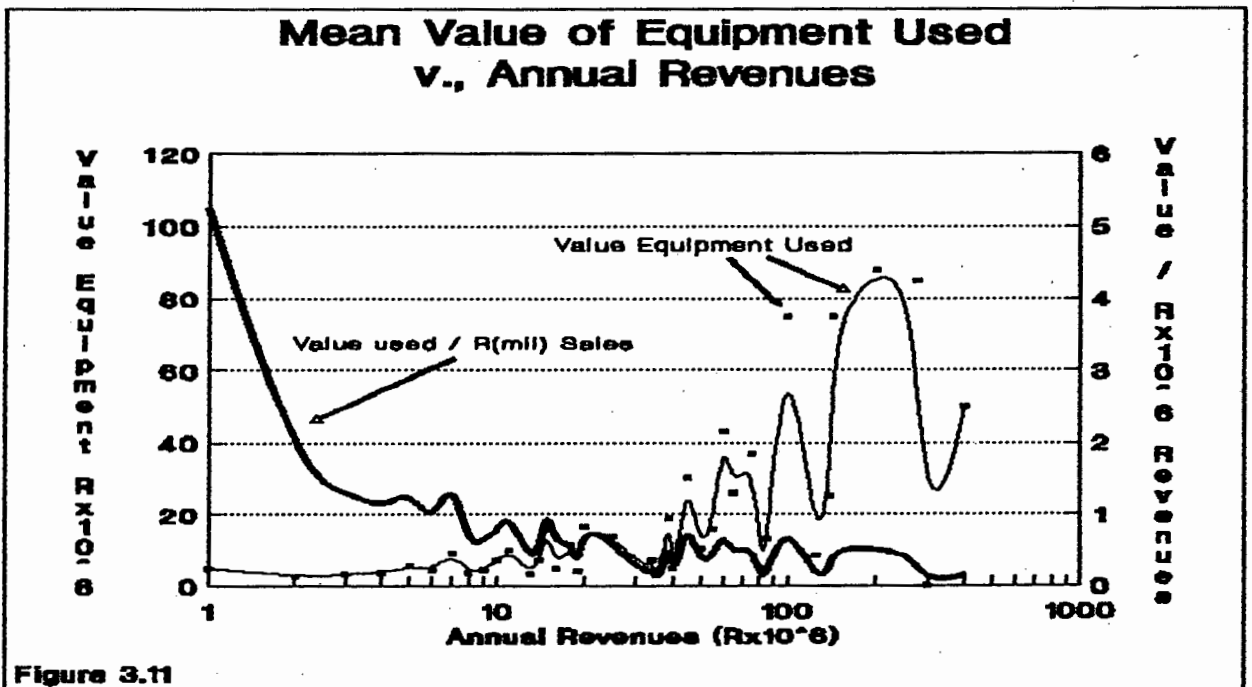


Figure 3.10

A measure of equipment productivity is obtained by estimating the value of equipment used per million Rand of annual sales. This is reliant on a linear relationship between the value of the annual sales and the total number of labourers employed across the range of companies. That is, the equipment productivity, or the value of construction performed by R1.00 worth of equipment in a large company can only be compared to that of a small company if they both use the same amount of labour, i.e. do not substitute labour for plant when performing similar tasks. Referring to figure 3.6, there is an approximately linear relationship between the total number of employees, and the value of annual sales. The coefficient of linear regression across the full range of companies is 0.95. Figure 3.7 shows the labour productivity. The larger companies record slightly fewer labourers per Rand annual sales than do the small companies.



In figure 3.11, the thin line denotes the replacement value of equipment used, that is equipment owned plus equipment hired, throughout the range of companies. The thick line denotes the equipment productivity, which is the ratio of the value of the equipment used to the value of the work undertaken annually. On

average, the large companies have an equipment productivity ratio of about 0.5. The smaller companies exhibit a ratio of about 2, which suggests that their equipment is only one quarter as productive as that owned by large companies. This information, combined with the slightly higher labour productivity experienced in large companies, implies that they are generally more productive than the smaller companies. Large organizations are more able to secure large contracts which enables them to achieve a bigger economy of scale than the smaller companies. This partly accounts for their superior productivity.

3.1.5 Percentage of Work Subcontracted

On average, 14% of work by Rand value is subcontracted in construction work. As is intuitive, the larger companies subcontract more than the medium to small companies, and the very small companies usually subcontract less than 8% of their work. These figures are illustrated in figure 3.12.

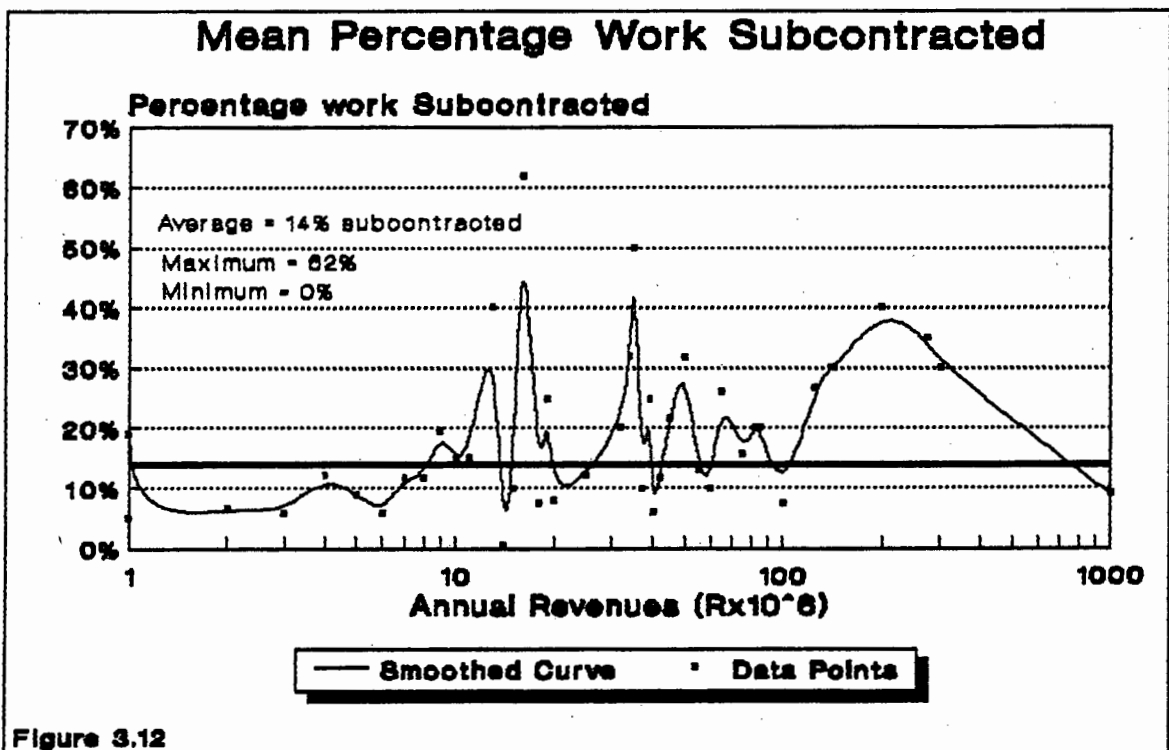


Figure 3.12

3.1.6 Types of Computer Usage

The survey asked the respondents to classify their computer usage into groups headed: (i) On Site, (ii) Centralized Control, (iii) Terminal to Outside Service, and (iv) None. It was found that 74% of the companies used centralized control, and that 78% of the companies used only one type of computer service. 10% of companies had no computer service available.

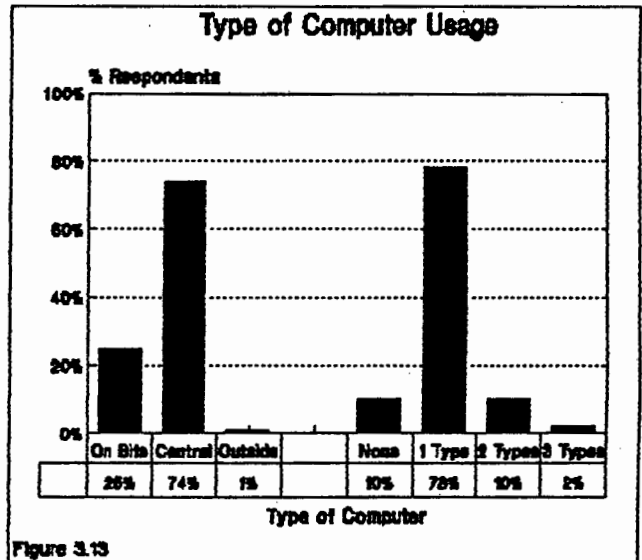


Figure 3.13

3.1.7 Geographic Location of Projects

The geographic dispersion of the construction companies responding to the survey is illustrated in figure 3.14. The majority (69%) of respondents operate in only one of these geographic locations.

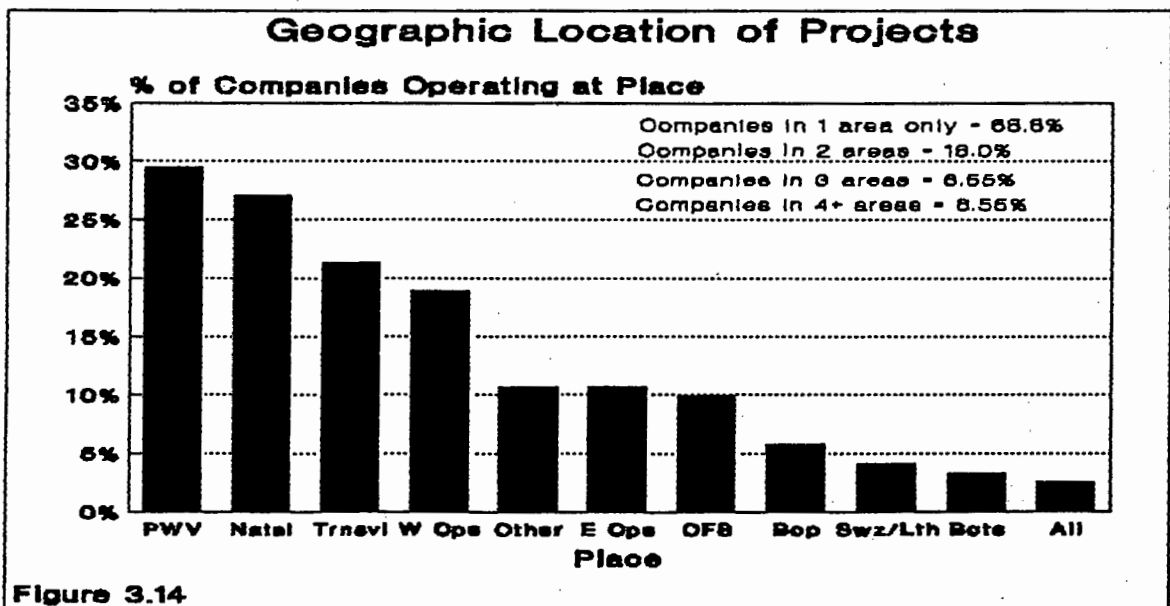


Figure 3.14

3.2 Analysis of Part 2. Question 10.

Question 10. asked the respondents to rate certain motivational factors as to the importance they believed their labourers attached to these factors. The motive was to compare these results to the *actual* importance the labourers attach to the factors which will be determined at a later stage. The executives would rate their believed importance on a scale from 1 to 5. The idea was borrowed from a previous survey, and the results are listed in table 3.1 below. (See Volume 1, Ch.4, p.47 for a more complete insight to the previous study.) At this stage, the actual importance that the labourers attach to the factors is not known.

TABLE 3.1

Ranking of Motivational Factors According to the Executives Beliefs

This Survey		Previous Survey	
		Supervis. Ranking	Employee Ranking
1	Good Wages	1	5
2	Financial Incentives		
3	Job Security	2	4
4	Good Working Conditions	4	7
5	Full Appreciation of Work Done	8	2
6	Sympathetic Help with Personal Problems	9	9
7	Personal Loyalty to Employees	7	8
8	Tactful Approach to Discipline	6	10
9	Promotion and Growth in the Organization	3	6
10	Feeling of being in on things	10	3
11	Interesting Work	5	1

The relative importance of each motivational factor is shown in figure 3.19 below. The importance is evaluated by summing the ratings attached to the each of the factors.

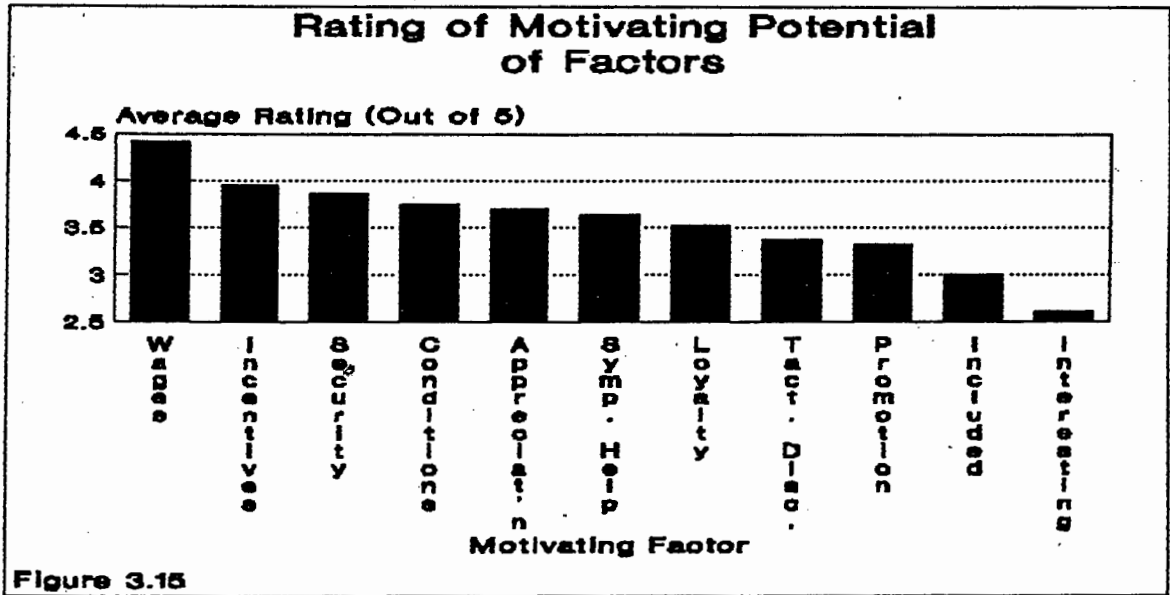


Figure 3.15

The distributions of the respondents' answers are illustrated in the following figures. The factors are coded as follows:

- 1 = Tactful approach to discipline
- 2 = Interesting work
- 3 = Sympathetic help with personal problems
- 4 = Personal loyalty to employees
- 5 = Feeling of being in on things
- 6 = Good working conditions
- 7 = Promotion and growth in the organization
- 8 = Good wages
- 9 = Financial incentives (bonuses, prizes, etc.)
- 10 = Full managerial appreciation of work done
- 11 = Job security

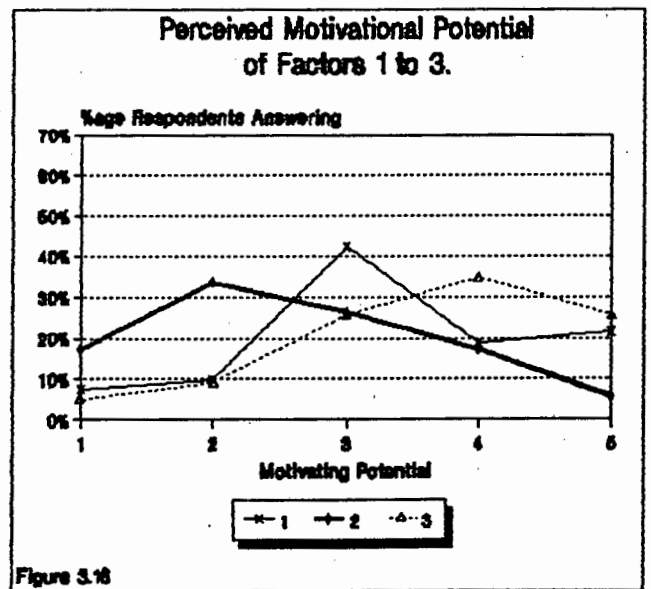
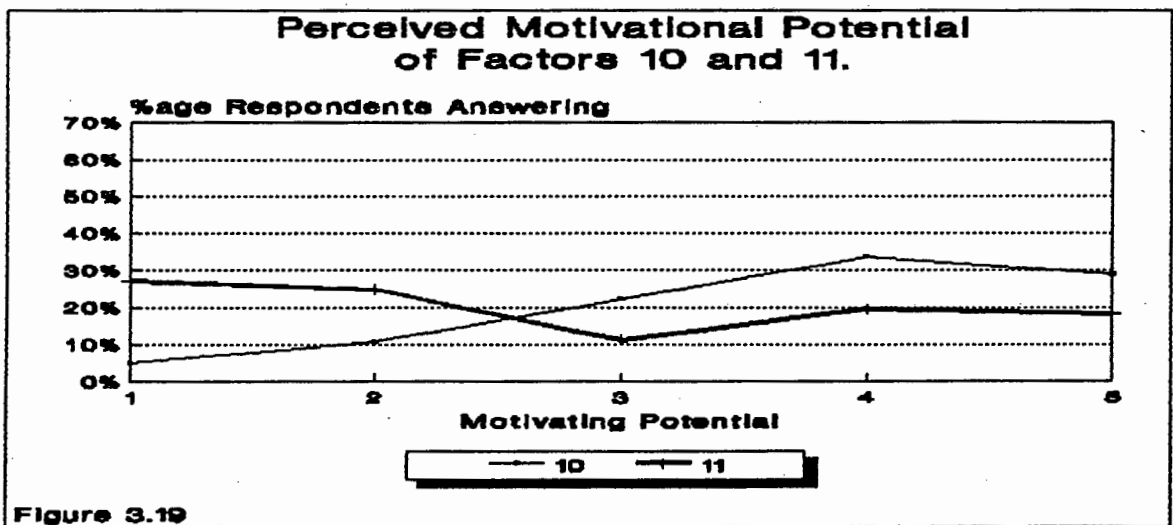
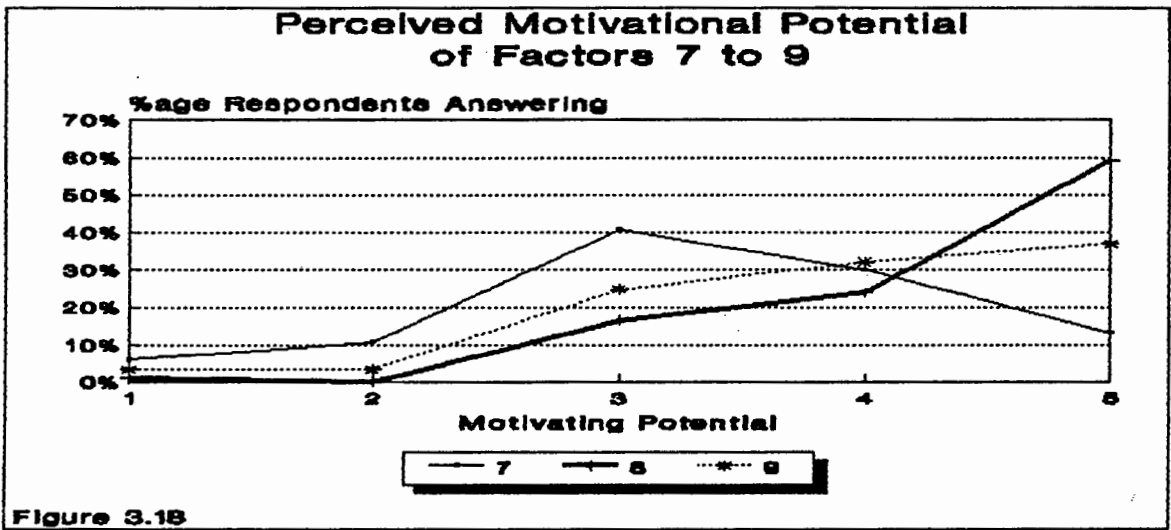
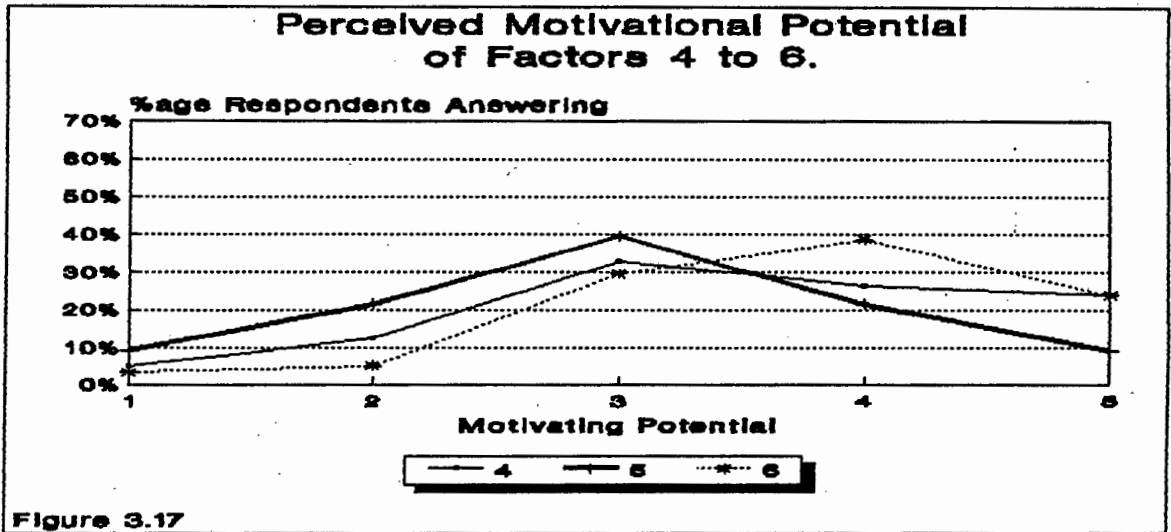
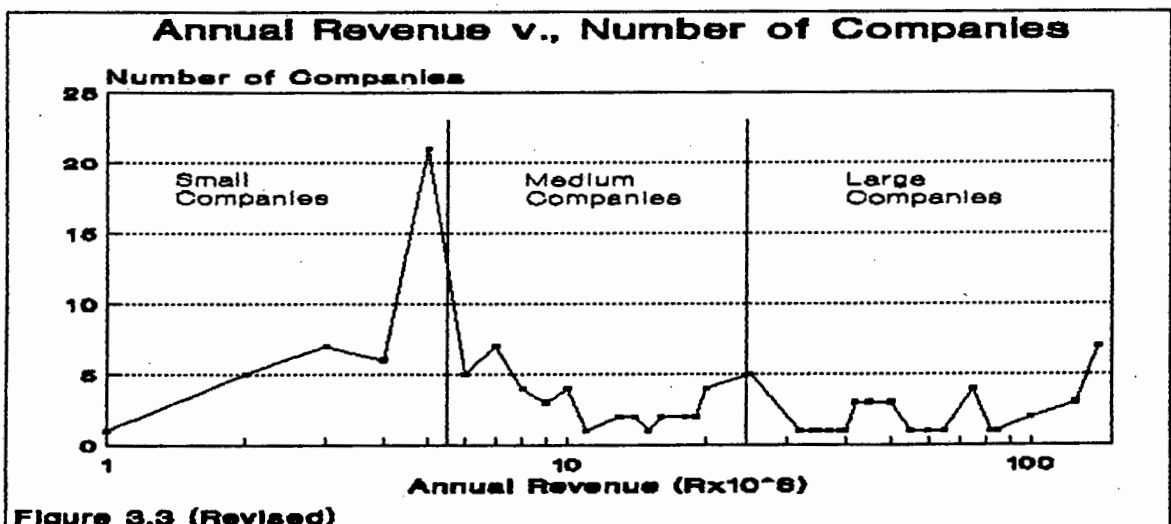


Figure 3.16



3.3 Analysis of Part 3. Question 11.

Question 11 is concerned with the potential for opportunity with respect to productivity improvement for certain "headquarter-type" functions. The respondents were asked to rate the functions with score from 1 (needs no improvement) to 5 (needs much improvement). The data is analysed in a trend form. Where two or more companies have the same annual sales, the average potential for improvement is used. Similarly, the data collected from companies with annual revenues over R140 million have been grouped and averaged so as to normalize anomalies created by freak results. Figure 3.3 (p.22) shows that all ordinates plotted against annual revenues above R140 million are recorded by single companies, and therefore averaging the results from these companies enhances the statistical significance for this new group. Figure 3.3 (Revised) shown below, illustrates the revised grouping of the companies according to their annual revenues. From here it can be seen that all companies with annual revenues of more than R140 million are now taken as one company size. These few companies are so large when compared to the rest of the population, that for the purposes of this analysis, they can be considered of equal size. The data is also averaged over the small, medium, and large companies to allow comparison to the results obtained from the previous surveys conducted in the U.S.A.°



It is important to relate the results of this survey to those conducted in the U.S.A. However, in the previous surveys, respondents were asked to rate the functions "high, medium, or low" with respect to potential for productivity improvement. It is therefore necessary to translate the "high, medium, and low" ratings used previously to the five point scale used to collect data in the current survey. In order to accomplish this, the average proportion of the companies in each size category answering high, medium, or low, were weighted by 4.4, 3.0, and 1.6 respectively. These weighted proportions were summed to obtain scores which can be compared to those obtained using the five point scale. The magnitudes of the weights (4.4, 3.0, and 1.6) were chosen at the authors' discretion. An example of the procedure appears in table 3.2 below.

TABLE 3.2

An Example of Converting High, Medium, and Low Scores to the Five Point Scale.

COMMUNICATIONS

Data taken from figure 2.6

Large Companies

Category	E1*	E2*	Mean(M)	Weight(W)	Score = MxW
High	35%	43%	39%	4.4	1.72
Medium	50%	46%	48%	3.0	1.44
Low	15%	11%	13%	1.6	0.21
Total					3.37 = +/- 3.4

* E1, E2 refer to the surveys conducted in references 4 and 5 on the ENR top 400 companies.

3.3.1 Communications

Previous Ratings are:

Small/medium 3.5

Large 3.4

(Refer to Figure 2.6)

The ratings for this function are very similar to those recorded in the previous surveys. Previously, however, the large companies rated this function lower than did the small companies.

3.3.2 Planning

Previous Ratings are:

Small/medium 3.8

Large 3.6

(Refer to Figure 2.5)

The ratings in the current survey are substantially below those recorded previously.

3.3.3 Scheduling

Previous Ratings are:

Small/medium 3.5

Large 3.4

(Refer to Figure 2.5)

Again, the current ratings are well below those estimated from the studies done in the United States.

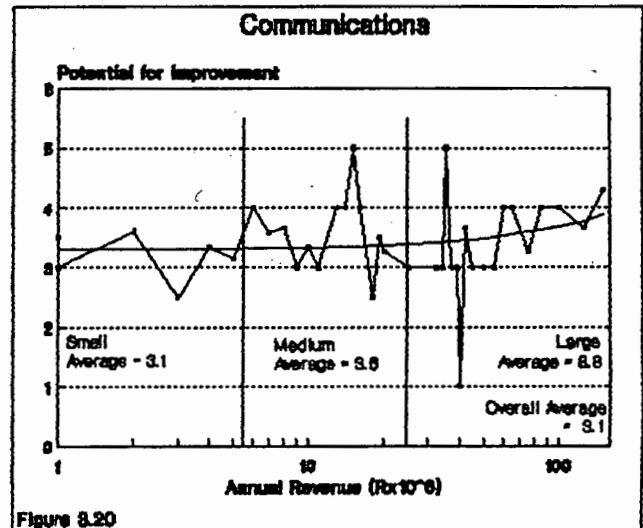


Figure 3.20

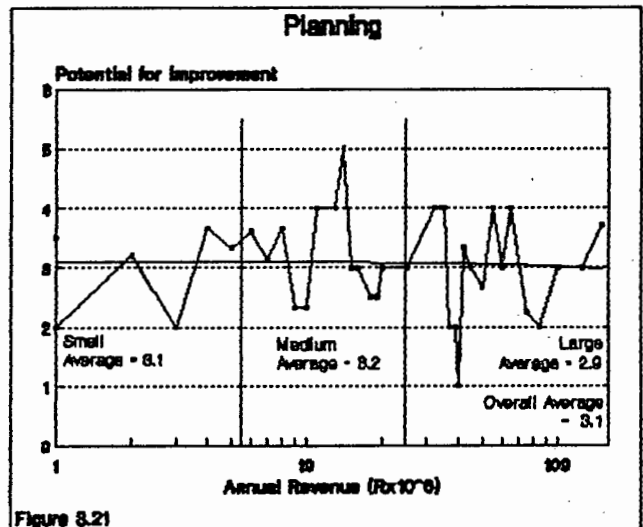


Figure 3.21

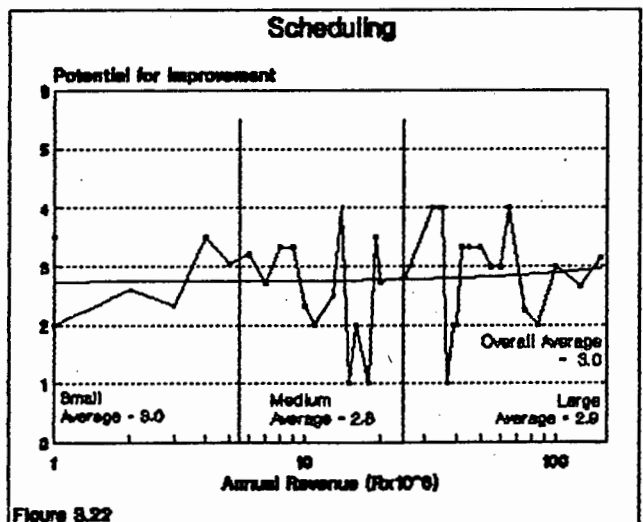


Figure 3.22

3.3.4 Estimating

Previous Ratings are:

Small/medium 2.8

Large 3.2

(Refer to Figure 2.5)

The disparity in importance of this function between the small/medium companies and the large companies is apparent in both the current and the previous surveys.

3.3.5 Marketing

Previous Ratings are:

Small/medium 2.4

Large 3.0

(Refer to Figure 2.6)

The current ratings for marketing are much higher than the previous ones. The rise in importance of marketing is still apparent from small to large companies.

3.3.6 Procurement

Previous Ratings are:

Small/medium 2.9

Large 2.8

(Refer to Figure 2.6)

The large companies in the current survey put more of an emphasis on the procurement function.

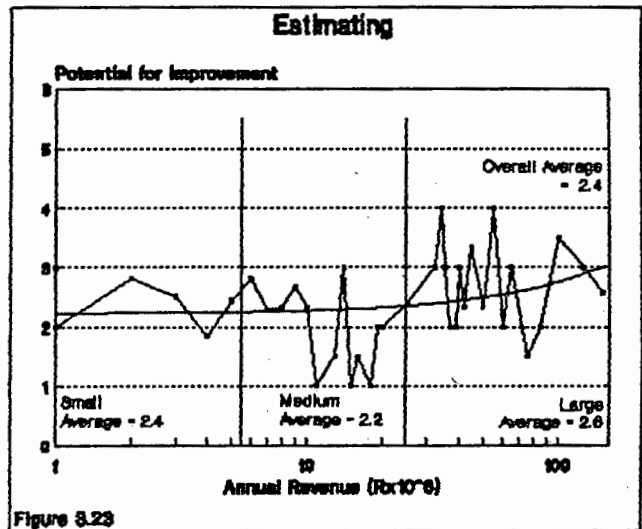


Figure 3.23

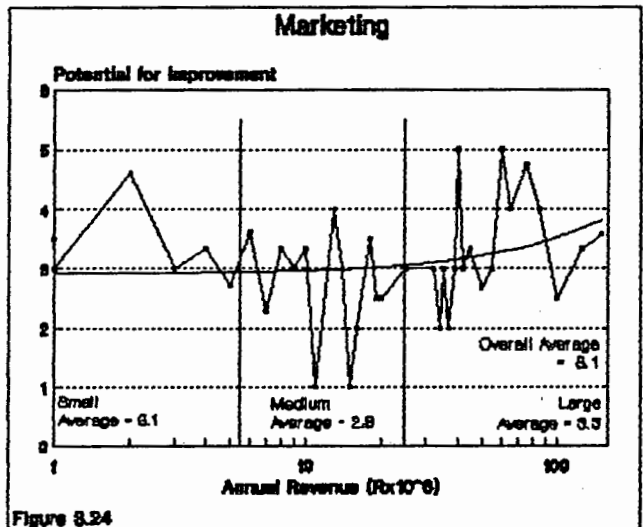


Figure 3.24

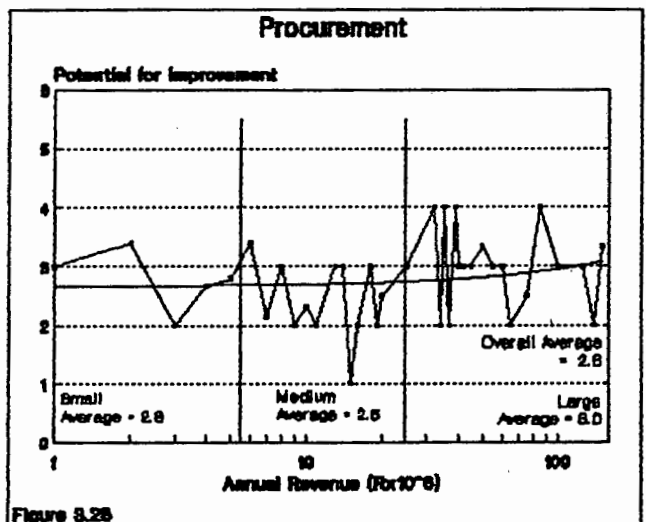


Figure 3.25

3.3.7 Drafting

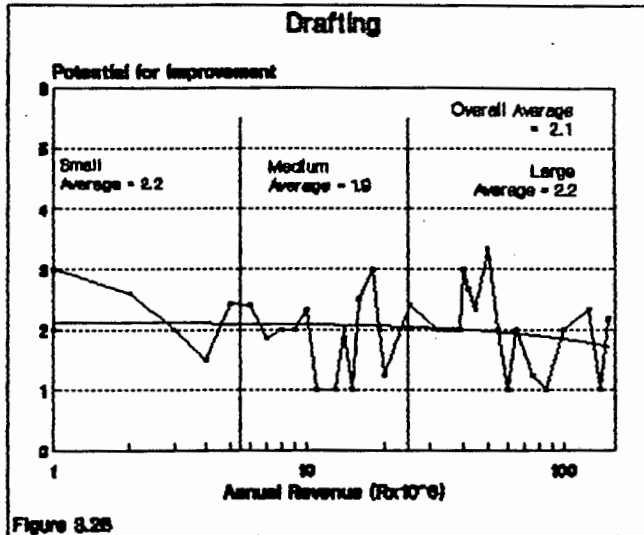
Previous Ratings are:

Small/medium 2.4

Large 2.5

(Refer to Figure 2.7)

There is a large comparative drop in improvement potential in the medium sized companies. Overall, potential is lower than in previous surveys.



3.3.8 Specifications

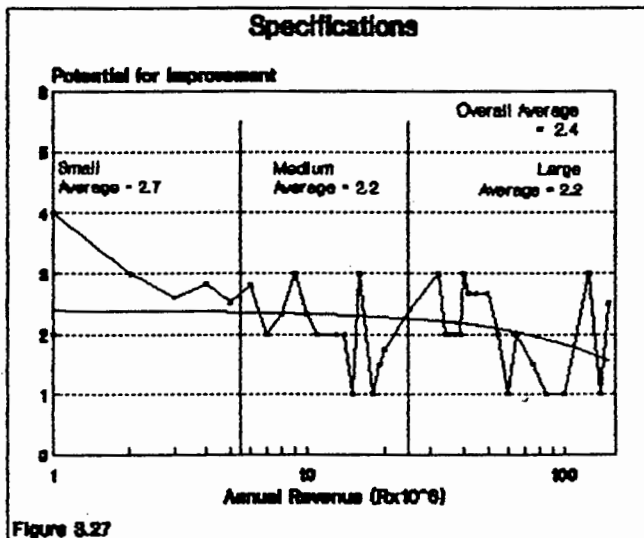
Previous Ratings are:

Small/medium 3.0

Large 2.7

(Refer to Figure 2.7)

The current ratings are about 0.5 points below those in the original surveys. Many respondents did not rate this function.



3.3.9 Engineering

(Design)

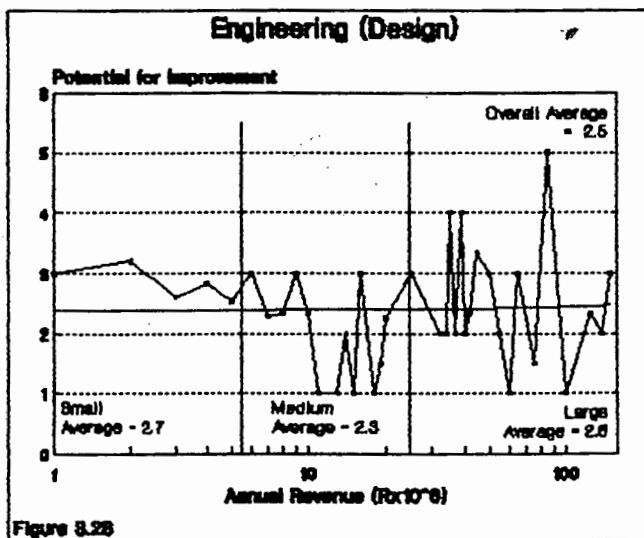
Previous Ratings are:

Small/medium 3.0

Large 2.9

(Refer to Figure 2.7)

The disparity between the current and previous ratings is more noticeable in the small/medium companies than in the large companies.



3.4 Analysis of Part 4. Question 12.

Question 12. asked the respondents to rate on a scale from 1 to 5, certain "site-type" functions with respect to their opportunity for productivity improvement. The rating "1" means that the function needs no improvement, whereas the rating "5" suggests that the function needs much improvement. These functions were categorized into groups headed (i) Materials (ii) Management, (iii) Equipment, (iv) Engineering, (v) Regulatory Boards, (vi) Labour, and (vi) Construction Techniques.

Note: The data is analysed in a trend form. Where two or more companies have the same annual sales, the average potential for improvement is used. The data is further averaged over the small, medium, and large companies to allow comparison to the results from the previous U.S.A. surveys. Comments on the data and the comparisons will appear in volume 3.

To allow comparison to the results obtained from the previous surveys, those results have been weighted so as to convert them to the same form as the results collected during this survey. Table 3.2 shows an example of the weighting procedure.

3.4.1 Materials

These questions deal with the handling, applications, and availability of new and existing materials.

Delivery

Previous ratings are:

Small/medium 3.5

Large 3.1

(Refer to Figure 2.9)

Small/medium companies currently rate this function much lower than they did in the previous surveys.

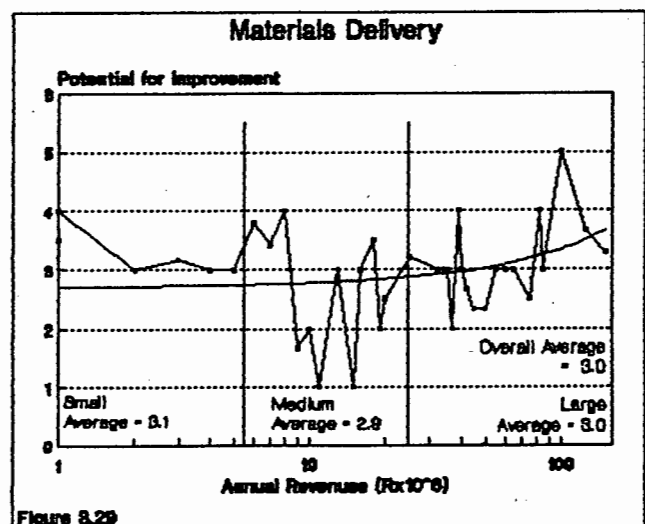


Figure 3.29

Storage

Previous ratings are:

Small/medium 2.6

Large 2.7

(Refer to Figure 2.9)

The storage of materials does not pose much need for improvement, and this has not changed from the previous to the present surveys.

Packaging

Previous ratings are:

Small/medium 2.2

Large 2.3

(Refer to Figure 2.9)

The ratings concerning the packaging of materials do not show much difference in opportunity for improvement. The average rating of 2.3 indicates a well performed function.

Prefabrication

Previous ratings are:

Small/medium 3.0

Large 3.1

(Refer to Figure 2.10)

This function should not be confused with pre-cast work. The current ratings are far lower than those indicated previously.

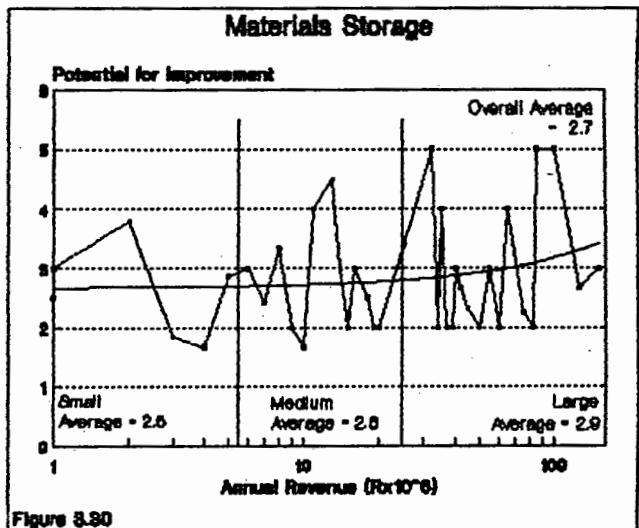


Figure 3.30

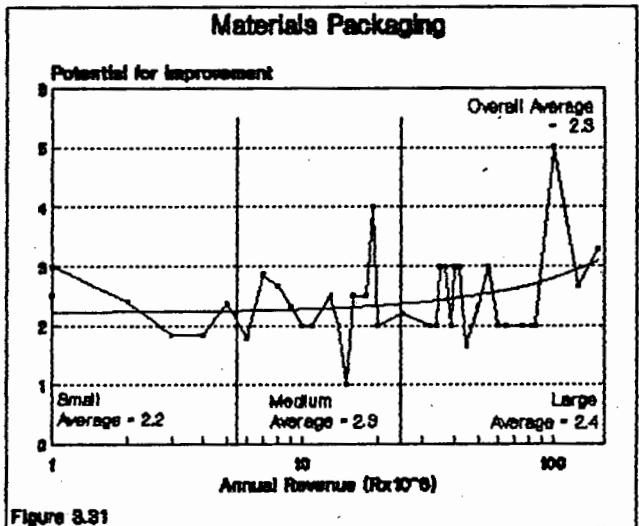


Figure 3.31

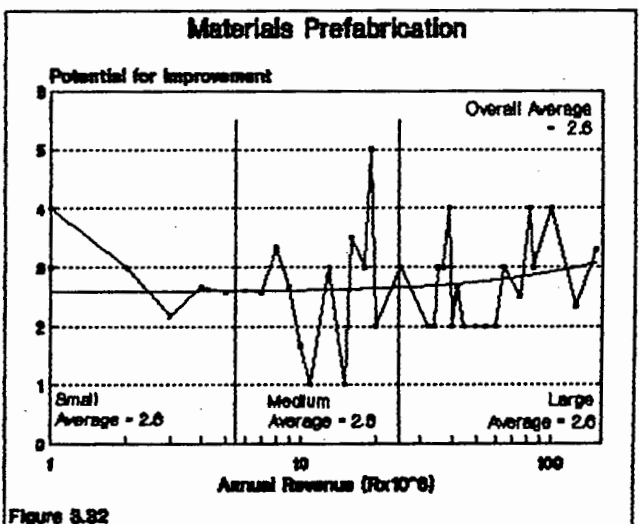


Figure 3.32

Standardization

Previous ratings are:

Small/medium 3.2

Large 3.3

(Refer to Figure 2.10)

The ratings recorded in the current survey are similar to those recorded previously. The ratings indicate substantial room for improvement.

Product Availability

Previous ratings are:

Small/medium 3.0

Large 2.9

(Refer to Figure 2.10)

A slightly higher rating was given to this function by the small/medium companies during the current survey.

New Products

Previous ratings are:

Small/medium 3.0

Large 2.9

There was a downward trend in the need for improvement for this function from the small/medium, to the large companies in the previous surveys. However, the trend is currently in an upward direction.

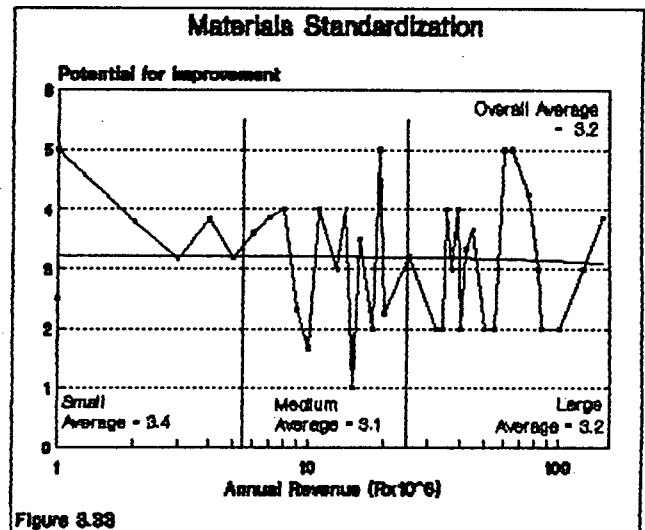


Figure 3.33

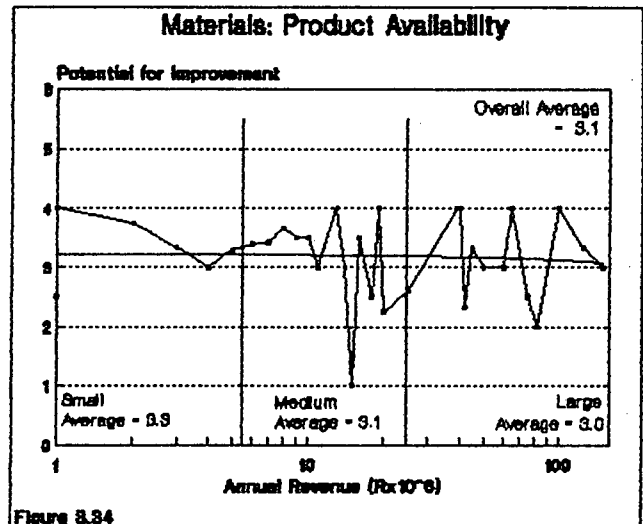


Figure 3.34

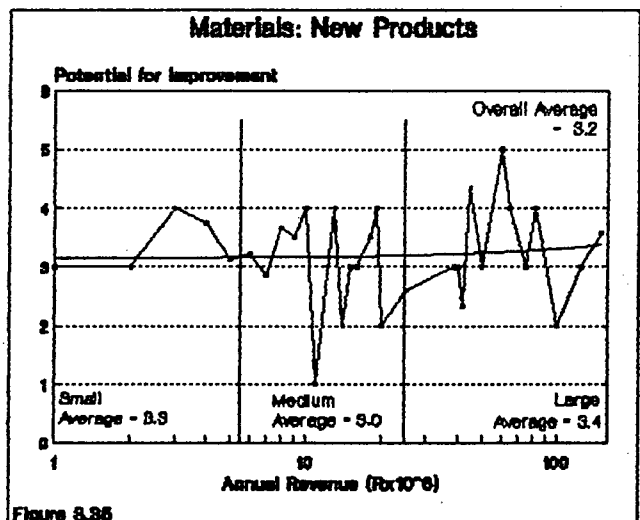


Figure 3.35

3.4.2 Management

Labour Relations

Previous ratings are:

Small/medium 3.7

Large 3.4

(Refer to Figure 2.8)

Surprisingly, the current ratings for labour relations in the small/medium companies are lower than those recorded in the original studies.

Cost Control

Previous ratings are:

Small/medium 3.4

Large 3.4

(Refer to Figure 2.8)

The large companies presently exhibit less need to improve this function than do the small companies.

Supervision

Previous ratings are:

Small/medium 3.9

Large 3.5

(Refer to Figure 2.8)

The downward trend seen in the previous surveys has been reversed in the current one, with the large companies suggesting more room for improvement than the small/medium companies.

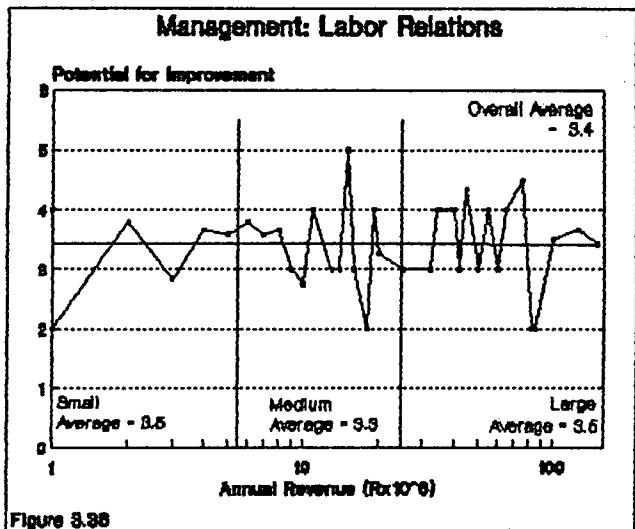


Figure 3.36

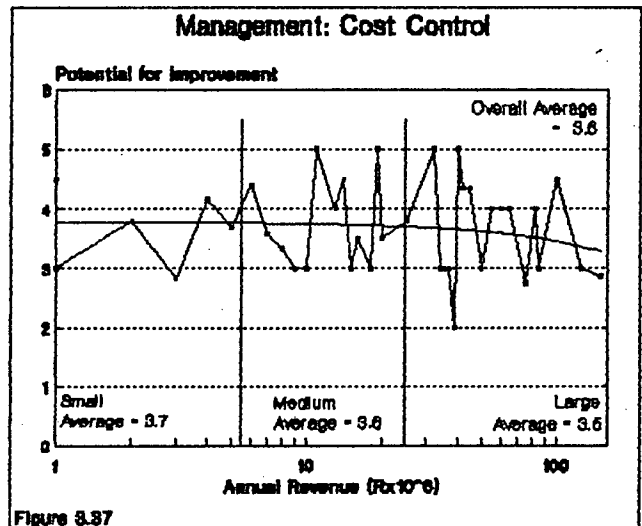


Figure 3.37

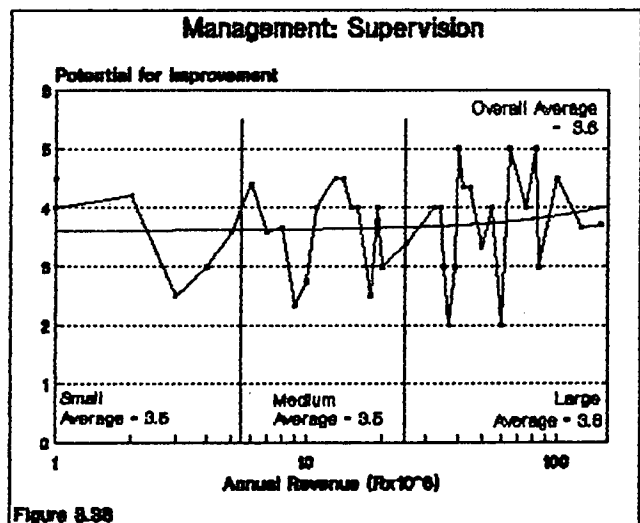


Figure 3.38

3.4.3 Equipment

Capacity

Previous ratings are:

Small/medium 2.9

Large 2.6

(Refer to Figure 2.13)

The current survey records this function as 0.4 points below that in the original surveys. The trends are otherwise similar showing an improvement in this function.

Simplicity

Previous ratings are:

Small/medium 3.0

Large 2.9

(Refer to Figure 2.13)

The previous surveys suggest that the simplicity of equipment has more room for improvement than does the present survey which shows an average rating of 2.6.

Maintainability

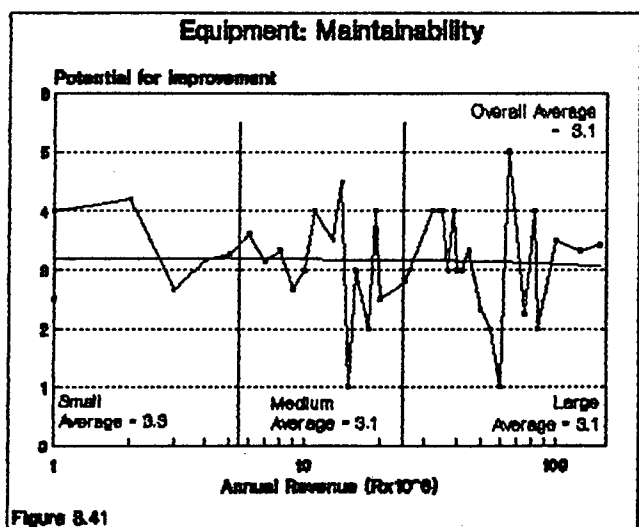
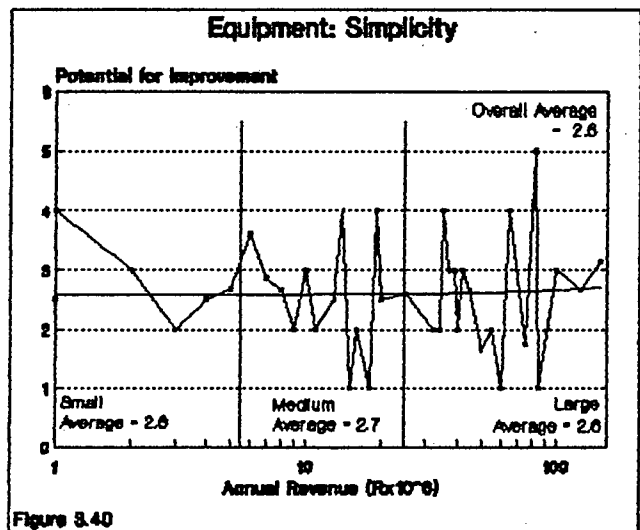
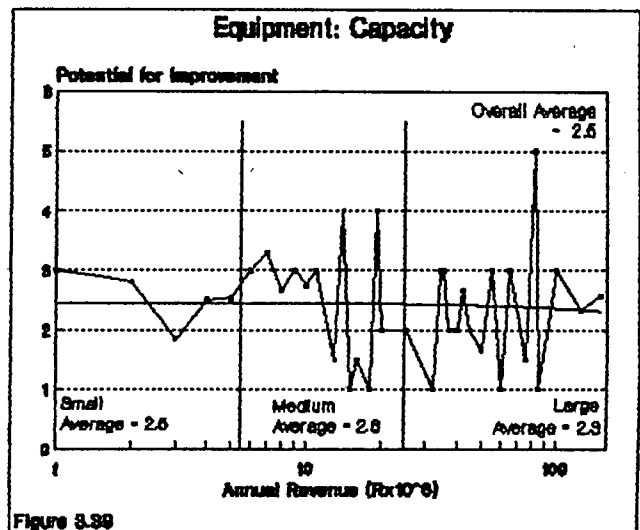
Previous ratings are:

Small/medium 3.4

Large 3.1

(Refer to Figure 2.13)

The different surveys record very similar opportunities for improvement for the maintainability of their equipment.



Utilization

Previous ratings are:

Small/medium 3.2

Large 3.3

(Refer to Figure 2.14)

Previously, the large companies indicated that equipment utilization has more opportunity for improvement than did the large companies in the present study.

3.4.4 Engineering

Design Standards

Previous ratings are:

Small/medium 3.2

Large 3.1

(Refer to Figure 2.15)

The previous surveys indicate more room for improving the design standards across the board than does the present survey. This question was inapplicable to many of the respondents.

Design Improvement

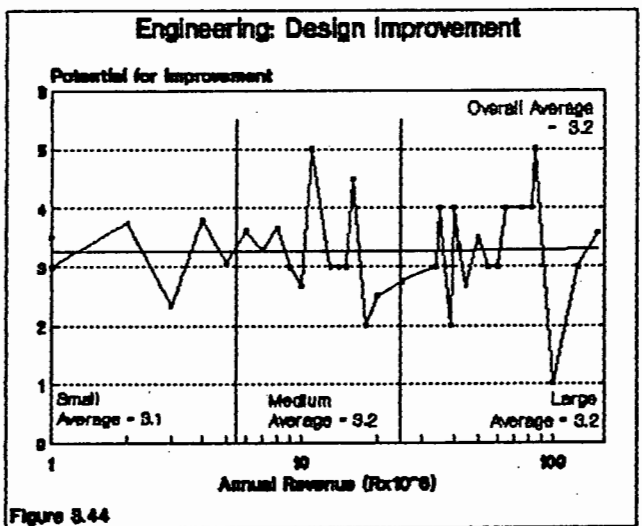
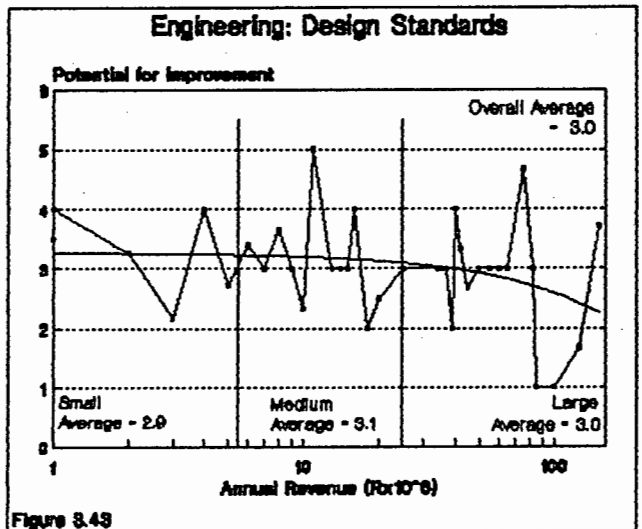
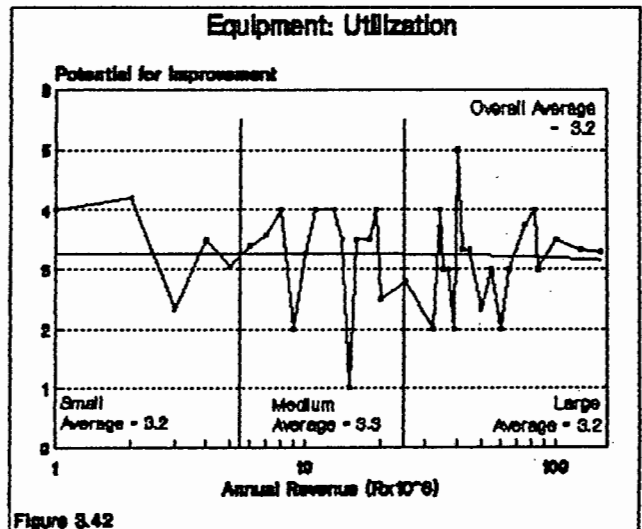
Previous ratings are:

Small/medium 3.2

Large 3.4

(Refer to Figure 2.15)

This function needs more improvement than "Design Standards" in both studies.



Standard Specifications

Previous ratings are:

Small/medium 3.1

Large 3.1

(Refer to Figure 2.15)

The present study indicates that the large companies regard this function as having less opportunity for improvement than the large companies in the previous surveys. However, the opposite is true for the small companies.

3.4.5 Regulatory Boards

The main boards in South Africa are CAWU and BACAWU, but there are other minor boards which have been mentioned by the respondents. These include the Industrial Council, UWNSA, NAWUSA, BIWUSA, and the NPI. These boards have been grouped together with CAWU and BACAWU for analysis purposes in the "AVERAGE" category included overleaf.

CAWU

Construction & Allied Workers Union

BACAWU

Building and Construction Allied Workers Union

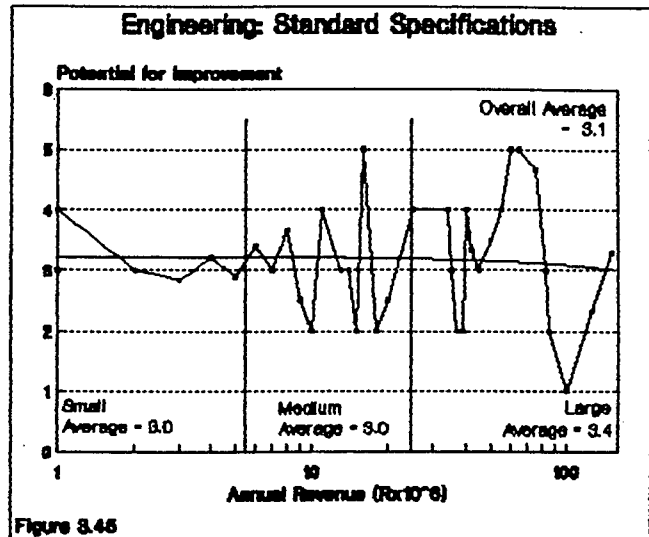


Figure 3.45

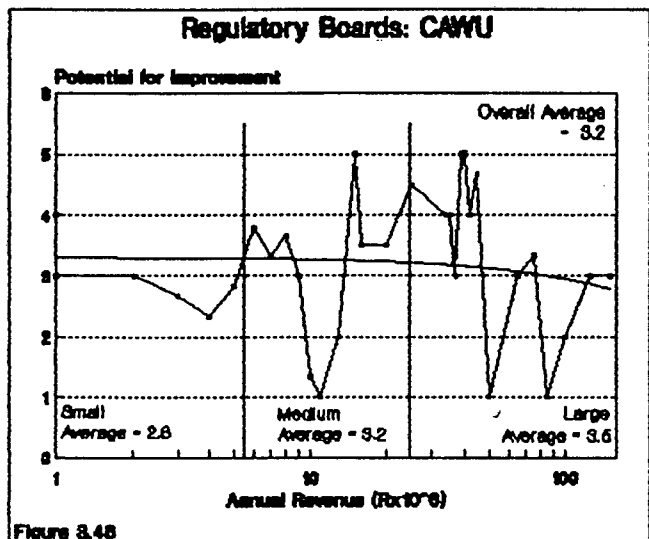


Figure 3.46

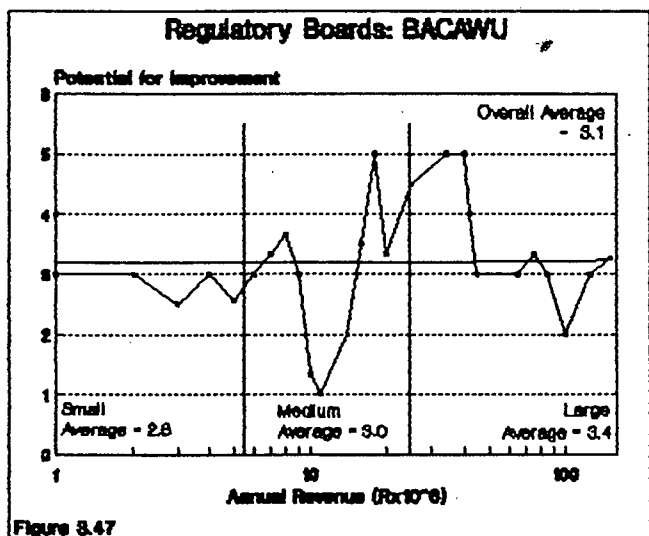


Figure 3.47

Average

CAWU, BACAWU, Industrial Council, UWNSA, NAWUSA, BIWUSA, NPI.

3.4.6 Labour

Contract Agreements

Previous ratings are:

Small/medium 3.9

Large 3.3

(Refer to Figure 2.11)

The original surveys conducted in the United States indicate that much more improvement is needed in contract agreements than does the present survey.

Training

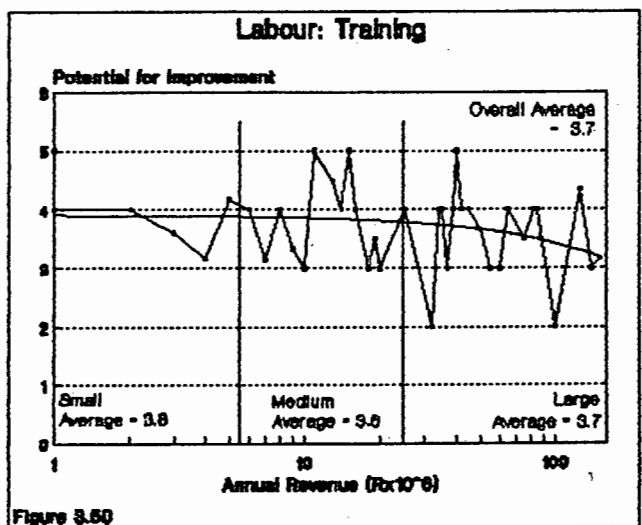
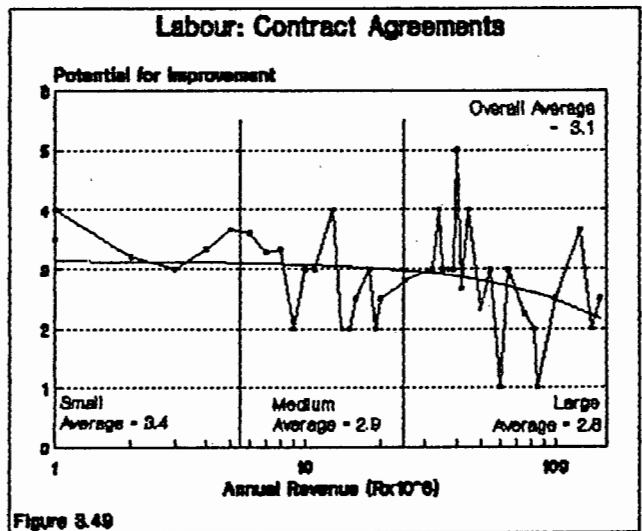
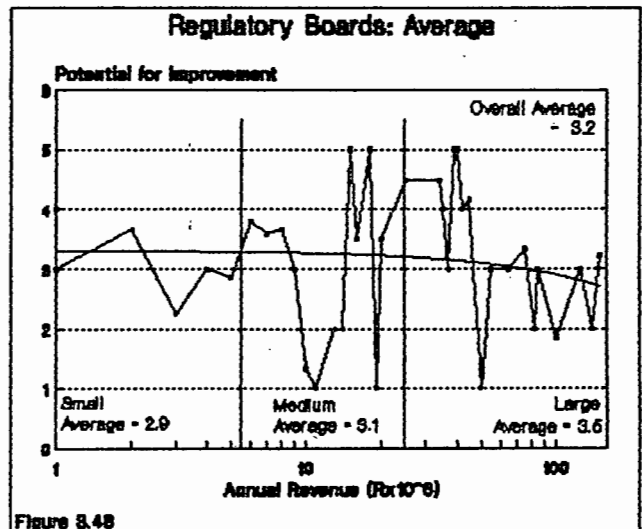
Previous ratings are:

Small/medium 3.5

Large 3.6

(Refer to Figure 2.11)

The data collected in this survey indicates that the present need to train the labour seems to be more urgent than it did during the previous surveys.



Labour Quality Control

Previous ratings are:

Small/medium 3.2

Large 3.3

(Refer to Figure 2.11)

The present study suggests that quality control is more of a problem than it was during the original studies. This is in line with the present poor training.

Turnover

Previous ratings are:

Small/medium 3.0

Large 3.0

(Refer to Figure 2.12)

The small/medium companies are presently experiencing more problems with labour turnover than the large companies, and than all the companies did during the original studies.

Availability

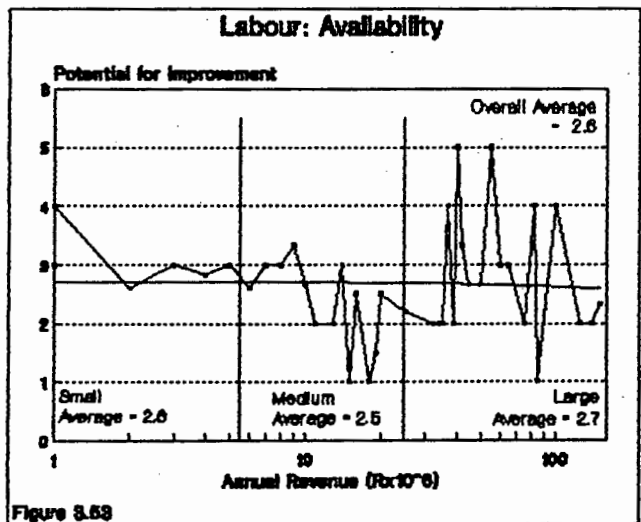
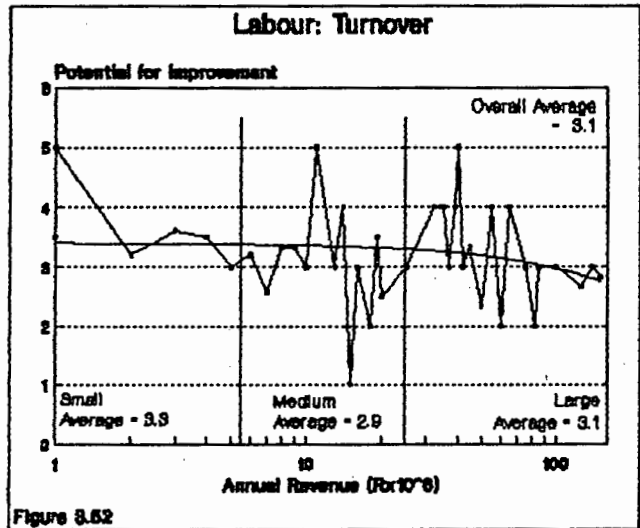
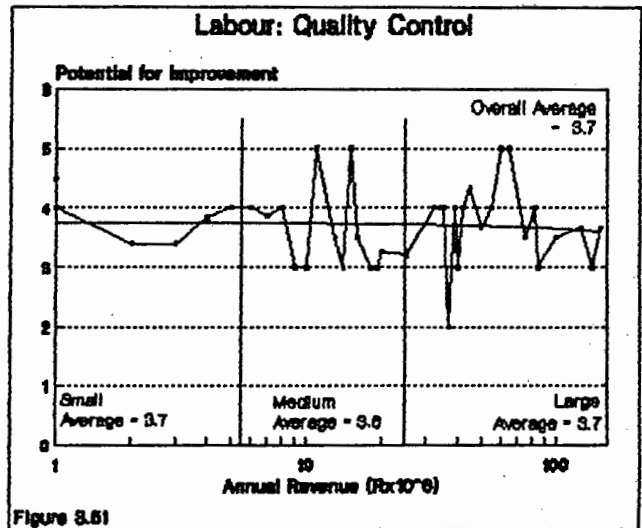
Previous ratings are:

Small/medium 2.8

Large 2.9

(Refer to Figure 2.12)

The local, present availability of labour does not need much improvement at all according to the recent results.



Incentive Schemes

The improvement of incentive schemes does not seem to warrant much attention, especially in the small companies. This, however, does not gel with the fact that managers have rated financial incentives second in importance on the list of labour motivational factors. (Refer to Table 3.1)

3.4.7 Construction Techniques

Pre-Cast Elements

Previous ratings are:

Small/medium 3.0

Large 3.0

(Refer to Figure 2.16)

The current ratings imply that the pre-cast elements need less improvement than they did previously.

Pre-Assembled Units

Previous ratings are:

Small/medium 2.9

Large 3.0

(Refer to Figure 2.16)

This function poses less opportunity for improvement than the pre-cast function both presently, and previously.

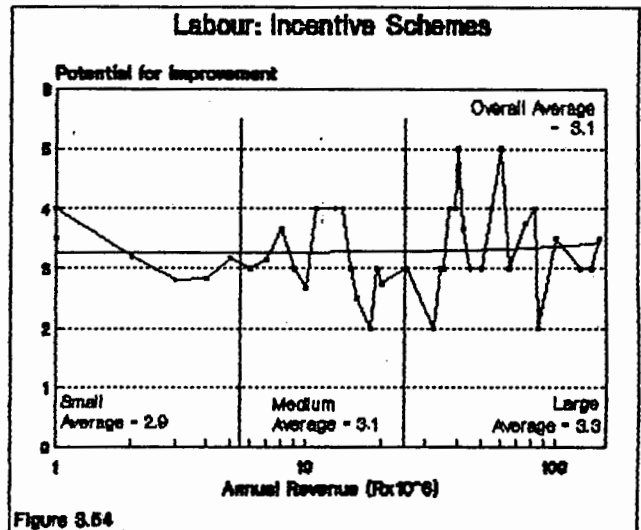


Figure 3.54

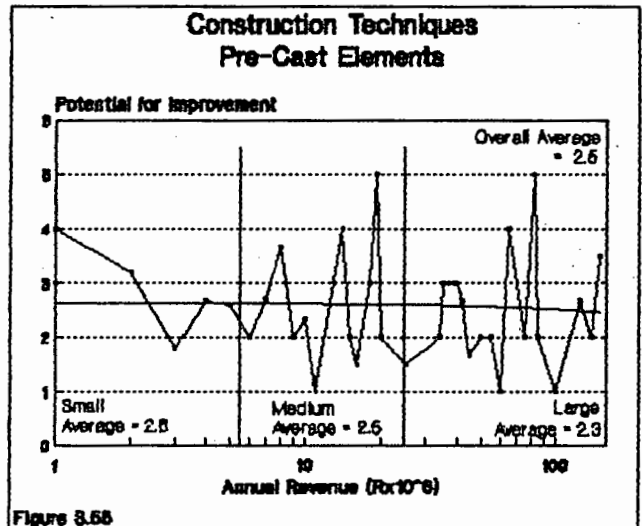


Figure 3.55

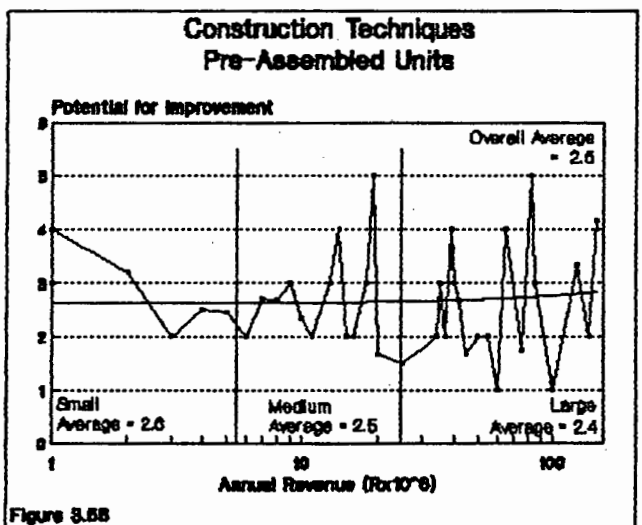


Figure 3.56

Foreign Technology

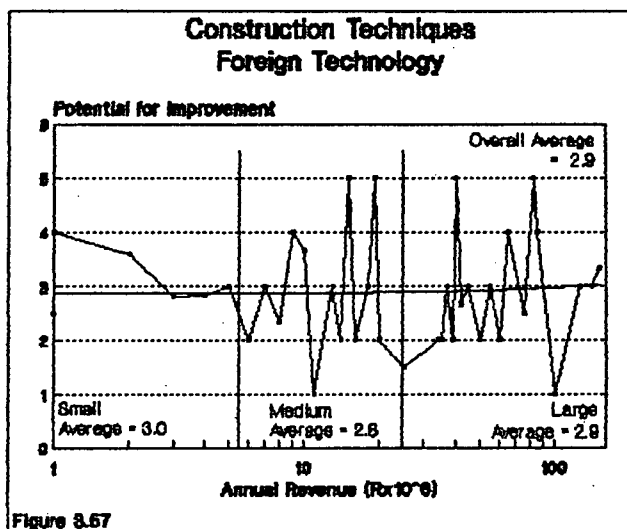
Previous ratings are:

Small/medium 2.3

Large 2.0

(Refer to Figure 2.16)

Currently, the figures show that there is a much greater need for foreign technology than there was during the time and place of the previous surveys.



3.5 Analysis of Part 5 Question 13

This section is concerned with the interest expressed by the respondents in participating in activities related to the improvement of productivity. The previous surveys collected the data in a Yes/No fashion, and their results are shown in table 3.3 below.

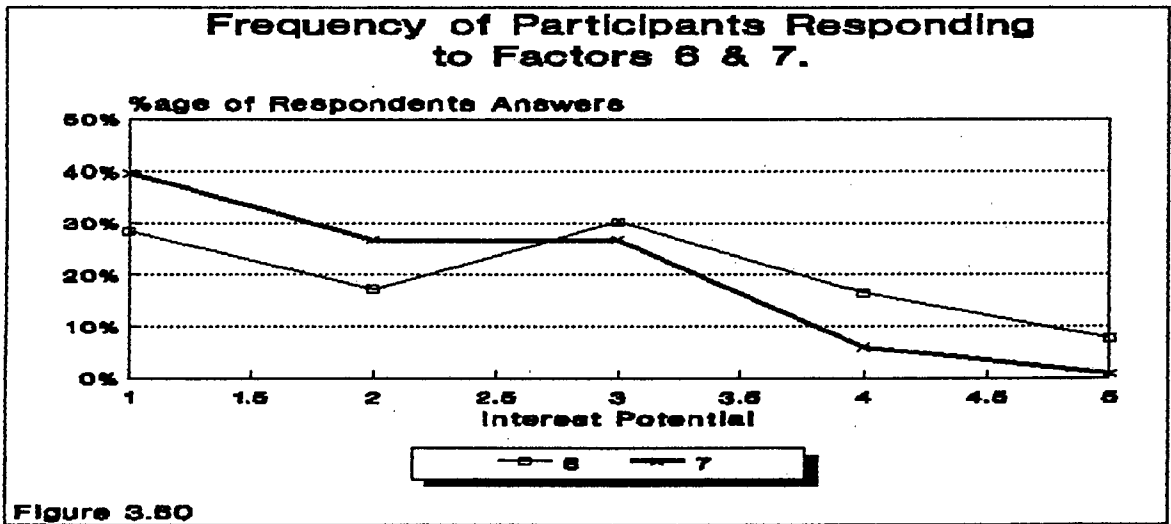
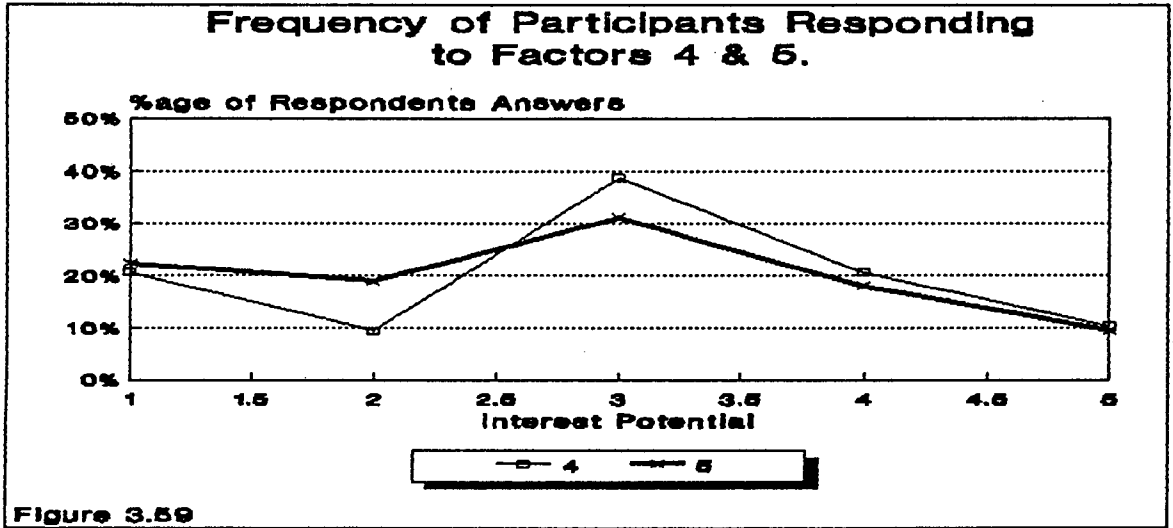
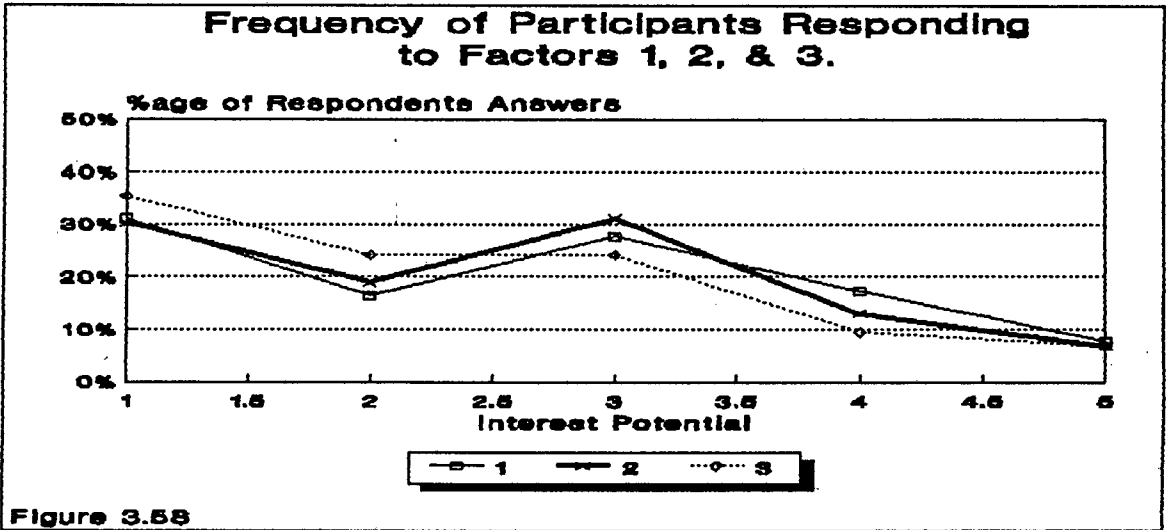
TABLE 3.3

After Arditi 1985

Percentage of Respondents Answering "Yes" to Participating in Productivity Improvement Related Activities

	1979	1983
1) Evaluate results of projects aimed at improving construction productivity.	54%	54%
2) Attend conferences and meetings on productivity improvement in construction.	55%	49%
3) Serve as a member of a group that identifies productivity problems.	43%	39%
4) Subscribe to a construction productivity information service.	41%	36%
5) Conduct projects aimed at improving construction productivity.	40%	38%
6) Develop projects aimed at improving construction productivity.	26%	26%
7) Contribute funds to support programs aimed at improving construction productivity.	26%	18%

The present survey has collected the data using a 5 point scale. (1 = not interested, 5 = very interested.) The frequency distribution of the answers will be presented so as to indicate the strength of willingness, or unwillingness the companies show in participating in the various activities. The activities have been numbered 1 through 7 in table 3.3, and this code will be used in the following illustrations.



3.6 Tabular Summary of Results

The information illustrated in the previous diagrams is now presented in a tabular format. The various functions have been listed in order of potential for productivity improvement. The "rank" refers to this order within sub-sections (for example, in Site-type function - Materials), whereas the "over-all rank" refers to the placing of the factors over the whole range of functions. Table 3.8 lists the fifteen factors possessing the most opportunity for productivity improvement, and table 3.9 lists the five factors possessing the least potential for productivity improvement. Table 3.10 compares the current Placings and ratings of the factors to their Placings in the previous surveys. The ratings for the previous surveys have been computed by averaging the small/medium and large ratings calculated in section 3.4.

TABLE 3.4

AVERAGE EXECUTIVE RATING OF LABOURERS' MOTIVATIONAL FACTORS (Rating out of 5)

RANK		AVERAGE RATING			
		ALL	SM'L	MED.	L'RG.
1	Good Wages	4.40	4.36	4.28	4.56
2	Financial Incentives	3.96	3.95	3.87	4.05
3	Job Security	3.90	3.62	3.84	4.24
4	Good Working Conditions	3.75	3.64	3.64	3.95
5	Full Managerial Appreciation of Work Done	3.70	3.64	3.46	4.00
6	Sympathetic Help with Personal Problems	3.67	3.55	3.49	3.98
7	Personal Loyalty to Employees	3.52	3.45	3.54	3.56
8	Tactful Approach to Discipline	3.40	3.36	3.29	3.54
9	Promotion and Growth in the Organization	3.34	3.07	3.49	3.48
10	Feeling of Being In on Things	3.00	2.81	2.92	3.27
11	Interesting Work	2.61	2.45	2.87	2.51

TABLE 3.5

AVERAGE RATING OF HEADQUARTER FUNCTIONS
(Rating out of 5)

			AVERAGE RATING			
OVER			AVERAGE RATING			
-ALL			ALL	SM'L	MED.	L'RG.
RANK	RANK					
6	1	Communications	3.39	3.15	3.57	3.48
14	2	Planning	3.13	3.15	3.19	3.05
16	3	Marketing	3.12	3.12	2.84	3.37
24	4	Scheduling	2.88	2.95	2.72	2.95
26	5	Procurement	2.76	2.78	2.50	2.98
32	6	Engineering	2.54	2.70	2.25	2.62
35	7	Estimating	2.39	2.41	2.16	2.59
36	8	Specifications	2.39	2.68	2.21	2.26
38	9	Drafting	2.11	2.24	1.94	2.13

TABLE 3.6

AVERAGE RATING OF SITE-TYPE FUNCTIONS
(Rating out of 5)

			AVERAGE RATING			
OVER			ALL	SM'L	MED.	L'RG.
-ALL						
RANK	RANK					
MATERIALS						
7	1	Standardization	3.27	3.37	3.12	3.29
11	2	New Products	3.17	3.26	3.03	3.22
13	3	Product Availability	3.15	3.29	3.19	2.97
22	4	Delivery	3.02	3.07	2.89	3.08
27	5	Storage	2.71	2.63	2.61	2.88

OVER			AVERAGE RATING			
-ALL			ALL	SM'L	MED.	L'RG.
RANK	RANK					
28	6	Prefabrication	2.63	2.62	2.55	2.73
37	7	Packaging	2.38	2.23	2.36	2.55
MANAGEMENT						
3	1	Supervision	3.59	3.46	3.53	3.78
4	2	Cost Control	3.58	2.59	3.68	3.49
5	3	Labour	3.43	3.44	3.32	3.51
EQUIPMENT						
8	1	Utilization	3.25	3.28	3.30	3.17
12	2	Maintainability	3.16	3.26	3.16	3.07
29	3	Simplicity	2.63	2.62	2.67	2.61
34	4	Capacity	2.45	2.49	2.65	2.24
ENGINEERING						
10	1	Design Improvement	3.21	3.14	3.21	3.28
15	2	Standard Specifications	3.12	2.97	3.03	3.36
21	1	Design Standards	3.02	2.94	3.06	3.06
REGULATORY BOARDS						
9	1	CAWU	3.21	2.84	3.16	3.48
19	2	BACAWU	3.07	2.78	2.95	3.41
23	3	Other	2.97	3.02	2.97	2.95
LABOUR						
1	1	Training	3.72	3.92	3.63	3.61
2	2	Quality Control	3.68	3.73	3.62	3.68
17	3	Turnover	3.11	3.30	2.94	3.07
18	4	Incentive Schemes	3.10	2.87	3.06	3.37
20	5	Contract Agreements	3.04	3.40	2.94	2.78
30	6	Availability	2.60	2.64	2.53	2.63
CONSTRUCTION TECHNIQUES						
25	1	Foreign Technology	2.85	3.03	2.78	2.75
31	2	Pre-Assembled Units	2.57	2.59	2.52	2.61
33	3	Pre-Cast Units	2.53	2.65	2.52	2.44

TABLE 3.7

AVERAGE RATING OF INTEREST IN PARTICIPATING IN PRODUCTIVITY
IMPROVEMENT ACTIVITIES

(Rating out of 5)

RANK		AVERAGE RATING			
		ALL	SM'L	MED.	L'RG.
1	Subscribe to an Information Service	2.91	2.71	3.00	3.00
2	Conduct a Project aimed at Productivity Improvement	2.71	2.58	2.66	2.88
3	Help Develop a Project	2.57	2.43	2.66	2.63
4	Evaluate the Results of a Project	2.52	2.36	2.44	2.76
5	Attend Conferences and Meetings	2.46	2.46	2.33	2.59
6	Serve as a Member of a Group	2.25	2.15	2.21	2.39
7	Contribute Funds	1.99	1.85	1.92	2.20

TABLE 3.8

THE FIFTEEN FACTORS POSSESSING THE MOST OPPORTUNITY FOR
IMPROVEMENT.

(Rating out of 5)

RANK		Function Type*	AVERAGE RATING			
			ALL	SM'L	MED.	L'RG.
1	Labour Training	S	3.72	3.92	3.63	3.61
2	Labour Quality Control	S	3.68	3.73	3.62	3.68
3	Management Supervision	S	3.59	3.46	3.53	3.78
4	Management Cost Control	S	3.58	3.59	3.68	3.49
5	Management Labour Relations	S	3.43	3.44	3.32	3.51
6	Communications	H	3.39	3.15	3.57	3.48
7	Materials Standardization	S	3.27	3.37	3.12	3.29
8	Equipment Utilization	S	3.25	3.28	3.30	3.17
9	CAWU	S	3.21	2.84	3.16	3.48
10	Engineering Design Improvement	H	3.21	3.14	3.21	3.28

RANK	Function Type*	AVERAGE RATING				
		ALL	SM'L	MED.	L'RG.	
11	Materials New Products	S	3.17	3.26	3.03	3.22
12	Equipment Maintainability	S	3.16	3.28	3.30	3.17
13	Materials Product Availability	S	3.15	3.29	3.19	2.97
14	Planning	H	3.13	3.15	3.19	3.05
15	Engineering Standard Specifications	H	3.12	2.97	3.03	3.36

* S = Site-type Function, H = Headquarter-type Function

TABLE 3.9

THE FIVE FACTORS RATED LOWEST
(Rating out of 5)

RANK	Function Type*	AVERAGE RATING				
		ALL	SM'L	MED.	L'RG.	
45	Contribute Funds to Support Productivity Improvement Programs	A	1.98	1.81	1.92	2.19
44	Drafting	H	2.11	2.24	1.93	2.12
43	Serve as a Member of a Group that Identifies Productivity Problems	A	2.23	2.10	2.21	2.39
42	Specifications	H	2.36	2.67	2.15	2.25
41	Materials Packaging	S	2.37	2.18	2.37	2.55
41	Estimating	H	2.37	2.35	2.13	2.58

* A = Participation in an activity aimed at improving productivity
H = Headquarter-type Function
S = Site-type Function

TABLE 3.10

COMPARISON OF CURRENT AND PREVIOUS PLACINGS AND RANKINGS
(Rating out of 5)

CURRENT SURVEY			PREVIOUS SURVEY	
RANK	RATING		RANK	R'TNG
1	3.72	Labour Training	5	3.53
2	3.68	Labour Quality Control	13	3.25
3	3.59	Management Supervision	1	3.67
4	3.58	Management Cost Control	7	3.42
5	3.43	Management Labour Relations	4	3.54
6	3.39	Communications (Headquaters)	8	3.41
7	3.27	Materials Standardization	14	3.22
8	3.25	Equipment Utilization	11	3.27
9	3.21	CAWU	-	-
10	3.21	Engineering Design Improvements	10	3.30

Table 3.10 above shows that the top ten current factors, bar CAWU, fall within the top fourteen factors as rated by combining the previous surveys. This shows that there is a fairly close correspondence between the typical problems experienced on local construction sites and construction sites in the U.S.A.

4 THE COMPILATION OF SURVEY 2 - INTERVIEWS WITH PERSONNEL IN THE CONSTRUCTION INDUSTRY

This purpose of the second survey is to follow up on the most important factors as ascertained from the first survey - the construction productivity questionnaire. An interview-type survey usually yields the best quality data and that is the reason that this method was chosen to collect data concerning specific and specialized topics.

Table 3.8 in the previous chapter lists the 15 factors which, according to the construction executives, possess the most potential for productivity improvement. The interviews will concentrate mainly on the first eight functions. These have been repeated in table 4.1 below.

TABLE 4.1

THE EIGHT FACTORS POSSESSING THE MOST OPPORTUNITY FOR IMPROVEMENT.
(Rating out of 5)

RANK		AVERAGE RATING			
		ALL	SM'L	MED.	L'RG.
1	Labour Training	3.72	3.92	3.63	3.61
2	Labour Quality Control	3.68	3.73	3.62	3.68
3	Management Supervision	3.59	3.46	3.53	3.78
4	Management Cost Control	3.58	3.59	3.68	3.49
5	Management Labour Relations	3.43	3.44	3.32	3.51
6	Communications	3.39	3.15	3.57	3.48
7	Materials Standardization	3.27	3.37	3.12	3.29
8	Equipment Utilization	3.25	3.28	3.30	3.17

During the interviews, emphasis will be placed on the functions according to their ranking. The standard interview has been

designed to draw the interviewee's opinions out over a wider, rather than narrower or specific topic range. That is, rather than ask clear-cut questions, a general topic area will be discussed, covering policies, limitations, new ideas, past mistakes, personal opinions, and industry generalizations.

Due to the nature of the first six topics, interviews were conducted with the personnel managers where possible. The companies were selected according to their size or their past participation in activities relating to productivity improvement. If a company was "large" as defined in survey 2 (i.e. the annual revenue was in excess of R20 million) or if they had recently completed training, either internally, or with B.I.F.S.A.(4.1), the C.E.I.T.B.(4.2), or the N.P.I.(4.3), then they were approached for interview.

Abstracts of the interviews have been included in the following chapter.

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- 4.1 B.I.F.S.A. The Building Industries Federation of South Africa.
 - 4.2 C.E.I.T.B. The Civil Engineering Industry Training Board.
 - 4.3 N.P.I. National Productivity Institute.

5. INTERVIEW ABSTRACTS

The interviews followed a predefined course, but the material covered during each session was not necessarily typical of the company involved, their particular problems, policies, or ideas. The abstracts appear in the order in which the interviews were conducted, and this order has no particular significance.

5.1 Interview No. 1.

This company manufactures asphalt for the civil engineering contractors throughout the Western and Eastern Cape, and will, if required, extend its services to any viable location. Being basically a service organization, productivity and quality are of paramount importance to them. Each manufacturing plant employs about sixteen labourers and is completely responsible for its own internal affairs.

The company has a policy of spending at least 2% of the value of total annual salaries and wages on training, and every employee should attend a training course at least once a year. Although the N.P.I. have been consulted, most of the training is performed in-house. Every two years, some of the top management are sent overseas to study international developments. Although training is an important part of the company's policy, there is no system in operation to measure the results of these schemes. Recently, the company finished an AIDS training course, and are presently studying the implementation of literacy training. The interviewee was of the opinion that training increased worker motivation which further encouraged the workers to remain with the company, thereby creating a stable work force.

Quality is controlled using formalized procedures which guarantee the S.A.B.S. standards. Both the incoming raw materials and the final product are subjected to various quality tests, and the computerized manufacturing equipment ensures that the product is manufactured within certain tolerances throughout the process. The employees controlling the manufacturing process have been employed for many years, and although they have not undergone any specific training, they have acquired sufficient experience to

guide the process so as to produce a high quality product. The major quality problem is the fact that the workers do not comprehend the full organizational system of which they are a part. They do not understand that small errors on their part can affect the whole system. The management have tried to emulate the Japanese idea that any worker can stop the process if they detect poor quality at any point, but here, the employees seem to be scared of stopping the process. They also regard the "suggestion box" system with much trepidation.

Management policy decrees that the defined channels of communication must be adhered to. This policy limits errors caused by issuing two sets of conflicting instructions to the workers. It also provides a concentrated power and responsibility base which the subordinates grow to respect. The system ensures that the workers have only one boss to whom they are completely responsible, and who will look after them in all company respects. The company's systems have laid the groundwork for participative management which is becoming widely used.

The labour relations are satisfactory, and approximately 50% of the labour force are unionized through CAWU^(5.1). Due to the small size of the work force, the union has had few dealings with the company. The company has approached the union on one occasion, asking them to convince the labourers that the industry was going through a recession and to notify the workers that the wage rise would not be as large as they had hoped for. The unions have not been of any further use to the company.

The formal communications procedures work well. In this context, formal communications are those which ensure the day to day efficient running of the company's affairs. However, the informal communications, i.e. that system which channels "one-off" information, is very poor, although the company feels an improvement will not be significantly beneficial. One reason for the poor communications is that the company hierarchy evolved from that of a smaller organization with little strategic

5.1 CAWU Construction & Allied Workers Union.

planning. As mentioned earlier, each site is totally responsible for its own actions, and therefore, the poor informal communications do not directly affect site control in the short term.

Materials standardization is achieved with strict computerized process controls, and the fact that the company usually only produces twelve standard asphalt mixes. A research and development department investigates new products, and quality tests mixes proposed by future clients.

Equipment utilization does not present a problem to this company as the manufacturing process has been optimized for various conditions as part of the computerization procedure. A planned preventive maintenance scheme is in use, but it is not strictly adhered to.

5.2 Interview No. 2.

This interview was conducted with the personnel manager of a construction company based in the Western Cape, engaging mainly in civils work. Using various divisions, they undertake work throughout both the Western and Eastern Cape, and employ about 2500 labourers.

Consistent with the results concerning large companies, the interviewee suggested that management supervision posed the largest problem in his company, and should be emphasized more than any other area when tackling the productivity question. The company has both in house and external training schemes which incorporate personnel at all levels. One of the major problems associated with quality was that the labourers do not understand the business system of which they are a part, and therefore do not see that their individual actions make a difference to the productivity of the whole company. The company's solution to this problem has been to concentrate training at the lower levels of management so as to give them decision making, problem solving, and other necessary management skills. The worker training is limited to the basic skills needed for specialized contract purposes. For instance, if the company wins a contract

in which there is much brick paving, they will send a number of labourers on a paving course. The results of training are not specifically measured. The company is slowly moving towards a more participative management style, as the present, mainly autocratic style is proving to be less effective under the current situation. Workers tend to stay with the company as long as there is work for them.

A major part of the company's quality problems were due to poor communication between the foremen and the workers. For instance, if the job task was not properly defined, there was a good chance that it would not be performed correctly. Another larger problem causing poor quality was that the labourers and low level management do not regard quality as important, and do not understand where it fits into the business cycle. Past experience has shown that explaining the concepts of business to these people has improved their quality and productivity. This entails sending the people on a one to four day training course in which the concepts and consequences of poor quality, absenteeism, tendering, profit, bank loans, interest, ownership, company shares, company hierarchy, individual responsibilities, and other characteristic properties of the company are explained to them. Once the worker has an understanding of the role he plays in generating his income, he will probably be motivated to improve his quality and performance. Again, the cost of quality was not measured and controlled.

This company generally does not adhere to the defined channels of communication. The informal communications, that is, those which are usually communicated in a monthly or quarterly journal, are almost nonexistent. The formal communications have no strict procedures, and although only a few major problems have arisen due to slow and incorrect routing of information, there is much room for improvement.

The company is partially unionized with CAWU, and does not report any recent union problems, but neither have the unions been of any use to the company.

Equipment utilization poses a major problem to this company, and can be partly attributed to the lack of training that the labour have in operating and looking after the equipment. Many break-downs occur to over-stressed plant, or its operation under circumstances for which it was not designed. The planned preventive maintenance scheme is not properly adhered to or administered.

Problems with materials standardization have been encountered with non-conforming products, and the lack of inter-company standardization.

5.3 Interview No. 3.

This company is a subsidiary of a major national organization which has divisions in civil, mechanical, and electrical engineering. The personnel manager of the civils division in the Western Cape was interviewed.

The organization has recently completed several courses with the N.P.I. They follow a well planned routine when recording the productivity on each construction site. The site agent is responsible for this task, and he is aided by the site manager and general foremen. Productivity charts are upgraded daily and are compared each month to the time-keeping records and cost allocation charts. These productivity charts provide daily feedback as to the site staff's performance, and a productivity control comparable to the planned allowables. Top management commitment was essential to the success of this system, and once the users were accustomed to it and acknowledged its main purpose, the system worked well. The costs of running this system are negligible. Of course, the system was not introduced in isolation, but only after a series of courses which were directed mainly at the site staff and management. The company is able to measure the results of their training programs through the same system that they use to measure their productivity. However, although there is an expressed desire to attend any worth-while courses, there is no ongoing training. The labourers were definitely motivated by their completion of the N.P.I.

course, and are reported to feel as if they play an important role in the company. The labour do not leave the company unless they are retrenched.

Training was implemented in stages allowing the company to record the "before" and "after" effects it had on the quality and productivity of those involved. Productivity improved noticeably due to increased motivation and understanding on the part of the worker. The interviewee indicated that even though quality had improved, the current majority of defects were still due to human error rather than defective materials or poor specifications. He stated that poor quality is characteristic of fast track projects over which control is difficult to maintain.

Company-wide communications have been well planned. There are well administered systems to ensure that all necessary information is communicated through a series of meetings which is initiated at a monthly board meeting in Johannesburg. Lower level meetings then communicate relevant information throughout the rest of the company. On site communications procedures are strictly adhered to, and there is a cultivated, yet informal network which completes the system. The company hierarchy has been strategically planned, as are the site structures. Each site job is accompanied by a definition of tasks and responsibilities, and it is found that there is little discrepancy between the planned job description, and the actual performance.

Labour relations are adequate after strike action was suppressed in 1989. The strikes were called when management autonomously decided to change the pay interval from fortnightly to monthly. The workers were not satisfied with this, and strike action was initiated through their union. The labourers were given an ultimatum, and those who had not returned to work were fired. The unions have not interfered with the company since then, and have never been of any benefit to the company.

Equipment utilization has been improved through the use of training schemes, and the system whereby one employee is made

responsible for a certain piece of machinery. An in-house mechanic trains the employees in basic preventive maintenance, and routinely inspects all equipment.

5.4 Interview No. 4.

Company No. 4 can be classified according to the definition used in survey 1, as a large company. The organization employes about 450 labourers and is involved mainly in building work. The personnel manager was interviewed.

The personnel manager viewed the main productivity problem as being one of communications. The information flow between all hierarchical levels is lacking, as is understanding between the managers and the workers. It is not the lack of skilled or educated workers that poses a productivity problem, but rather the poor communication systems that are used to transfer the necessary information to those who physically have to complete the job. To compound the problem, each management level generally has an antagonistic attitude towards the levels below it. The problem is fueled by a superior's fear that if he passes too much information on to his subordinates, they will end up knowing more than he does, and will become a threat to his job. It is hoped that the proposed training course will relieve these inter-level tensions.

The company is presently developing an in-house training scheme aimed mainly at the first- and second-line site management. They feel that if the communications in this area are improved, productivity will increase. The training course is designed to improve the management attitudes, and to promote the use of a participative management style where appropriate. Management feel that the labourers are not prepared for a style much different from one described as "humanely directive", but given time and education, the participative style will create a motivated work force.

The N.P.I. has been asked to advise the company on how to improve its measurement systems which are at present practically non-existent. Although unable to comment on the returns of the new

program, the personnel manager hopes that it will, in due course, increase worker motivation, and improve their attitude towards the company. This in turn will stimulate increased productivity. The company follows the usual policy of "last in, first out" with regards to retrenchment of their labour force. As a result, there is a stable core of labourers which forms a base for the generally stable management levels.

The company records an acceptable quality standard, which could, according to the personnel manager, be improved by enhanced supervision. To reiterate, much of the poor quality is due to bad communications, rather than the lack of skilled workers. However, the company does not have any formal quality control systems, and therefore, a good quality record may be the result of the system's failure to record instances of poor quality. To improve quality, management has opted to improve the standard of supervision rather than improve the skills of the labour who carry out the work. Interestingly, the management feels that most of the poor quality is due to poor design, rather than poor workmanship. This may be due the company's large involvement in the building industry, but "feelings" should be supported by facts obtained from formal measurements. The company does not partake in many fast-track projects which are more likely to involve design defects.

The company is unionized with CAWU, and have recently resolved two major disputes. The personnel manager, who was hired to help solve the problems, suggested that their main cause was a lack of communications between the management, the union, and the workers. He believes that the unions should be used for specific purposes, and that they form an important part of industrial relations.

Being in the building trade, much of the equipment is simple to operate, and therefore does not require the users to be trained. The equipment is generally well treated and maintained.

5.5 Interview No. 5.

One of the largest organizations in the country, company number 5 has projects throughout South Africa and the neighboring countries. The organization is presently engaged in the initial stages of an in-house productivity improvement process. One of the company's projects managers was interviewed.

The Productivity Improvement Process: After much consideration, the company is adamant that the best motivational factor for the labourers is the opportunity to earn extra money. Consequently, a major section of the productivity improvement process is devoted to the planning and implementation of an incentive scheme. It must be pointed out that although the incentive scheme forms a large part of the program, the company adopts an holistic approach to productivity improvement.

It was decided that the incentive scheme (i) must be easily understood by the workers, (ii) it must be easily administered, and (iii) it must include every function or area of construction. To comply with requirement (ii), the incentive was not to be awarded on an individual basis which would require a purely piecewise measuring system and much administration. Another problem that occurs with the piecewise system is that the reward is usually issued according to the volume of work completed over and above a certain standard volume. It is difficult to find fair and mutually acceptable standards which provide each employee with the same opportunity to earn their bonus. The group incentive scheme has an in-built bias in that different tasks require different numbers of labourers to complete. It was found that economy of numbers can affect the bonus to a large degree, that is if a work team is made up of a number of labourers which is different to the optimum number required to perform a particular task, the efficiency with which the task is performed can be considerably reduced.

After having considered the above-mentioned difficulties, management decided to award the bonus on a profit based system. Under this scheme, workers are given an allowable cost with which their task must be completed. This figure is obviously derived from the tender rates. The workers, advised by the site staff, are allowed to decide the task methodology. If the final cost of completing the task is less than the allowable, the "profit" is split equally between the workers and the company. At present, only the labour cost is included in the system. Management is trying to include the materials costs into the scheme, but this is proving to be fraught with difficulties. For example, a certain effort to improve aluminium wastage results in a far greater monetary saving than does the same effort to improve concrete aggregate wastage, and disputes over bonus equity would arise if the bonus was awarded in proportion to the monetary savings. However, problems may arise with this payment system as the tender apportions unequal profit margins to different sectors of the project. Consequently, it will be easier to beat the allowable costs in some tasks than it will in others. On several occasions, gangs have approached site management asking them to reduce the size of their gang, as they find that they can complete tasks more efficiently with fewer workers. Management has relocated the extra workers and the fear of retrenchment is almost nonexistent.

Various different training courses have been experimented with in order to find the best method with which to transfer the concepts of productivity / efficiency, quality, cost control, and measurement to the workers. Management has implemented a simplified version of quality circles on selected small sites. As there is no word for, or europeanized concept of "quality" in Xhosa, management have spent much time formulating suitable phrases to convey the concepts. For instance, quality circle meetings are known as "quality indaba." Feedback to management about the quality circles seems to be positive, but the system is still too

new to confidently express its success. The suspicious feelings accompanying the new systems are still existent, but are slowly being dissipated.

It was decided to improve productivity through the use of an in-house incentive scheme rather than to improve it by subcontracting most of the work on a piecewise basis, as the company found that subcontractor management was exploiting their labour. The subcontractors were winning contracts by submitting very low tenders and making their profit by paying the labourers less than the minimum wage. The system's lack of ethics forced management to explore morally sound methods for improving productivity.

Another aspect of the improvement process is that the labour is divided into well defined gangs which repeatedly perform specific tasks. This is to allow the workers to form a cohesive and efficient team, and to proceed along the learning curve as far as possible.

Training is mostly limited to that necessary for the implementation of the productivity improvement process as discussed above. The company does not have a problem with the shortage of skilled labour, and has recently completed a labour survey to create a list of "core" labourers. In poor economic times, such a list will guide the management in their retrenchment policies. This is "as close to guaranteed job security as [the labour] will come." (company project manager) The implementation of incentive schemes and quality circles requires a stable labour force so as to easily perpetuate the systems.

Quality control has been improved by the recently introduced productivity improvement program. Materials wastage has been monitored and curbed with the introduction of suitable controls. The prime cause of poor quality is the lack of communications when detailing tasks to the labour gangs.

Management supervision is adequate especially as the company has chosen the productivity improvement route of self-motivation

rather than increased supervision. The company is actively encouraging the managers to adopt a more participative style, and assume a paternalistic role of advisor rather than the traditional role of task master.

Although the labour has not been officially unionized since the retrenchment of most of the force in 1986 following management / union disagreements, there is a system of internal workers' committees. External unions are presently becoming more involved with the company's labour. The labour - management relations are said to be good.

General communications have been vastly improved since the implementation of the productivity improvement process, and formal channels to ensure that relevant feedback reaches the workers have been created. Site hierarchies are custom-designed for each project, and specific job definitions are created during the process.

Materials standardization does not present a problem to the company as they use tried and tested materials with which the labourers are completely familiar. The equipment is generally well treated and efficiently used.

6 ASPECTS OF TRAINING

There are three major training boards which train employees for the South African Construction industry. The information for this chapter was collected through interviews conducted with personnel working for the training boards, and through their published literature. Each of the three boards has its own approach to training, and each board specializes in different areas.

Training can be classified into two categories, the first being "skills" training, and the second is commonly known as "development" training. Employees can be trained either in-house, or through one of the training organizations such as the N.P.I., the C.E.I.T.B., or B.I.F.S.A. In-house training is often regarded as the "cheap and easy" alternative requiring less commitment from the company as a whole. As a result, top priority is not given to the completion of an in-house course which is therefore cut short, and the training is often inferior to that given by one of the above-mentioned organizations.

Skills training prepares workers to efficiently perform certain job-related tasks such as paving or shuttering. One of the unfortunate effects of the structure of the industry is that in hard times, companies do not have the funds required to train their labour, and in good economic times, the companies are usually too busy to allow their labourers "time off" to train. Consequently, the work force is made up of many raw or semi-skilled workers who, through little fault of their own, produce sub-standard work. Skills

FIGURE 6.1

**TYPICAL SITE
ORGANIZATIONAL HIERARCHY.**

Site Management
General Foreman
Foreman
Junior Foreman
Senior Section Leader
Section Leader
Ganger
General Labourer

training is often aimed at the lowest levels in the organizational hierarchy.

Development training is ideally aimed at all members of the organization, but usually only covers those people at and above the section leader level. This training is designed to develop a person's management and business related skills to enable them to successfully handle the additional responsibilities accompanying a promotion along their career path. Currently, most development training is occurring at the supervisory (i.e. junior foreman / section leader) level. Unofficial figures for the period January 1991 to the end of April 1991 are listed in table 6.1^(6.1) below.

TABLE 6.1 **C.E.I.T.B. (6.1)**

Cape Regional Training Statistics - 1st Period 1991

COURSE CATEGORY	No. TRAINED	MAN DAYS	% of Total
1. Management	0	0	0
2. Supervisory	212	1213	79%
3. Construction Site Practice	3	177	11%
4. Plant Skills and Other	22	155	10%

Compared to the figures quoted for the same period in 1990, the current figures show a 257% increase in the time spent on training.

A successful training program has two important pre-requisites: management commitment, and delegate preparation:

Commitment by the top management is required to create the atmosphere in which training is regarded as important. This atmosphere will motivate those employees who are selected to

6.1 Source of Table 6.1 - Unofficial training statistics, Civil Engineering Industry Training Scheme.

attend the training courses, and will prevent the course from being cut short so as to allow the personnel to return to their respective sites to "put out the fires" which started during their absence.

If employees are sent on a training course with little or no preparation, it is unlikely that they will understand why they are being trained. As a result, the delegates will not be completely motivated, maximum benefit will not be derived from the course, and the trainees may complete the course with the feeling that it was a waste of time.

An opportunity to attend a training course will often raise the self-esteem of a properly prepared delegate. Subsequently, it is generally found that a well trained worker takes great pride in producing top quality work. However, training should be regarded as a continuing exercise, and it is important to follow up the training course with practical situations in which the trainee can put his newly acquired skills to use.

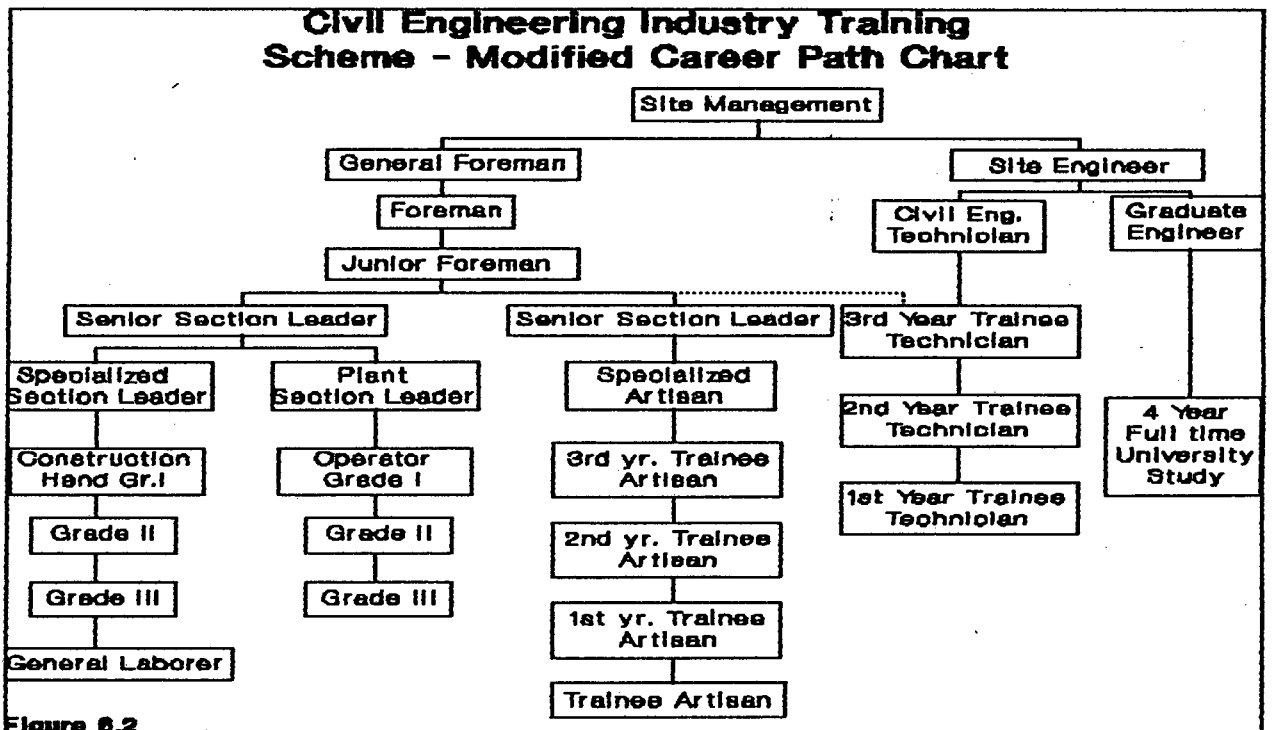
There are barriers which must be overcome in order to ensure successful training. Important here are the language and education barriers. Many of the low level workers are not literate in English or Afrikaans and have little or no grasp of basic mathematics. Another barrier is that training is often regarded merely as a management policy, rather than a tangible long-term financial investment with measurable returns.

The following sub-chapters outline the differing approaches adopted by each of the three major training boards, and illustrate the different areas of training each board specializes in.

6.1 The C.E.I.T.B. Approach to Training

Figure 6.2 shows the C.E.I.T.B. career path that a person in the construction industry may take from their point of entry to the site management level.

The C.E.I.T.B. is a national organization which is funded by mandatory subscriptions provided by the civil construction



industry. They conduct many courses aimed at all levels of employee. Figure 6.2 shows their "ideal career path" which a person in the construction industry should take. They realize however, that the present situation is far from ideal, partly because of the poor economic climate.

Following this career path, a person entering the industry at the general labourer level, provided he is physically fit, and has had some form of formal education, will gain experience over two years before receiving his first formal training. This would be either a general curriculum covering the likes of manholes, kerb-laying, pipe-laying, and stone pitching, or, the more specialized fields of reinforcing, shuttering, concreting, or excavating. These people would then proceed to the "Construction Hand - Grade III Level." With further experience and the completion of two more courses, the trainees complete the third, "leadership qualities and supervisory training" course prior to writing the "National Standards Test." Attaining this standard qualifies the person to become a section leader in the field for which he has been trained. Further training and experience separate the next

hierarchical levels. The board estimates that a general labourer with sufficient aptitude, qualifications, and ambition may achieve the rank of foreman within six to eight years of entering the industry. The C.E.I.T.B. caters for those people entering the industry who are training as either a foreman, artisan, technician, or engineer. A very brief overview of the full curriculum is presented in table 6.2 below.

The C.E.I.T.B. strongly suggest that any trainees have a mentor. The mentor will usually be a superior who can guide the trainee "within the culture of the company, and the application of the course content in his job."⁽¹⁾ The C.E.I.T.B. reserves the right to review any of their trainees after completion of a C.E.I.T.B. course. They also suggest that a formal, objective, trainee assessment program is followed according to the C.E.I.T.B. guidelines.

TABLE 6.2

Source: C.E.I.T.S.⁽¹⁾

Contents of the C.E.I.T.B. Supervisory Development Program

Section 1 - Section Leader Level

Module	Title
1A	Business Appreciation
1B	Basic Mathematics
2	Communication I
3	On-Job-Training
4	Job Role / Status
5	Safety Representatives

Section 2 - Senior Section Leader

Module	Title
5	Safety Representatives (repeat)
6	Personnel Performance Intensification Programme
7	Communication II
8	Planning and Organizing
9	Basic Industrial Relations I

Table 6.2 (Continued)

Section 3 - Junior Foreman

Module	Title
10	Interpersonal Skills I
11	Job Role / Status II
12	Quality Control
13	Application of Business Principals
14	Efficiency and Performance I
15	Motivation
16	Safety for Supervisors
17	Basic Industrial Relations II

Section 4 - Foreman

Module	Title
18	Technical Planning
19	Job Role / Status III
20	Interpersonal Skills II
21	Personnel Performance Intensification Programme
22	Efficiency and Performance II
23	Foreman's Role Facilitator
24	Safety for Foremen
25	Situational Leadership
26	Basic Industrial Relations III

6.2 The N.P.I. Approach to Training

The construction unit of the N.P.I. view productivity as an holistic concept where all of the company's resources are taken into account. Over the past five years, they have been developing managerial and supervisory programs "aimed at achieving improvement through better motivation and development of staff and employees, but focussing on the foreman / supervisor interface." (2) They realize that the local lack of skilled labour is a major productivity problem, but reason that inadequate management could not fully utilize a trained work

force, and therefore, the prime issue should be to address the ineffective supervision.

Research shows that the problems of low productivity on site usually stem from the foreman / supervisor interface, either through the lack of understanding of the problem, or by their choosing to ignore the problem. Supervisor training should be complemented by foreman training, and in order for this twin-pronged attack to be successful, it will have to be driven by management. In other words, the N.P.I. sees "productivity improvement as the end result of an integrated, top-down process, which provides structured enhancement of managerial and supervisory skills through inter-linked training programs from managing director down to labourer." (2) In order to improve the efficient utilization of available resources, while minimizing materials waste, selective training in communications, measurement, and planning, is concentrated at the foreman and supervisor level. The N.P.I. stresses the use of selective training, as they realize that each employee has his limits, and that an organization will not benefit by gaining a mediocre supervisor at the cost of a good worker.

The stated objectives of the N.P.I. program are to provide a company with the training and follow-up needed to improve their long-term site productivity. It is often found that a change of attitude is needed between the various levels, replacing the common antagonistic attitudes with a more cooperative one. Again, active participation by all levels, but especially senior management, is needed. The improvement process is comprised of three separate phases:

- i) The investigation and negotiation phase during which barriers to productivity improvement are identified, and action plans determined.
- ii) Training for all levels of the organization.
- iii) Implementation and reinforcement of training on site, backed up by improved measurement, communications, and planning systems.

force, and therefore, the prime issue should be to address the ineffective supervision.

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- i) The investigation and negotiation phase during which barriers to productivity improvement are identified, and action plans determined.
- ii) Training for all levels of the organization.
- iii) Implementation and reinforcement of training on site, backed up by improved measurement, communications, and planning systems.

A typical N.P.I. process is illustrated in table 6.3 below. The N.P.I. would fill the role of process consultant, but would not become an internal factor of the process.

TABLE 6.3

Source: N.P.I. (2)

The N.P.I. Productivity Improvement Process

- 1a) Site Evaluation
 - 1b) Two-Day Productivity Workshops for Senior Management
 - 2) Consultation on Measurement Systems
 - 3) Three-Day Workshops for Foremen
 - 4) Three-Day Workshops for Supervisors
 - 5) Labourer Training by the Organization's Trainers
 - 6) Implementation and Follow Through.
-

- 1) **Site Evaluation:** Here, a comprehensive understanding of the organization's management style, corporate climate and structure, and its systems and procedures is gained. The productivity levels would be determined, and the training material tailored to suit the particular organization.
Two-Day Senior Management Workshops: Concepts of productivity improvement are presented to the senior management, and a commitment to the holistic improvement process is sought.
- 2) **Consultation on Measurement Systems:** Advice is given on how to improve existing measurement systems to provide more effective motivational feedback to foremen and supervisors on site.
- 3) **Three-Day Workshops for Foremen:** Two, 3-day workshops are presented to the foremen covering similar principles to those in section 1b, but with greater emphasis on site

productivity. They are split by a period of about four weeks to allow the initial lessons to be practised, and their production to be comparatively measured.

- 4) **Three-Day Workshops for Supervisors:** This set of courses has been developed specifically for first-line supervisors. It creates an understanding of the principles of productivity, and trains the supervisors in the use of on-site measurement tools. Follow-up workshops discuss results and problems experienced in implementation.
- 5) **Labourer Training:** This section teaches the labourers about the functions of the company and the importance of their contribution to its successful performance. The main objective is to improve the attitude among the labourers.
- 6) **Implementation:** This stage reinforces the new systems by applying the new principles and skills in the work environment. The N.P.I. would act as a mentor, encouraging site management and supervisory staff to apply the new principles and to develop their skills while becoming comfortable with the process.

The process is aimed at generating initiative from production teams, achieved through integrated and applied training, backed up by practical and timeous measurement and feedback systems.

6.3 The B.I.F.S.A. Approach to Training

The Building Industries Federation of South Africa is a training board committed to the training of personnel in skills which are applicable to the building industry. The federation is funded by mandatory contributions from organizations involved in building work. The Principal of B.I.F.S.A. (Western Cape) was interviewed and he provided some insight into the objectives of the training scheme.

Although B.I.F.S.A. does have "development" training programs similar to those of the C.E.I.T.B. and the N.P.I., their emphasis is on "skills" training. Minimum entrance requirements for

commencing apprenticeship training are a minimum age of 16 years, and a standard 7 or equivalent qualification. A successful applicant will be accepted to train in one of the following trades:

- Bricklayer
- Carpenter
- Joiner and Wood Machinist
- Painter and Decorator
- Plasterer and Tiler
- Plumber
- Shopfitter

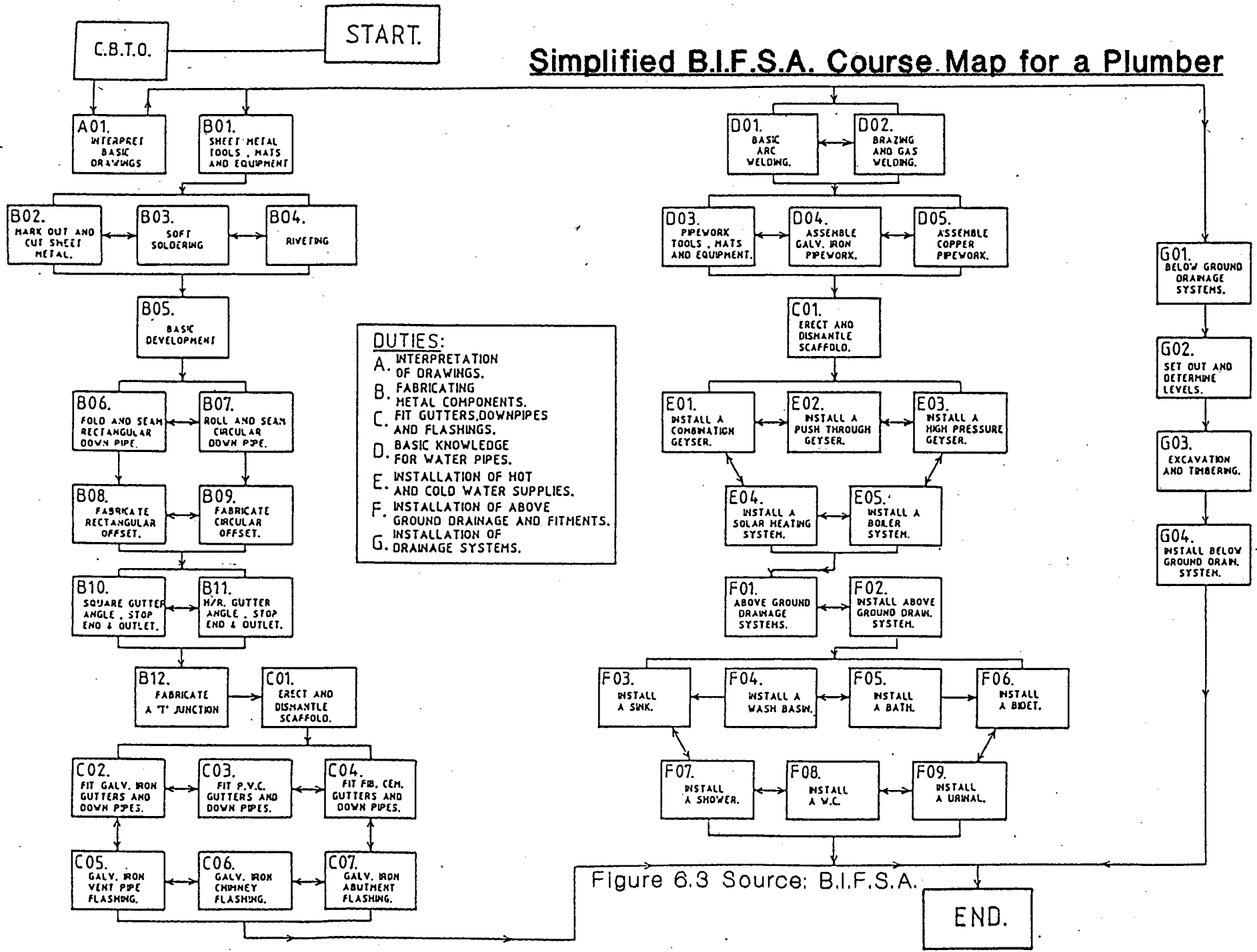
In order to qualify as an apprentice, the trainee will have to complete four training stages. The first requires the trainee to obtain the National Technical Certificates (Parts 1 & 2), with a pass in trade theory. Secondly, the trainee will undergo institutional training at a B.I.F.S.A. training college until he has met with the Training Performance Criteria in all tasks and modules as is specified by B.I.F.S.A. This is discussed in more detail below. Thirdly, the trainee will partake in practical training with an accredited employer or at a B.I.F.S.A. training college until he has met with the Production Performance Criteria in those tasks specified for the relevant trade. A further 18 to 24 months practical site experience comprises the fourth part of the apprentices' training. The trainee will then pass a trade test after which he will receive a Designated Tradesman Certificate.

The institutional training at the B.I.F.S.A. training colleges has been designed to equip the trainee tradesmen with all the appropriate skills. A curriculum has been designed for each trade and consists of several modules, all of which have to be completed with the passing of a module test before the Designated Tradesman Certificate can be awarded. The simplified curriculum, or course map followed by a trainee plumber is shown overleaf.

Development training was first implemented by B.I.F.S.A. about ten years ago and consisted of a simple course comprising nine phases including, principles of supervision, concrete technology, materials management, setting out, industrial relations,

START.

Simplified B.I.F.S.A. Course Map for a Plumber



DUTIES:

- A. INTERPRETATION OF DRAWINGS.
- B. FABRICATING METAL COMPONENTS.
- C. FIT GUTTERS, DOWNPIPES AND FLASHINGS.
- D. BASIC KNOWLEDGE FOR WATER PIPES.
- E. INSTALLATION OF HOT AND COLD WATER SUPPLIES.
- F. INSTALLATION OF ABOVE GROUND DRAINAGE AND FITMENTS.
- G. INSTALLATION OF DRAINAGE SYSTEMS.

Figure 6.3 Source: B.I.F.S.A.

END.

interpretation of drawings, and the like. However, B.I.F.S.A. realized that there have been fundamental changes in the industry over the past ten years, and have revised their development training to cater for a wide variety of firms from the multi-national organizations to the smallest builders, the suppliers to the sub-contractors. Further, the new scheme accommodates supervisors from all the hierarchical levels having a wide range of backgrounds. Table 6.4(s) shows a simple version of the B.I.F.S.A. Management Development Program.

TABLE 6.4

Source: Butt P. (B.I.F.S.A.)

B.I.F.S.A. Management Development Program.

- (* Level PRS = Prerequisite Skills Level
 Level No. 1 = Basic Supervision
 Level No. 2 = Intermediate
 Level No. 3 = Advanced)

Lvl*	Topic	Module
PRS	Skills-related courses	Concrete Technology Setting Out and Levelling Builders Bookkeeping Plant Management Materials Management Work and Wages Interpreting Documentation
L1	Financial Control	Budgetary Control
	Production Management	Production Control Production Measurement Quality Workmanship
	Human Behavior	Supervision Leadership
	Industrial Relations	I.R. An Introduction and Overview

General Information

Interpreting Documentation
Management of Time
Basic Site Safety

L2	Organizational Behavior	Structure of Companies
	Financial Control	Methods of Control
	Estimating and Tendering	Final Accounts Variations
	Production Management	Method Selection Basic Planning
	Human Behavior	Effective Communication Motivation
	Industrial Relations	Discipline Grievance Procedure Proper I.R. Procedures
	Legal Requirements	Basic Contracts Site Documents
	General Information	Decision Making Safety and Loss Control

L3	Organizational Behavior	Nature of the Industry Company Objectives Development of Staff
	Financial Control	Financial Management Accounts Procedures Cash Flow Management Overheads Business and the Economy
	Estimating and Tendering	Types of Contracts Analysis of Prices Types of Documentation Monthly Payments
	Production Management	Planning Methods Organizing Schemes Site Control Site Layout Programming Methods Resource Levelling

	Subcontract Management
	Quality Management
Human Behavior	Human Behavior
	Incentive Schemes
Industrial Relations	Trade Unions
	Negotiating Skills
	Labour Practices
Legal Requirements	General Legislation
	Contracts
	P & G Clauses
	Delays and Extensions
General Information	Problem Solving
	Personal Development
	Basic Purchasing
	Security on Site
	Safety Management

At present, each module consists of three afternoons comprising two 45 minute lectures together with discussion periods. After completion of the required number of modules, the candidates spend two days revising and discussing the work, prior to being tested. A certificate is awarded after the completion of a certain number of modules at each level.

Despite the poor economic climate, the skills training school is running at capacity in the Western Cape. This is due to the fact that there is a market for personnel with good building skills as the building industry has not suffered as much as the civil engineering industry. Skills training is also regarded as a long term personal investment.

Unlike the views expressed by the C.E.I.T.B., the principal of B.I.F.S.A. favors the use of in-house training programs. He is also of the opinion that the present training schemes are of good quality, and that the only changes needed in the future will be to take into account any new materials or methods that will be developed. For example, a new development is that most modern

buildings have "computer floors" built into them to house computer cables, and that the tradesmen have to be taught the correct methods with which to install these floors.

6.4 The Future and Training

The present state of basic education has frustrated the efforts of several contracting companies to introduce the concept of quality circles to their labour force. However, with the proposed government policy encouraging improved across the board education, and the increase in trainees following recognized career paths, the industry's climate may soon favor the implementation of the concept. A stable economy will enable the companies to plan in the long term, and training will then become one of the top priorities.

"It is now widely accepted that a company's future foremen are already working for them now within the labour force or lowest levels of supervision. Their advancement will be determined by in-house development." (2) This statement clearly illustrates the long term consequences of a company's training policy. It is up to the industry to ensure an adequate supply of well equipped personnel to professionally and successfully perpetuate the construction industry.

7. IMPORTANCE OF MOTIVATIONAL FACTORS FOR WORKERS

Question 10 of the Construction Productivity Questionnaire asked the construction executives to rate certain motivational factors as to the importance they believed their labourers attached to them. These factors are listed in table 7.1 below in their supposed order of importance.

TABLE 7.1

EXECUTIVE RATING OF LABOURERS' MOTIVATIONAL FACTORS

RANK

1	Good Wages
2	Financial Incentives
3	Job Security
4	Good Working Conditions
5	Full Managerial Appreciation of Work Done
6	Sympathetic Help with Personal Problems
7	Personal Loyalty to Employees
8	Tactful Approach to Discipline
9	Promotion and Growth in the Organization
10	Feeling of Being In on Things
11	Interesting Work

The objective of this part of the thesis was to ascertain the actual importance that the labourers attached to these motivational factors, so as to be able to compare the true order of importance to the believed order of importance. However, this proved to be fraught with difficulties.

Methodology: Question 10 of the Construction Productivity Questionnaire was extracted from the questionnaire (See Appendix I) and the instructions were amended to read

"Consider the following motivational factors. What importance do you attach to them?" (See figure 7.1) The rest of the question initially appeared in exactly the same form as it did on the questionnaire.

The union C.A.W.U. was approached in the hope that they would help in collecting the data. A meeting was set up with the regional secretary (Cape), and ten shop stewards. The purpose of this meeting was to enlighten the shop stewards as to the purpose of the research, and to ask them to collect data from the employees they represent. Prior to the meeting, the regional secretary had been familiarized with the purpose of the research, and with the proposed data collection methods.

It was proposed that the data be collected by asking a group of employees the degree of importance that they attached to the motivational factors. The members of the group that regarded that particular motivational factor as very important (i.e. rating 5) would indicate this by raising their hand. The process would be carried out in a similar way for ratings 4 through 1, and for the rest of the motivational factors. The data would then be collated and the order of importance would be apparent.

During the meeting, the regional secretary explained, at length, in Xhosa, the objectives of the research. An explanation of each of the motivational factors was given, along with an example taken from a common job-related situation, and this was translated to the shop-stewards. The shop stewards had a working knowledge of the English language, and the translator was supposedly able to clear up any ambiguities. The process was then practised so as to further reinforce the important points.

Problems: The convenor of the survey asked the shop stewards the degree of importance that they attached to the first factor. It was here that the first difficulties were encountered:

- 1) Instead of the shop stewards each giving their own answer, they would discuss the importance of the factor among themselves and then come up with a group answer - always "very important". Attempts to get each person to answer separately were met by a "leader" volunteering that the factor was "very important", and the rest of the shop stewards following suit. However, they were adamant that they did not follow the example of the "leader".
- 2) It was found that the shop stewards could not understand the five-point scale. They could not relate the symbol "5" to mean "very important", the symbol "1" to mean "not important", and the numbers 2, 3, and 4, to symbolize degrees between "very important", and "not important". This problem was solved by changing the five point scale to into categories headed "Very Important", "Medium Important", and "Not Important". The shop stewards were asked to fill in the number of labourers answering to each of these categories in the space provided on the amended form. (See figure 7.1)
- 3) The next problem discovered was that the shop stewards had mistaken the question to be "Are these motivational factors used in your work place?" For example, they thought that they were being asked "Is your work interesting?" as opposed to, "Do you think that it is important to have interesting work?" This problem was solved by means of a lengthy explanation.

As it was impossible to prevent the shop stewards from discussing the importance of the factors prior to giving a group answer, the convenor asked each man separately to decide upon the factor that was most important to him. Again, one person decided that a "tactful approach to discipline" was the most important factor, and was immediately followed by five others. Two people decided that "financial incentives" was the most important, and "full managerial appreciation of work done" and "personal

loyalty to employees" each gained one vote. Unfortunately, this sort of information is meaningless.

Figure 7.1 gives an example of the final format of the questionnaire that the shop stewards were given to complete at their next workers meeting.

FIGURE 7.1

AMENDED FORM FOR RANKING WORKER MOTIVATIONAL FACTORS

CONSIDER THE FOLLOWING MOTIVATIONAL FACTORS. WHAT IMPORTANCE DO YOU ATTACH TO THEM?

	VERY IMPORTANT	MEDIUM IMPORTANT	NOT IMPORTANT
Tactful approach to discipline	<input type="text"/>	<input type="text"/>	<input type="text"/>
Interesting work	<input type="text"/>	<input type="text"/>	<input type="text"/>
Etc.	<input type="text"/>	<input type="text"/>	<input type="text"/>

Fill in the number of respondents in each category in the space provided.

At the end of the initial meeting, the shop stewards were eager to help collect the information, but only one return was ever received. This return stated that 200 employees each ranked all the motivational factors as being very important.

Although no positive information has come out of this research, one can assume that the factor "good wages" has not dominated the other factors as is believed by many managers.

Advice for Future Researchers: This sort of information would be extremely useful to managers in the construction industry. Unfortunately, it is difficult to collect any useful information. A person intending to further this research should bear the following problem factors in mind:

- i) CAWU is an extremely inefficient organization when compared to the efficiency of the average construction company. This, coupled with the fact that the shop-stewards have practical transport problems, makes it very difficult to organize meetings. Meetings which have been "finalized" are often cancelled for no apparent reason, or else the delegates do not arrive on time, or at all. The reader will appreciate that much time and patience will be needed to successfully complete any future research.
- ii) Labourers tend to come from a culture that stresses group action. As a result, there is very little individualism which hampers efforts to collect data using the ordinary methods. As mentioned previously, the workers do not give individual answers which can then form a data base to be analysed using the usual methods. Another form of data collection will have to be employed. Attempts to collect such information should be preceded by a study into appropriate data collection methods.
- iii) The researcher must bear in mind that a large portion of the work force is illiterate, and will therefore have problems with filling in forms.

The usefulness of this information is such that it would be worth the significant time and effort necessary to collect it. If a morally sound method could be found to utilize this group behavior found in the general work force, while motivating them in the best possible way, many of the construction productivity problems could be solved along with the problem of poor management - worker relations.

8. CLOSURE

This volume of the thesis has covered the compilation of the Construction Productivity Questionnaire, and the analysis of the ensuing data. It was found that labour training and quality control, management supervision, cost control and labour relations, and communications were the six factors that possessed the most opportunity for productivity improvement. The ratings for these and other factors related to productivity improvement were compared to the modified ratings from similar surveys conducted in the United States. It was found that the studies produced similar results.

The second part of the volume contains the information collected through a series of interviews held with personnel in the construction industry. It is mainly concerned with furthering research into the areas possessing the most opportunity for construction productivity improvement. A study into training methods forms part of this section. The results and conclusions formed from this data appear in volume 3 along with the conclusions relating to volume 1.

GLOSSARY Volume 2

CAWU. Construction & Allied Workers Union

C.E.I.T.B. The Civil Engineering Industry Training Board.
 (South Africa)

E1: Construction Productivity Improvement survey conducted in
 1979 on the ENR top 400 companies by Chromokos J. & McKee
 K.E.

E2: Construction Productivity Improvement survey conducted in
 1983 on the ENR top 400 companies by Arditi D.

E.N.R. Top 400. The largest 400 U.S.A. contracting companies as
 listed annually by the Engineering News Record periodical.

N.P.I. The National Productivity Institute. (South Africa)

S1: Construction Productivity Improvement survey conducted in
 1981 on small/medium companies by Koehn E. & Caplan S.B.

S2: Construction Productivity Improvement survey conducted in
 1986 on small/medium companies by Koehn E. & Manuel J.

YEAR 1981

- 4) Choromokos J. and Mckee K.E.
Construction Productivity Improvement
Journal of the Construction Division, ASCE, Vol. 107,
No.CO1, Proc. Paper 16105, Mar., 1981, pp.35-47.
UCT REF: 620.5 AME

YEAR 1985

- 5) Arditi D.
Construction Productivity Improvement A024579
J Constr Eng Manage 111(1,Mar)1-14 85 26 R
UCT REF: 620.5 AME

YEAR 1987

- 6) Koehn E. and Caplan S.B.
Work Improvement Data for Small and Medium Size Contractors
J Constr Eng Manage 113(2,Apr)327-339 87
UCT REF:

YEAR 1988

- 7) Koehn E. and Manuel J.
Variation in Work Improvement Potential for Small / Medium Contractors.
J Constr Eng Manage 114(3,Sep)505-509 88 3 R
UCT REF: 620.5 AME

YEAR 1991

- 8) Butt P.
Supervisory Training in the Building Industry
S.A. Builder, May 1991, pp.25 to 32

APPENDIX I CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

14 Laurier Road
Claremont
Cape Town
7760

The Managing Director

18 April 1991

Dear Sir,

PRODUCTIVITY IMPROVEMENT IN THE CIVIL CONSTRUCTION INDUSTRY

The decline of productivity in the construction industry is of international economic concern. Research in the United States has prompted similar South African studies to ascertain the areas in which productivity improvement is critical. Follow-up research into strategic methods improvement will be conducted on the results of this survey.

The convenors of this investigation are based at the University of Cape Town and guarantee complete confidentiality of all specific data. The ten minutes spent on completing the questionnaire would be appreciated.

If you have any queries or further contributions, please contact me at the above address or at telephone 021-683-1987.

Yours faithfully,

Rupert Marshall.

7. PERCENTAGE OF WORK (By Rand Value) SUBCONTRACTED ON AVERAGE JOB (excluding value performed by nominated subcontractors).

-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. TYPE OF COMPUTER USAGE

On Site	S
Centralized Control	C
Terminal to Outside Service	T
None	N

9. GEOGRAPHIC LOCATION OF MAJORITY OF PROJECTS.

PWV Area	PWV	Natal	Natal
Other Transvaal	Trans	Swaziland / Lesotho	Swaz
Orange Free State	OFS	Bophuthatswana	Bop.
Western Cape	W.C.	Botswana	Bots.
Eastern Cape	E.C.	Other (Specify)_____	

10. CONSIDER THE FOLLOWING MOTIVATIONAL FACTORS. WHAT IMPORTANCE DO YOU BELIEVE YOUR LABOURERS ATTACH TO THEM?

(1 = not important, 5 = very important)

Tactful approach to discipline	1	2	3	4	5
Interesting work	1	2	3	4	5
Sympathetic help with personal problems	1	2	3	4	5
Full managerial appreciation of work done	1	2	3	4	5
Personal loyalty to employees	1	2	3	4	5
Feeling of being in on things	1	2	3	4	5
Good working conditions	1	2	3	4	5
Job security	1	2	3	4	5
Promotion and growth in the organization	1	2	3	4	5
Good wages	1	2	3	4	5
Financial incentives (Bonuses, Prizes, etc.)	1	2	3	4	5

11. RATE THE FOLLOWING "HEADQUARTER-TYPE" FUNCTIONS FOR POTENTIAL WITH RESPECT TO OPPORTUNITY FOR PRODUCTIVITY IMPROVEMENT. (1= Needs No imprvmnt; 5 = Needs Much imprvmnt)

Communications	1	2	3	4	5	Procurement	1	2	3	4	5
Planning	1	2	3	4	5	Drafting	1	2	3	4	5
Scheduling	1	2	3	4	5	Specifications	1	2	3	4	5
Estimating	1	2	3	4	5	Engineering (design)	1	2	3	4	5
Marketing	1	2	3	4	5	Other_____	1	2	3	4	5

12. RATE THE FOLLOWING "SITE-TYPE" FUNCTIONS FOR THEIR POTENTIAL WITH RESPECT TO OPPORTUNITY FOR PRODUCTIVITY IMPROVEMENT.

(1 = Needs No improvement; 5 = Needs Much improvement)

MATERIALS		Product Availability	1	2	3	4	5				
Delivery	1	2	3	4	5	New Products	1	2	3	4	5
Storage	1	2	3	4	5	MANAGEMENT					
Packaging	1	2	3	4	5	Labour Relations	1	2	3	4	5
Prefabrication	1	2	3	4	5	Cost Control	1	2	3	4	5
Standardization	1	2	3	4	5	Supervision	1	2	3	4	5

EQUIPMENT

Capacity	1	2	3	4	5
Simplicity	1	2	3	4	5
Maintainability	1	2	3	4	5
Utilization	1	2	3	4	5

ENGINEERING

Design Standards	1	2	3	4	5
Design Improvement	1	2	3	4	5
Standard Specs.	1	2	3	4	5

REGULATORY BOARDS

CAWU	1	2	3	4	5
BACAWU	1	2	3	4	5
Other_____	1	2	3	4	5

LABOUR

Contract Agreements	1	2	3	4	5
Training	1	2	3	4	5
Quality Control	1	2	3	4	5
Turnover	1	2	3	4	5
Availability	1	2	3	4	5
Incentive Schemes	1	2	3	4	5

CONSTRUCTION TECHNIQUES

Pre-cast Elements	1	2	3	4	5
Pre-assembled Units	1	2	3	4	5
Foreign Technology	1	2	3	4	5
Other_____	1	2	3	4	5
Other_____	1	2	3	4	5

13. WOULD YOUR COMPANY BE INTERESTED IN PARTICIPATING IN ANY OF THE FOLLOWING ACTIONS? (1 = not interested, 5 = very interested)

- i) Serve as a member of a group that identifies productivity problems. 1 2 3 4 5
- ii) Contribute nominal funds (together with other companies) to support programs aimed at improving constructing productivity. 1 2 3 4 5
- iii) Help develop a project aimed at improving construction productivity. 1 2 3 4 5
- iv) Conduct or participate in a project aimed at improving construction productivity. 1 2 3 4 5
- v) Evaluate the results of a project aimed at improving construction productivity. 1 2 3 4 5
- vi) Attend construction productivity conferences and meetings. 1 2 3 4 5
- vii) Subscribe to a construction productivity information service. 1 2 3 4 5
- viii) Other _____ 1 2 3 4 5

14. YOUR COMMENTS RELATIVE TO PROBLEMS OR SOLUTION DIRECTIONS FOR CONSTRUCTION PRODUCTIVITY, WOULD BE APPRECIATED. PLEASE MAKE THESE COMMENTS IN THE SPACE PROVIDED AND RETURN THE COMPLETED QUESTIONNAIRE IN THE PROVIDED POSTAGE PAID ENVELOPE.

APPENDIX II UNPROCESSED DATA FROM THE CONSTRUCTION
PRODUCTIVITY QUESTIONNAIRE

A	C	E	F	G	H	I	J	K	L
No.	Ref No.	1 Type			2	3	4	5	6
					Ann	Perm.	Temp.	Const	Equip
					x10 ⁶	Empl.	Empl.	Equip	Hired
								x10 ⁶	x10 ⁶
1	63	1	1	1					20
2	120	0	1	1		35	100	25	5
3	57	0	1	0	1	12	0	5	5
4	11				2	12	8	7	1
5	73	0	1	0	2	35	0	2	5
6	90	0	1	0	2	18	0	2	21
7	110	0	1	0	2	18	25	1	50
8	119	0	1	0	2	12	50	1	20
9	7	0	1	0	3	50	50	9	0
10	8	0	1	0	3	35	0	3	5
11	15	0	1	0	3	18	62	2	95
12	24	0	1	0	3	14	50	1	11
13	75	0	1	0	3	25	0	3	0
14	117	1	0	0	3	17	0	1	1
15	121	1	1	0	3	60	30	4	36
16	36	0	1	0	4	50	0	3	0
17	72	0	1	0	4	65	18	4	15
18	83	0	1	0	4	45	70	3	30
19	84	0	1	0	4	80	12	1	0
20	91	0	1	0	4	38	15	2	10
21	98	0	1	0	4	100	0	10	10
22	10	0	1	0	5	40	200	2	2
23	13	0	1	0	5	20	0	3	1
24	17	0	1	0	5	13	100	5	50
25	22	0	1	0	5	75	15	6	14
26	28	0	1	0	5	180	62	6	0
27	34	0	1	0	5	100	0	6	30
28	41	0	1	0	5	30	35	4	0
29	58	1	1	0	5	75	12	1	70
30	59	0	1	0	5	160	10	5	15
31	62	0	0	1	5	25	8		97
32	67	0	1	0	5	12	0	5	0
33	68	0	1	0	5	38	13	5	15
34	76	1	1	0	5	25	100	5	20
35	77	0	1	0	5	12	125	5	45
36	79	0	1	0	5	35	25	1	50
37	92	0	1	0	5	175	0	10	0
38	93	1	1	0	5	38	0	15	3
39	107				5	12	12	5	5

A	C	E	F	G	H	I	J	K	L
No.	Ref No.	1 Type			2 Ann	3 No.	4 No.	5 Val.	6 %
					Sals x10 ⁶	Perm.Empl.	Temp.Empl.	Const.Equip	Hired
									x10 ⁶
40	109	0	1	0	5	90	5	5	5
41	111	0	1	0	5	75	13	4	75
42	115	1	0	0	5	50	25	2	20
43	23	0	1	0	6	200	50	5	5
44	51	0	1	0	6	175	12	6	5
45	56	0	1	0	6	70	87	5	15
46	105	0	1	0	6	80	75	1	30
47	122	1	1	0	6	38	12	5	5
48	14	0	1	0	7	175	100	10	5
49	29	0	1	0	7	75	75	35	30
50	31	0	1	0	7	100	100	2	5
51	32	0	1	0	7	130	3	7	0
52	44	0	1	0	7	250	25	3	4
53	66	0	1	1	7	48	42	3	65
54	101	0	1	1	7	175	100	5	25
55	27	1	0	0	8	200	20	3	10
56	71	0	1	0	8	100	25	3	30
57	112	0	1	0	8	325	0	3	15
58	113	1	1	0	8	32	45	6	2
59	64	0	1	0	9	175	18	5	20
60	95	0	1	0	9	160	20	6	3
61	104	0	1	0	9	45	37	3	50
62	5	0	1	0	10	50	5	5	20
63	30	1	1	0	10	50	15	10	10
64	85	1	1	1	10	100	50	3	10
65	102	1	1	1	10	25	100	10	0
66	25	0	1	0	11	110	0	10	15
67	38	1	0	0	13	22	150	3	60
68	99	1	1	0	13	200	95	4	1
69	35	0	1	0	14	200	32	4	0
70	42	0	1	0	14	65	35	10	2
71	3	0	1	0	15	250	40		5
72	65	1	1	1	16	300	35	4	60
73	69	1	1	1	16	37	7	6	95
74	18	0	1	0	18	85	0	8	0
75	81				18	38	200	15	2
76	16				19	875	0	3	15
77	49	1	1	0	19	325	25	5	6
78	20	0	1	1	20	50	75	9	7
79	86	0	1	0	20	325	8	19	2
80	94	1	1	0	20	175	35	25	0
81	97	0	1	0	20	160	175	14	3
82	2	0	1	0	25	300	110	18	8
83	26	1	1	1	25	25	15	1	10
84	39	1	1	1	25	400	10	10	10

A	C	E	F	G	H	I	J	K	L
No.	Ref No.	1 Type			2 Ann Sals x10 ⁶	3 No. Perm. Empl.	4 No. Temp. Empl.	5 Val. Const. Equip	6 %
85	45	0	1	0	25	300	35	30	2
86	89	1	1	0	25	250	300	10	10
87	87				32	220	38	5	5
88	60	1	1	0	34	950	20	7	20
89	19	1	0	0	35	75	225	3	25
90	43	0	1	0	37	500	0	7	3
91	61	0	1	0	39	450	45	19	25
92	118	0	1	0	40	180	170	5	95
93	21	0	1	0	42	600	50	8	10
94	52	0	1	0	42	1500	500	10	20
95	53	1	1	0	42	425	37	17	25
96	55	0	0	1	45	70	300	10	80
97	82	0	1	0	45	350	280	65	15
98	108	0	0	1	45	175	650	16	5
99	9				50	40	300	1	90
100	74	0	1	0	50	100	750	10	70
101	78	0	1	0	50	450	0	20	5
102	33	1	1	0	55	300	210	16	35
103	46	0	1	1	60	900	65	43	5
104	96	0	1	0	65	580	65	26	6
105	37	0	1	0	75	160	750	20	20
106	100	0	1	0	75	175	625	23	10
107	106	0	1	0	75	750	25	100	15
108	114	0	1	0	75	375	300	5	30
109	70	0	1	0	82	65	25	5	30
110	88	1	1	1	85	900	350	13	30
111	6	0	1	0	100	500	250	75	10
112	12	1	1	1	100	1200	60	75	30
113	50	0	1	0	125	1500	1000	20	70
114	54	0	1	0	125	175	0	0	20
115	116	1	1	1	125	1400	40	6	6
116	4	1	1	1	140	350	250	25	5
117	48	1	1	1	143	170	1600	75	2
118	47	0	1	0	200	2750	250	88	20
119	103				275	3500	350	85	35
120	1	1	1	0	300	1500	0	0	100
121	40				400	6500		50	20
122	80	1	1	1	1000	9999	5000	500	4

A	M	N	O	P	R	S	T	U
No.	7	8				9		
	%	Type				Loc.		
	Work	of				Maj.		
	Sub-	Compu				Proj.		
	Contr							
1	35	1	1	1	1	4	2	5
2	3	1	1	0	1	5		
3	5	1	0	0	2			
4	18	0	0	1	4			
5	5	0	0	0	6			
6	0	0	1	0	1	6		
7	0	0	0	0	6			
8	10	0	1	0	5			
9	5	0	1	0	4			
10	0	0	1	0	4			
11	25	0	1	0	6			
12	0	0	1	0	4			
13	0	0	0	0	2			
14	1	0	0	0	4			
15	10	0	0	0	6			
16	5	0	1	0	5			
17	25	0	1	0	1			
18	20	0	1	0	10			
19	0	1	0	0	3			
20	3	0	1	0	1			
21	20	0	1	0	2			
22	4	0	1	0	10			
23	3	0	1	0	4			
24	20	0	1	0	1	2		
25	5	0	1	0	4			
26	0	0	1	0	8	10		
27	0	0	1	0	10			
28	0	0	0	0	3	10		
29	20	0	1	0	2			
30	4	0	1	0	10			
31	25	0	0	0	2			
32	0	0	0	0	6			
33	15	0	0	0	6			
34	5	0	1	0	5			
35	15	0	1	0	6			
36	0	0	1	0	6			
37	0	0	1	0	1			
38	1	0	1	0	3			
39	5	0	1	0	1			
40	10	0	1	0	3			
41	25	0	1	0	6			
42	30	0	1	0	6			
43	5	0	1	0	1	2		
44	15	0	1	0	4			
45	4	0	1	0	1			

A	M	N	O	P	R	S	T	U
No.	%	Type				Loc.		
	Work	of				Maj.		
	Sub-	Compu				Proj.		
	Contr							
46	0	0	1	0	1	2		
47	5	0	1	0	4			
48	5	0	0	0	4			
49	30	0	1	0	1			
50	2	0	1	0	2	6	10	
51	0	0	1	0	1			
52	10	0	1	0	6			
53	15	0	1	0	2			
54	20	0	1	0	3			
55	6	1	1	0	10			
56	20	0	1	0	5	10		
57	1	0	1	0	10			
58	20	0	1	0	1			
59	30	1	0	0	6			
60	13	0	1	0	5			
61	15	1	0	0	6			
62	0	0	1	0	1	6		
63	20	0	0	0	6			
64	30	1	0	0	6	7		
65	10				1			
66	15	0	1	0	1			
67	55	0	1	0	6			
68	25	0	1	0	2			
69	1	0	1	0	1	8		
70	0	0	1	0	1			
71	10	0	1	0	4			
72	50	0	1	0	3	8		
73	74	1	0	0	1	2	3	
74	5	0	1	0	6			
75	10	0	1	0	4			
76	25				3			
77		0	1	0	6			
78	5	0	1	0	1			
79	13	1	0	0	1			
80	1	0	1	0	1			
81	13	0	1	0	2			
82	8	0	1	0	4			
83	10	0	1	0	2	7		
84	20	0	1	0	1	2		
85	3	0	1	0	6			
86	20	1	0	0	6			
87	20	0	1	0	6			
88	32	0	1	0	5			
89	50	1	0	0	5			
90	10	0	1	0	4			

A	M	N	O	P	R	S	T	U
No.	7	8				9		
	%	Type				Loc.		
	Work of	of				Maj.		
	Sub-	Compu				Proj.		
	Contr							
91	25	1	1	0	4	5	6	
92	6	0	1	0	1	2		
93	20	1	1	0	4			
94	5	0	1	0	1	2	8	
95	10	0	1	0	1	6		
96	25	1	0	0	2			
97	15	1	1	0	4	10		
98	25	1	0	0	5			
99	60	0	1	0	4			
100	20	0	1	0	6			
101	15	0	1	0	4			
102	13	0	1	0	3	6	7	
103	10	0	1	0	1	2		
104	26	0	1	0	1			
105	10	1	1	0	6			
106	3	1	1	0	2	8	9	
107	20	1	0	0	1	2	6	9
108	30	1	1	0	1	2	3	8
109	20	1	1	0	1	2	3	4
110	20	1	0	0	5	6	10	
111	10	0	1	0	All 9 areas			
112	5	1	1	1	1	2	3	8
113	10	0	1	0	5	6		
114	25	1	0	0	1	7	9	
115	45	0	1	0	6	10		
116	30	1	1	0	4			
117	30	1	1	0	1	2		
118	40	1	0	0	7	9		
119	35	1	1	0	1			
120	30	1	1	0	4			
121		1	0	0	All 9 areas			
122	9	1	0	0	All areas			

A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
No.	10 Rating			of	Motivational						Factors
	[---	---	---	---	---	---	---	---	---	---
	T	I	S	F	P	F	G	J	P	W	F
	a	n	y	u	e	e	o	o	r	a	i
	c	t	m	l	r	e	d	b	o	g	n
	t	r	p	l	s	l			m	e	a
1	3	2	4	3	3	3	4	4	3	5	4
2	3	1	4	3	4	3	4	4	3	4	4
3	3	4	4	5	4	4	4	4	4	3	4
4	3	2	5	5	4	1	2	2	2	4	4
5	3	4	2	4	3	3	3	3	5	4	4
6	1	2	4	4	3	2	4	4	3	5	5
7	3	4	2	3	4	4	4	4	4	5	5
8	5	1	5	4	3	2	3	3	3	5	5
9	5	4	4	4	5	3	4	4	4	5	5
10	5	4	4	5	5	4	3	5	3	3	3
11	1	1	1	1	1	1	1	1	1	5	5
12	4	1	3	2	3	3	2	5	2	5	4
13	1	1	1	1	1	1	1	1	1	5	5
14	5	5	5	5	5	5	5	5	5	5	5
15	3	3	3	2	2	2	3	5	1	5	5
16	5	3	4	5	4	3	4	4	3	4	3
17	3	4	4	5	5	3	4	5	3	5	5
18	2	4	5	4	3	4	5	5	3	4	4
19	3	3	5	2	3	3	3	3	1	5	1
20	3	2	3	3	4	4	4	3	3	4	4
21	5	2	5	3	4	2	5	4	3	5	5
22	4	2	4	4	3	2	3	3	3	4	2
23	4	2	1	5	3	4	5	5	4	5	5
24	1	1	3	5	3	3	3	3	3	3	3
25	5	3	4	3	2	2	3	4	3	5	5
26	3	2	3	3	3	3	3	3	3	4	4
27	3	3	5	3	5	3	4	5	5	5	5
28	1	1	3	1	1	1	1	1	3	3	1
29	4	4	3	5	4	2	3	5	4	4	2
30	4	2	3	2	4	1	4	3	2	5	4
31	5	1	2	5	2	2	5	1	3	3	3
32	5	2	5	5	5	3	5	5	5	5	5
33	4	3	5	4	4	4	4	4	3	5	3
34	3	1	5	3	3	3	5	1	3	3	3
35	1	2	3	2	3	2	3	4	3	3	4
36	3	2	4	4	5	3	5	3	1	5	3
37	3	1	5	3	1	1	5	3	3	5	5
38	4	3	3	5	5	4	4	5	3	5	5
39	5	1	3	5	5	4	3	5	5	5	3
40	3	3	2	5	3	3	4	4	4	4	4
41	3	4	3	4	4	3	4	4	3	4	4
42	4	3	3	4	4	5	5	3	3	3	4
43	3	2	3	4	3	3	4	4	4	4	5

A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
No.	10 Rating			of	Motivational						Factors
	[---	---	---	---	---	---	---	---	---	---
	T	I	S	F	P	F	G	J	P	W	F
	a	n	y	u	e	e	o	o	r	a	i
	c	t	m	l	r	l	d	b	o	g	n
	t	r	p	l	s	l	d		m	e	a
44	3	1	3	2	4	1	4	4	2	5	3
45	3	3	1	2	3	1	3		2	4	1
46	5	5	1	5	5	5	5	5	5	3	2
47	2	1	3	4	4	3	3	5	4	5	4
48	3	3	2	2	2	2	4	4	2	5	5
49	5	3	3	4	5	3	5	5	5	5	5
50	4	2	5	5	5	2	4	4	4	5	4
51	4	3	3	4	5	3	5	5	4	5	4
52	5	3	4	5	5	3	4	4	4	5	4
53	4	3	4	4	3	3	4	4	4	4	3
54		2	2	2	2	2	3	3	3	3	3
55	5	3	5	4	5	3	4	5	4	5	4
56	3	4	4	2	2	3	3	3	2	4	4
57	2	3	3	2	3	3	4	4	4	5	5
58	2	2	4	3	3	2	3	4	4	5	4
59	4	3	4	4	2	1	3	3	3	3	3
60	3	2	5	4	3	2	2	4	3	4	5
61	3	2	5	4	3	3	2	5	4	5	4
62	3	4	3	5	4	2	3	2	3	5	5
63	3	2	2	5	4	4	5	2	4	4	4
64	3	2	4	3	3	2	5	4	4	5	4
65	1	1	1	1	1	1	1	1	1	1	1
66	4	5	4	4	4	2	4	3	3	4	3
67	2	2	3	1	2	1	3	4	2	5	5
68	2	2	4	3	5	4	4	3	4	3	3
69	2	2	2	3	2	3	4	3	2	3	4
70	3	3	4	4	5	3	5	5	5	5	5
71	2	3	5	5	3	5	2	4	3	4	2
72	4	4	3	5	5	5	3	3	4	3	3
73	4	5	4	4	5	4	4	4	4	5	5
74	5	5	5	3	5	5	5	5	5	5	5
75	1	3	4	1	2	3	3	3	3	5	5
76	3	2	3	4	4	5	5	5	4	5	5
77	5	5	5	5	5	4	5	5	5	5	5
78	4	2	5	2	3	3	3	3	3	4	3
79	5	2	4	4	4	3	4	5	4	5	4
80	3	4	3	3	3	4	2	4	3	4	4
81	3	4	4	4	2	3	3	3	3	3	4
82	3	3	5	4	4	3	3	4	3	3	5
83	3	1	4	3	3	3	3	5	3	5	4
84	2	2	3	4	2	2	3	4	2	5	5
85	4	3	4	4	3	3	4	5	3	5	5
86	4	2	5	5	4	3	3	4	3	4	3

A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	
No.	10 Rating			of	Motivational					Factors		
	[---	---	---	---	---	---	---	---	---	---]
	T	I	S	F	P	F	G	J	P	W	F	
	a	n	y	u	e	e	o	o	r	a	i	
	c	t	m	l	r	e	d	b	o	g	n	
	t	r	p	l	s	l			m	e	a	
87	3	3	4	3	3	2	4	5	4	4	3	
88	3	2	3	3	3	3	4	4	4	5	4	
89	3	4	5	3	2	4	5	5	3	4	4	
90	3	2	5	5	5	4	4	5	5	5	5	
91	5	2	4	3	3	3	4	2	2	5	3	
92	6	2	4	2	2	4	5	5	3	5	5	
93	5	2	4	3	4	5	4	4	3	5	5	
94	4	2	3	4	4	3	3	4	5	5	4	
95	3	4		4	5	4	4	5	4	4	5	
96	3	3	4	5	4	4	3	5	4	4	3	
97	5	3	4	3	4	4	4	4	4	5	3	
98	4	1	5	3	5	2	3	4	3	5	3	
99	3	1	4	5	3	4	5	5	2	5	5	
100	3	3	3	4	3	4	4	3	4	4	5	
101	3	2	5	4	4	4	5	5	5	3	4	
102	3	3	2	5	4	4	4	4	3	4	4	
103	5	2	5	5	5	3	5	5	3	5	3	
104	3	2	2	3	3	3	3	4	4	5	3	
105	2	2	4	5	4	3	3	5	3	5	4	
106	3	4	4	4	3	3	4	5	3	3	3	
107	2	1	4	4	1	4	5	2		5	5	
108	5	3	4	5	5	4	4	4	4	5	4	
109	4	1	4	4	4	2	3	4	3	5	4	
110	3	4	5	4	4	5	4	3	3	5	4	
111	3	2	4	4	3	3	5	5	4	5	5	
112	5	1	3	5	5	3	4	4	5	5	3	
113	5	3	5	5	2	3	4	3	4	3	5	
114	3	4	4	5	3	2	4	4	2	3	3	
115	3	3	3	3	3	2	4	3	3	5	5	
116	4	3	4	3	3	2	5	5	4	5	3	
117	2	4	5	5	5	5	4	5	5	5	5	
118	3	4	4	4	4	2	5	5	4	5	5	
119	5	1	5	4	3	3	4	4	1	5	3	
120	1	2	2	4	3	2	3	4	3	4	4	
121	4	2	3	4	4	3	3	4	4	5	3	
122	5	5	5	5	5	5	5	5	5	5	5	

A AI AJ AK AL AM AN AO AP AQ
 11
 No. Rating of Head. Funct's

	[---	---	---	---	---	---	---	---]
	C	P	S	E	M	P	D	S	E	
	o	l	c	s	a	r	r	p	n	
	m	a	h	t	r	o	a	e	g	
	m	n	e	i	k	c	f	c	i	
1	4	3	3	2	3	3	2	2	3	
2	3	4	4	4	4	3				
3	3	2	2	2	3	3	3	4	3	
4	4	4	3	2	5	5	3	3	5	
5	3	2	2	2	5	4	3	2	2	
6	4	4	2	3	3	2	2	3	3	
7	4	3	3	4	5	2	2	4	3	
8	3	3	3	3	5	4		3	3	
9	3	2	3	4	4	3	3	2	2	
10	3	2	2	2	2	2				
11	1	1	2	3	4	3	3	5	5	
12	5	5	5	3	4	2	2	2	2	
13	2	1	1	2	3	1	1	1	1	
14	1	1	1	1	1	1	1	3	3	
15										
16	2	3	3	1	2	2	1	2	2	
17	3	4	4	2	3	3	1	2	1	
18	3	2	2	2	3	2	1	2	2	
19	3	4	4	1	5	3	1	5	5	
20	4	4	3	3	4	3	3	4	4	
21	5	5	5	2	3	3	2	2	3	
22	3	3	3	4	4	4	3	3		
23	3	5	4	5	5	3	3	1	1	
24	3	3	3	3	3	3	3	3	3	
25	3	4	4	2	5	3				
26	3	3	3	2	3	2	2	2	2	
27	5	5	3	2	2	3	3	2	2	
28	3	3	4	4	4	3	3	3	3	
29	3	3	3	2	2	5	3	3	2	
30	3	3	2	2	2	2	2	2	3	
31	5	5	2	2	2	2	2	5	5	
32	1	2	2	1	2	2	2	1	1	
33	3	3	3	2	2	2	2	4	4	
34	3	2	2	2	2	3	3	2	2	
35	4	4	4	3	2	3	1	1	1	
36	3	2	2	2	2	2	2	3	2	
37	2	3	3	1	3	3	3	3	5	
38	3	4	3	4	4	3	4	4	3	
39	4	4	4	1	1	1	1	1	1	
40	2	2	3	2	1	3	2	3	3	
41	4	3	3	2	3	4	3	3	2	
42	3	4	4	3	3	4	2	2	3	

A	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
No.	Rating of Head. Funct's								
	[--	---	----	-----	-----	-----	-----	---]
	C	P	S	E	M	P	D	S	E
	o	l	c	s	a	r	r	p	n
	m	a	h	t	r	o	a	e	g
	m	n	e	i	k	c	f	c	i
43	4	4	3	2	3	2	2	2	2
44	3	3	3	2	4	2	2	3	2
45	5	4	4	2	2	5	3	2	4
46	5	5	4	5	5	4	3	3	3
47	3	2	2	3	4	4	2	4	4
48	3	3	3	2	1	2	2	2	2
49	3	2	2	1	1	1	1	1	1
50	3	1	1	1	3	2	1	1	5
51	4	4	2	2	4	3	2	2	2
52	3	3	3	3	3	2	3	4	2
53	4	4	4	5	3	4	3	3	3
54	5	5	4	2	1	1	1	1	1
55	3	4	4	3	5	4	3	3	3
56	4	4	3	2	3	2	1	2	3
57									
58	4	3	3	2	2	3	2	2	1
59	2	2	3	4	5	2	2	3	3
60	3	2	3	2	2	2	3	2	
61	4	3	4	2	2	2			
62	3	3	3	3	3	3	3	3	3
63	5	2	2	2	4	2	2	2	2
64	2	2	2	2	3	2	2	2	2
65									
66	3	4	2	1	1	2	1	2	1
67	4	4	2	2	5	4	1		
68	4	4	3	1	3	3	1	2	1
69	4	5	4	3	2	3	2	2	2
70	4	5		3	4				
71	5	3	1	1	1	1	1	1	1
72	5	4	2	1	1	3	3	4	4
73	3	2	2	2	3	1	2	2	2
74	2	2	1	1	2	2		4	
75	3	3	1	1	5	3	3	1	1
76	4	3	3	2	3	3	3	2	2
77	3	2	4	2	2	1	1	1	1
78	4	3	3	3	2	3	1	1	3
79	3	4	3	2	4	2	1	3	3
80	3	2	3	2	2	2	2	2	2
81	3	3	2	1	2	3	1	1	1
82	3	4	3	2	3	3	3	2	3
83	3	3	3	4	4	3	1	2	2
84	3	3	3	2	3	3	3	3	3

A	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
No.	Rating of Head. Funct's								
	[---	---	---	---	---	---	---]
	C	P	S	E	M	P	D	S	E
	o	l	c	s	a	r	r	p	n
	m	a	h	t	r	o	a	e	g
	m	n	e	i	k	c	f	c	i
85	3	2	2	3	4	2	3	3	4
86	3	3	3	1	1	4	2	2	3
87	3	4	4	3	3	4	2	3	2
88	3	4	4	4	2	2	2	2	2
89	5	4	4	3	3	4	2	2	4
90	3	2	1	2	2	2	2	2	2
91	3	2	2	2	3	4	2	2	4
92	1	1	2	3	5	3	3	3	2
93	5	3	3	2	4	4	2	2	2
94	3	5	5	3	4	4	3	3	3
95	3	2	2	2	1	1	3	3	2
96	3	3	3	4	5	4	2	2	4
97	4	2	2	2	4	3	3	3	2
98	2	4	5	4	1	2	2	3	4
99	3	3	4	2	4	3	4	2	3
100	3	3	3	3	3	3	3	3	3
101	3	2	3	2	1	4	3	3	3
102	3	4	3	4	3	3	2	2	2
103	4	3	3	2	5	3	1	1	1
104	4	4	4	3	4	2	2	2	3
105	4	3	1	1	4	3	1	1	1
106	4	2	2	1	6	3	1	1	1
107	3	2	4	2	5	2	2	3	3
108	2	2	2	2	4	2	1	1	1
109		3		2	3	3	2		
110	4	2	2	2	4	4	1	1	5
111	4	3	3	3	2	1			
112	4	3	3	4	3	3	2	1	1
113	3	2	2	3	1	2	2	3	1
114	5	4	3	3	5	4		3	3
115	3	3	3	3	4	3	2	3	3
116	2	2	2	2	3	2	1	1	2
117	5	4	4	2	2	3	1	1	2
118	4	3	2	2	5	3	2	4	3
119	5	3	3	1	3	3	1	1	4
120	5	5	3	3	3	4	2	3	3
121	4	4	3	3	4	2	2	1	1
122	5	5	5	5	5	5	5	5	5

A No.	AS	AT	AU	AV	AW	AX	AY	Type	BA	BB	BC
	12 Rating Materials			of	Site				---]	Mgt.	----]
	D	S	P	P	S	P	N		L	C	S
	e	t	a	r	t	r	e		a	o	u
	l	o	c	e	a	o	w		b	s	p
	i	r	k	f	n	d			o	t	e
1	3	3	2	3	2	2	3	.	4	5	5
2	4	2	3	3	3	3	3	.	4	4	4
3	4	3	3	4	5	4	3	.	2	3	4
4	3	5	3	3	3			.	3	5	5
5	1	4	2	5	4	4	3	.	5	5	4
6	4	3	2	3	4	3	2	.	3	3	4
7	3	4	2	3	3	3	4	.	4	3	5
8	4	3	3	1	5	5	3	.	4	3	3
9	5	2	2	3	5			.	2	3	2
10	4				4	4	2	.	2	3	4
11	5	3	3	3	5	5	5	.	3	2	1
12	3	1	1	2	2			.	3	5	4
13	1	1	1	1	2	1	5	.	2	3	3
14	1	1	1	1	1			.	5	1	1
15								.			
16	3	1	1	2	4	3	3	.	4	3	2
17	2	2	1	1	4	2	4	.	4	4	4
18	3	1	3	4	5	3	5	.	4	4	3
19	3	3	3	3	3			.	4	5	5
20	4	2	2	3	4	4	3	.	3	4	2
21	3	1	1	3	3			.	3	5	2
22	4	3	3	4	5	4	3	.	4	5	3
23	3	3	1	1	1	4	1	.	4	5	3
24	3	3	3	3	3	3	3	.	3	3	3
25	4	4	2	1	4	5	2	.	4	5	4
26	2	2	2	2	2			.	2	3	2
27	5	5	5	5	5	2	5	.	5	5	5
28	2	2	1	2	3	4	4	.	5	5	5
29	2	3	3	3	3	2	2	.	3	3	2
30	2	2	2	2	2	3	3	.	4	4	4
31	4	1	1	3	5	5	5	.	3	1	5
32	1	2	2	2	1	1	1	.	1	1	1
33	5	3	3	4	5			.	3	3	3
34	3	2	2	2	4	4	3	.	3	4	4
35	2	3	1	1	1	1	1	.	4	4	4
36	3	2	2		3	3	4	.	2	3	4
37	3	3	3	3	5	3	3	.	5	1	3
38	4	2	2	2	2			.	4	5	5
39	3	4	1	1	1	5	5	.	3	3	4
40	3	3	2	2	4			.	2	3	3
41	3	4	4	3	3	4	3	.	4	3	3
42	2	4	5	5	5	3	5	.	5	5	5

A	AS	AT	AU	AV	AW	AX	AY		BA	BB	BC
No.	12 Rating Materials			of		Site		Type		Functions	
	D	S	P	P	S	P	N	---	L	C	S
	e	t	a	r	t	r	e]	a	o	u
	l	o	c	e	a	o	w		b	s	p
	i	r	k	f	n	d			o	t	e
43	3	2	1	1	3	2	2	.	3	4	4
44	3	3	1	2	2	2	2	.	2	3	3
45	5	4	2	4	4	4	5	.	5	5	5
46	4	4	3	3	5	5	4	.	5	5	5
47	4	2	2	3	4	4	3	.	4	5	5
48	3	2	2	2	2	2	3	.	4	4	2
49	4	1	3	5	5	5	5	.	3	1	2
50	4	2	3	1	5	5	4	.	3	4	4
51	4	2	2	2	3	4	2	.	2	3	2
52	3	2	3	2	4	4	2	.	4	3	5
53	3	4	3	3	4	3	3	.	4	5	5
54	3	4	4	3	4	1	1	.	5	5	5
55	5	4	3	3	4	4	4	.	3	3	4
56	4	3	3	4	4	4	4	.	4	4	3
57								.			
58	3	3	2	3	4	3	3	.	4	3	4
59	1	1	2	3	3	3	3	.	2	2	2
60	2	2			2	4	4	.	3	3	2
61	2	3	3	2	2			.	4	4	3
62								.	3	5	3
63	3	2	3	2	2	3	3	.	2	2	2
64	2	2	2	2	2	4	5	.	3	2	2
65	1	1	1	1	1			.	3	4	3
66	1	4	2	1	4	3	1	.	4	5	4
67	4	4	2	5	5	4	4	.	3	4	4
68	2	5	3	1	1			.	3	4	5
69	2	3	2	2	4	3	2	.	4	5	5
70	4							.	2	4	4
71	1	2	1	1	1	1	3	.	5	3	4
72	3	4	3	4	5	3	3	.	4	4	5
73	3	2	2	3	2	4	3	.	2	3	3
74	4	2				2	2	.	2	3	2
75	3	3	3	3	1	3	5	.	2	3	3
76	2	2	4	5	5	4	4	.	4	5	4
77	2	2						.	3	4	4
78	4	4	4	3	3	3	3	.	4	5	4
79	2	2	2	3	4	2	2	.	4	3	2
80	1	1	1	1	1	1	1	.	3	2	2
81	3	1	1	1	1	3	2	.	2	4	4
82	3	3	3	3	2	2	3	.	2	3	4
83	3	4	3	4	2	2	1	.	4	4	2
84	4	4	2	2	4	5	3	.	4	5	4

A	AS	AT	AU	AV	AW	AX	AY	BA	BB	BC
No.	12 Rating Materials			of		Site		Type		Functions
	D	S	P	P	S	P	N	L	C	S
	e	t	a	r	t	r	e	a	o	u
	l	o	c	e	a	o	w	b	s	p
	i	r	k	f	n	d		o	t	e
85	3	3	2	2	4	2	4	2	2	2
86	3	3	1	4	4	2	2	3	5	5
87	3	5	2	2	2			3	5	4
88	3	2	2	2	2			4	3	4
89	3	4	3	3	4			4	3	3
90	2	2	3	3	3			4	3	2
91	4	2	2	4	4	4	3	4	2	3
92	3	3	3	2	2	4	3	4	5	5
93	3	2	3	2	2	2	2	3	4	5
94	3	4	4	4	4	3	3	4	5	5
95	2	2	2	2	4	2	2	2	4	3
96	3	3	2	2	4	4	5	4	5	5
97	2	2	2	2	3	3	4	4	3	4
98	2	2	1	2	4	3	4	5	5	4
99	2	1	3	1	1			2	2	3
100	3	3	3	3	3	3	3	4	4	4
101		2	1	2	2			3	3	3
102	3	3	3	2	2			4	4	4
103	3	2	2	2	5	3	5	3	4	2
104	3	4	2	3	5	4	4	4	4	5
105	2	2	2	2	3	2	1	4	3	4
106	4	3	2	4	5	3	3	5	3	5
107	1	2	2	2	5	4	5	4	2	2
108	3	2	2	2	4	1	3	5	3	5
109	4	2	2	4	3	2	4	2	4	5
110	3	5	2	3	2			2	3	3
111	4	3			3			3	4	4
112	5	5	5	4	2	4	2	4	5	5
113	3	3	2	2	2	3	3	3	2	2
114	5	3	3	3	4	4	3	4	4	5
115	3	2	3	2	3	3	3	4	3	4
116	3	3	2	2	2	2	3	2	3	2
117	4	3	3	4	3	3	4	4	3	5
118	4	3	3	2	3	2	3	3	2	4
119	2	2	3	3	5	3	3	3	3	3
120	3	3	3	3	4	4	5	3	2	3
121	2	2	4	4	5	2	2	4	2	4
122	5	5	5	5	5	5	5	5	5	5

A No.	BE	BF	BG	BH	BJ	BK	BL	BN	BO	BP
	Equipment				Engin'g		Boards			
	C	S	M	U	S	I	S	C	B	O
	a	i	a	t	t	m	p	A	A	t
	p	m	i	i	a	p	e	W	C	h
	a	p	n	l	n	r	c	U	A	e
1	3	2	2	5	4	4	3	4	4	4
2	3	3	3	3	3	3	3			
3	3	4	4	4	4	3	4	3	3	
4	3	3	4	3						
5	3	3	5	4	3	4	2			5
6	2	3	4	4	3	4	5	5	5	
7	3	3	5	5	4	4	4			
8	3	3	3	5	3	3	1	1	1	
9	2	2	3	3	2	3	3			
10	3	2	3	3	3	3	3	3		
11	3	5	5	3	5	5	5	4	4	
12	1	1	1	3	1	1	1	1	1	1
13	1	1	3	1	1	1	4			1
14	1	1	1	1	1	1	1			
15										
16	4	2	2	4						4
17	2	3	3	4	3	3	3	1	1	
18	2	4	4	4	4	4	3	4	5	
19	1	1	3	5	5	5	3			
20	3	2	3	2	4	3	4			
21	3	3	4	2	4	4	3	2	3	
22	3	4	3	4	1	4	3			
23	3	1	5	5	1	1	1	3	3	
24	3	3	3	3	3	3	3	3	3	3
25	1	3	3	2	5	5	5		1	
26										
27	2	2	4	5	3	3	4			
28	3	3	5	4	3	3	3	3	3	
29	2	2	2	2	2	2	3	3	3	
30	2	3	3	2	3	4	4			
31				5	4	2	1			
32	1	1	2	1	1	1	1			
33	3	3	4	2	3	4	5			
34	2	2	2	4	2	3	2	1	1	
35	3	3	4	4						
36	2	3	2	3						
37	3	3	3	3	5	5	3	5	5	
38	4	3	4	4	4	3	3	4	3	3
39	3	4	4	1	1	1	1	1	1	
40	2	2	2	2	3	3	4			
41	3	3	4	4	3	4	3	3		
42	3	3	3	3	2	4	3			5
43	2	2	3	3	2	2	2	1	1	1
44	1	2	4	3	4	4	3	5		

A No.	BE	BF	BG	BH		BJ	BK	BL	BN	BO	BP	
	Equipment				--]	Engin'g			--]	Boards		--]
	C	S	M	U	.	S	I	S	C	B	O	
	a	i	a	t	.	t	m	p	A	A	t	
	p	m	i	i	.	a	p	e	W	C	h	
	a	p	n	l	.	n	r	c	U	A	e	
45	4	5	4	4	.	3	3	3	5			
46	5	5	4	4	.	4	4	4	3	3		
47	3	4	3	3	.	4	5	5	5	5		
48	2	2	3	3	.	3	4	3		5		
49	4	3	2	2	.	3	3	3	3	2	2	
50	5	3	5	4	.	5	5	5				
51	2	2	2	3	.	2	2	2	4			
52	3	3	4	5	.	4	4	4				
53	3	3	3	4	.	3	4	3	3	3		
54	4	4	3	4	.	1	1	1				
55	3	3	3	4	.	5	5	5	4	3		
56	2	2	3	4	.	2	2	2	3	3		
57					.							
58	3	3	4	4	.	4	4	4	4	5		
59	3	2	2	2	.							
60	2	2	2	1	.	2	2	1	3			
61	4	2	4	3	.	4	4	4	3	3	3	
62			5	5	.							
63	2	3	2	3	.	3	3	2	1	1		
64	2	2	2	3	.	2	3	2	2	2		
65	3	3	3	3	.	2	2	2	1	1		
66	3	2	4	4	.	5	5	4	1	1	1	
67	2	2	4	5	.	5	5	5	2			
68	1	3	3	3	.	1	1	1				
69	3	3	4	3	.	3	3	3		2		
70	5	5	5		.			4				
71	1	1	1	1	.	3	3	2	5			
72	1	2	3	4	.	4	4	5	3	3		
73	2	2	3	3	.	4	5	5	4	4		
74	1	1	3	4	.	1	1	2				
75	1	1	1	3	.	3	3	2		5		
76	4	4	4	4	.						1	
77	4		5	4	.							
78	3	3	3	3	.	1	1	1	4	4	4	
79	1	3	3	3	.	3	4	4	4			
80	2	2	2	2	.	2	2	2	2	2	2	
81	2	2	2	2	.	4	3	3	4	4	4	
82	2	2	3	4	.	4	4	4	4			
83	1	1	1	1	.	4	2	5	5	5		
84	3	4	4	4	.				4	4		
85	1	2	2	2	.	2	3	4	5			
86	3	4	4	3	.	2	2	3				
87	1	2	4	2	.							
88	3	2	4	4	.	3	3	4	4	5		

A No.	BE	BF	BG	BH	BJ	BK	BL	BN	BO	BP
	Equipment				Engin'g			Boards		
	C	S	M	U	S	I	S	C	B	O
	a	i	a	t	t	m	p	A	A	t
	p	m	i	i	a	p	e	W	C	h
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APPENDIX III UNEDITED COMMENTS FROM QUESTION 14 OF THE
CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

3 May 1991

Dear Sir,

PRODUCTIVITY IMPROVEMENT IN THE CIVIL CONSTRUCTION INDUSTRY

With reference to your letter dated 18 April 1991 we wish to voice the following opinions relating to question 14 of your questionnaire:

If there was a more professional approach, the industry could improve and be seen as a respectable professional entity.

We believe that methods to improve the situation are among other:

1. Designing very large contracts with large contract values which ultimately involve massive undertakings in a limited amount of time. This eliminates the local contractors and encourages major concerns to dictate the market. The labour and plant are normally imported from other areas and the financial gain of the contract does not assist the local community in any way whatsoever. i.e. The last Motherwell Contract: +/- R34 million, +/- 10 months completion. The project could have been divided into smaller portions to encourage the local contractors to undertake the work.
2. When awarding contracts in areas, thought should be given to possible rebate to local tenderers, similar to the system which exists with material supplies tendering to State Bodies.
3. If the authorities could plan the cash flow to enable contractors continuity, i.e. once infrastructure has been set up and learning skills have expensively been bridged, the danger exists that once the contract is complete

retrenchment takes place plus all learning skills with it. If the trained personnel could be retained, productivity and savings could be achieved.

4. Prior to award, a full investigation of the contractor's workmanship, infrastructure, and credibility should take place to avoid contractors of ill repute being awarded contracts they cannot complete successfully to specification.
5. Consideration to awarding the contracts not to the lowest but possibly the third tenderer, would most definitely improve the cut-throat and desperate method of tender which has basically destroyed the industry, affecting workmanship, cash flow, and snow balling to all involved.

We trust our opinions will be of some assistance to you and look forward to any conclusions of your survey.

Yours faithfully,

Already being discussed internally: Discussions with N P I have been of little real assistance.

Productivity will not improve until the attitude of employees changes.

Our company [is] entirely in one market with small variations. Although it is a construction company, it operates as a service company to other contractors. Productivity is not the main issue, but rather the quality of service.

Our company has already done something about productivity. We have been given training through the S.A. Productivity Institute, N.P.I.

In S.A. attitudes are mainly to blame. Pride in workmanship belongs to a bygone era. Standards are being lowered to please the left-behind populations. Total neglect of training has deteriorated not only facilities, but numbers and standard of trainers. Politics, as practised from all sides had in the past, and is still taking its' toll. Efforts to rectify our situation must be aimed primarily at proper training and attitudes. Good luck to us all!

Productivity is not the problem - Lack of work is [the] major problem.

Productivity is generally unacceptably low. Motivation and incentive towards greater productivity is required. Poor communication is probably a major factor. The labourers' lot has to be improved for him to become productive and this will certainly require more than an extra wage. Wages are too high for the "real work" which is being done by the labourer.

- 1) Abolish trade unions - they appear to encourage non-productivity of workers by making unreasonable demands.
 - 2) They indoctrinate workers with fantasies of their rights and never seem to care about the employer's rights.
 - 3) They intimidate workers and force them to join unions and make all sorts of nebulous promises to workers.
 - 4) Trade unions are probably the biggest contributory cause of inflation.
-

Productivity relies heavily on a change of attitude. (Whole company)

There are existing training facilities available but each section of the Civil Engineering Industry requires specialist training.

The remark against "Regulatory Boards" is because they are mainly politically orientated and show little interest in improving productivity, they are also unbelievably inefficient.

Productivity in the construction industry, or lack thereof is not the fault of the industry. Unless a continuous flow of Capital Projects is planned by the government, the cyclical nature of work availability will continually destroy efforts to build up efficient teams.

The main problem appears to be the lack of an immediate measurement and control system that is simple enough to be used on site to monitor and motivate personnel by way of comparison of actual results with allowances and/or accepted production standards. With greater control, monitoring, feedback, and motivation, productivity standards will improve.

The labour used in construction is lacking in basic education and therefore understanding of the aims of a company and the need for productivity.

The N.P.I. have had some success with productivity improvement.

Communications with labour and trade unions needs drastic improvements. Trade unions [are] too politically motivated without consideration to workers, i.e. politically motivated stay-aways, go slow strikes, [and] lack of involvement in labour productivity.

Having invested time and energy in similar [activities] before, I am skeptical of the value. Hence the 1 in question (13) above.

Productivity in our industry could be vastly improved by (more) [increased] standardization of structures, structural details, and specifications. With our comparatively unsophisticated labour pool, standardization would be the greatest single influence on productivity. We have proved this on several occasions.

Measurement of productivity has always been a major problem in establishing improvement in productivity.

In view of the company size, we are limited in time available to senior personnel to attend conferences etc.

- 1) Cut down on labour to a minimum
 - 2) Pay labour well based on attendance, quality, and productivity.
 - 3) Supervise labour well.
-

Finish off the job in time and in the standard quality. (Do the job right the first time.) Hard time for management then your budget will give you no problems.

Each company must solve its own productivity problems. Productivity is important, but quality improvement is the bigger issue - an integrated approach is needed.

Education and training will solve many productivity problems, not just in quality and speed, but also with human relations as many of the frustrations (of both worker and manager) will be overcome.

Although I agree entirely with an "improved productivity" approach through training and better communication etc. etc.,

what is really needed is a program to get staff (all, but generally black) to appreciate and understand our so called Capitalistic System (Profit / loss etc.) particularly in these tight times when continuity of work etc. (at cut-throat prices) and survival are crucial.

Construction productivity would be greatly improved at the lower level (unskilled) if the minimum wage was to be done away with, especially in the rural areas.

Decentralize.

The intimidation prevalent, and the inability of the worker to improve or want to improve his lot from his remuneration earned is a major source of the problem of lack of productivity.

All of the time, effort, and money spent on the skilled and management training will continually be wasted until the economy develops to the stage where continuity of employment can be assured.

Productivity is very low at present due partly to the threat of retrenchment and due partly to union activity. It is our belief that productivity and remuneration must be directly linked and not denied by the unions as is presently the case. We believe that the unions are influencing productivity very negatively and purposely hindering economic growth probably for political reasons.

Our company is probably on the small side to make a meaningful contribution to what is obviously a big problem in this country

To be in a position to negotiate wage rates and contract agreements with labour without bureaucracy [in a position to negotiate] "hiring and firing". The industry is becoming too "unionized."

- 1) Productivity is not a labour problem, but a management one.
 - 2) A trained, motivated, and correctly supervised work force will increase production.
 - 3) These three are management tasks.
-

Our attempts to improve productivity by the creation of sub-contract teams have failed due to the inability of the team leaders in coping with supervisory roles in which they are required to assess their own productivity, quality control, and financial implications thereof.

Increased productivity is the single most important requirement in S.A. This will cut inflation and raise standards of living. It can be achieved by private enterprise initiate and high managerial skills and experience at every level. This also means that the management pyramid must be as flat as possible with minimum amount of levels down to the coal face.

Survival is the name of the game today - we are still spending a lot of time and money on training and have gone through an N.P.I. course already. We don't feel we have the resources to spend more on it.

The productivity in our firm is quite acceptable. Our labour force is stable above average and we are managing to keep our heads above water in difficult and trying times.

Higher productivity will result from better supervision and training. The very varied workload of the industry makes it

difficult to pursue long term training programs, especially for smaller companies.

Unattractive Industry - living away in the "bush" with the same pay as you could get in the metropolitan areas and working in an "easier" job. Result - good site staff are few and far between.

- 1) Building Industrial Councils - i) Seen as unfair / unnecessary by employees. ii) Ineffectual policing of regulations allowing unregistered persons to compete for the same work.
 - 2) Perhaps a grading system for companies to determine who tenders on a particular contract in order to maintain some form of continuity of work in order to encourage people (tradesmen) to remain in the industry.
-

We need foreign investment which will provide more construction projects which will in turn provide more job opportunities.

Because labour is "cheap", we employ too many. It is better to take [a longer time to complete the job] with fewer labourers, and to work with individuals, not groups.

AN INVESTIGATION INTO
PRODUCTIVITY IMPROVEMENT
ON CIVIL ENGINEERING AND
BUILDING CONSTRUCTION SITES

Volume 3: Conclusions

Prepared by: R.W. Marshall
2nd year M.Sc.
Engineering

Prepared for: The Faculty of
Engineering at the
University of Cape Town

20 July 1991

This thesis was completed in partial fulfillment of the requirements for the degree of M.Sc. in Engineering at the University of Cape Town.

There is one condition that is absolutely vital to productivity improvement: the organization must nurture a learning and questioning environment dedicated to the improvement of their productivity.

DECLARATION

- i) This is to certify that the results, calculations, graphs, drawings, and data presented in this thesis are essentially my own work except where otherwise indicated.

- ii) The whole or any portion of the contents of this thesis may be reproduced in any manner by the University of Cape Town for the purpose of research.

Signed: _____

Signed

Date: 20 July 1991

Rupert Marshall

ACKNOWLEDGEMENTS. Volume 3.

I am grateful to the following people for their assistance in the completion of this thesis:

Mr. J.F. McGeorge of the Department of Civil Engineering (U.C.T.)
for his supervision, help and advice.

NOTES. Volume 3.

- i) All the material contained in this thesis has been produced for research and educational purposes only. It may not be used in any other way.
- ii) Any reference to the male gender means to include the female gender, and visa versa where appropriate.
- iii) The views and opinions expressed in this thesis are not necessarily those of the University of Cape Town, or of the author.
- iv) American spelling has been used throughout this document.

TERMS OF REFERENCE. Volume 3.

This thesis was completed to fulfill the requirements of CIV 500Z at the University of Cape Town. It is an investigation into methods of productivity improvement on civil engineering and building construction sites.

Volume 3 of the thesis will:

- 1) Place the concepts from the literature review into the Southern African context.
- 2) Cover the conclusions and recommendations from the surveys and interviews, the methodologies of which appear in volume 2.
- 3) Formulate conclusions from the study of worker motivational factors.
- 4) Formulate a productivity process applicable to the construction industry and its Southern African environment.
- 5) Suggest areas for further research which have been initiated by this study.

SYNOPSIS Volume 3

Volume 3 of the thesis briefly illustrates some of the differences between the Southern African construction industry and its overseas counterparts. It then discusses the applicability of the management concepts which were covered in volume 1. The conclusions to the Construction Productivity Questionnaire and the interviews appear in chapters 4 through 6, and chapter 7 proposes some practical actions to take which will increase construction productivity.

Productivity Principles in the Southern African Context: There are a number of factors which contribute significantly to the productivity problems experienced in Southern Africa. Probably the biggest cause of ailing productivity is the "productivity ignorance" which is noticeable in all levels of personnel involved with construction. Many managers are unlearned in basic productivity improvement principles, and the general low levels of education that exist in the work force accounts for much of their seemingly uncaring attitude. Further, there is a serious lack of intercultural understanding between the mainly white or mixed-race managerial levels, and the mainly black supervisory and worker levels. Managers and workers are generally educated through different systems which place emphasis on different areas, and there is a vast difference between the level of management education and the level of worker education. As a result, many workers do not understand the capitalistic society in which the construction industry operates. They do not understand the role that they play in the organization, or the concepts of productivity, quality, profit and loss, or the purpose of the business. Another problem quoted often by personnel in the industry is that the unions are too politicized and do not serve the needs of the workers.

Management style plays a large role in influencing the productivity of the labour force. It is often said that the best style to use is one which combines aspects of both an authoritarian and a participative style. Most companies are presently trying to adopt a more participative style in the face

of increasing education. However, it is suggested that style is modified by both the worker's ability to understand, and his desire to work within the capitalistic framework of the construction industry. Further, the workers' culture places an emphasis on group activities and decisions to a far greater extent than does the managers' culture. This limits the individualism of the average worker, and enables management to control the workers as a group more effectively than would be possible under "manager culture". This does not suggest that management must not pay heed to the worker as an individual, but it does advise the management to make an effort to understand the group orientation of the worker.

Good communications are vital to the efficient running of a company. Often managers do not pay enough attention to the formulation of communication channels, for both formal and informal information flow. Organizational hierarchies often evolve, rather than grow to comply with a strategic plan. To complicate the problem, communications are hindered by language, cultural, and educational barriers.

Motivation in the third world cannot be based on the same models and principles that govern motivation in the first world. This is due to the culture differences, and the differences in the standards of living. Managers must consult with those who will benefit from the motivational factors to ascertain which factors will be most effective.

The quality of the final product can be efficiently increased by balancing and minimizing the costs of prevention and cure. Part of the "prevention" costs will be incurred by training programs. The level of education and the current prevalent attitudes will prevent the concept of quality circles from being successfully implanted into the industry without major changes to the basic form of the concept.

The construction industry will only become receptive to the changes needed to improve productivity after a major change in

attitude and education has taken place. This will take much time, effort, money, and patience.

The Construction Productivity Questionnaire: The large contracting companies dominate the construction market, and these companies use their equipment more productively than do the smaller companies. The construction management believes that good wages are by far the most effective worker motivational factor. The questionnaire found that six factors relating to construction possess great opportunity for improvement. These factors are: labour training and quality control; management supervision, cost control, and labour relations; and communications. These functions are closely related through the lack of basic education prevalent in the third world, and it will take time for the various sectors of the industry to find an equilibrium via the current economic, political, and educational reforms.

Further Research Based On Interviews: The six factors mentioned above formed the topic base of a series of interviews which were conducted with personnel from the construction industry. It was found that many companies are addressing the productivity problems through training programs. Some organizations concentrated their training at the supervisor level, hoping to improve supervisor - worker communications, and other companies trained at all levels, taking an holistic view of productivity improvement. Poor communications and low educational levels were cited as being major obstacles to improved productivity.

Training is an all important part of productivity improvement, but the approach to training taken by many organizations is very haphazard. The existing courses are readily available to serious trainees, and these courses are well prepared and presented.

The Productivity Improvement Process: A simple, practical approach to productivity is suggested. Top management commitment is vital to the success of such a program which consists of a number of interdependent steps.

The starting point for the process is the implementation of a measurement system which is simple to operate and provides timeous feedback to those who are interested in the information. The system should be flexible and must be designed from a motivational point of view. A materials management system should be established which ensures that all necessary materials and equipment are available when and where they are needed. The site hierarchy should be defined down to the lowest levels, and the labourers grouped into productive teams. The grouping of employees boosts productivity by increasing motivation and by utilizing the teams' enhanced ability to work together. The communications network should be formally defined to ensure that all the necessary information is obtained by those who need it. Motivational aspects should be planned for and introduced into all processes from the start. Training is necessary to realize the full leadership potential of the management levels, and to realize the full motivational and productive potential of the general work force.

The process must be continued through the learning and questioning environment which is itself fueled by the intrinsic motivation obtained from increased productivity levels, and the academic abilities initiated by training.

Future Research: Further research related to this thesis needs to be performed in three areas: The effect of different motivational factors needs to be ascertained; The motivational effect of training needs to be ascertained; and the returns from investments in training needs to be studied.

Productivity improvement is an ongoing process which must exist in a questioning and learning environment. Top management commitment is vital to initial successes, but the commitment of the whole organization will ensure that improvement continues.

VOLUME TITLES

Volume 1: Productivity Improvement in Construction - A Review.

Volume 2: The Compilation and Analysis of Survey 1 - The Construction Productivity Questionnaire.

The Compilation and Analysis of Survey 2 - Further Research Based on the Results of The Construction Productivity Questionnaire.

Volume 3: Conclusions

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1. INTRODUCTION

The third world is unique from a productivity and motivational point of view. Many of the classic theories and models of productivity improvement have been developed for use in first world countries. The complex cultural background of developing countries forces productivity issues to "take a back seat" in many instances. However, in order to be able to compete on the international markets, the third world countries have to beat the international competition. Failure to do so will restrict the developing economies to a dismal, financially dependent state that many third world countries already find themselves in. The proven productivity theories must be adapted, and the classic motivational models must be studied so as to ascertain their applicability to the local conditions.

This final volume of the thesis attempts to point out the differences between the Southern African construction industry and its overseas counterparts. Some of the limitations to the direct implementation of proven productivity improvement processes are highlighted. Several motivational theories are discussed in the light of these limitations, and some modifications are suggested.

The second part of this volume (Chapter 4) discusses the results obtained from the construction productivity questionnaire. The third part of this volume (Chapter 6 and 7) debates the issues that were raised during the follow-up interviews. The Fourth part of the volume (chapter 8) places all of the above ideas into context by developing a productivity improvement process which consists of practical recommendations as how to improve construction productivity. It is realized that each organization must, to a large extent, design its own productivity improvement process, but general guidelines are given on which to base such a program. Finally, further areas in which research should be conducted are suggested.

2. CONSTRUCTION IN THE SOUTHERN AFRICAN CONTEXT

Most of the research into productivity improvement has taken place in the United States of America. As a result of this, much of the literature used to compile the review in volume 1 is aimed at the construction industry in the U.S.A. The basic concepts behind productivity improvement are universal, however the specific methods of application are very reliant on the attitudes, state of education, and culture of the group to which the methods are being applied. In these, and other regards, the Southern African construction industry differs considerably from its overseas counterparts. These differences do not always hinder the improvement of productivity, and in some cases are even advantageous to the equivalent situations in more developed countries. One example is the availability of comparatively cheap labour in third world countries.

The largest obstruction to productivity improvement in Southern Africa is the general lack of overall education of those involved in every aspect of production. The lack of skilled labour is a product of both the past and present political systems and the poor economic climate resulting partly from the unstable political environments. However, the state of construction productivity cannot be blamed on the deficient abilities and malevolent or uncaring attitudes of the labourers as it is often those who supervise and manage the labour who do not have an understanding of the total concept of productivity improvement. This is illustrated by the increasing numbers of occurrences in which top managers are sub-optimizing their production processes without regard to the full picture, and then in some cases compounding their unwitting error by terminating their improvement efforts, in the mis-understanding that productivity improvement is achieved through the implementation of a finite, pre-defined recipe such as a training program. They do not adopt the approach of the masters of productivity improvement, that is the Japanese concepts where improvement is an on-going learning experience incorporating every internal and external aspect of the organization.

The educational, financial, political, and cultural gaps existing between the mainly white top and middle level managers, and the mainly mixed-race or black low level managers and labour force have created problems which extend far beyond those of productivity improvement. There is a general lack of intercultural understanding, which can be blamed primarily on the financial and political discrimination in the educational systems of the third world. This has resulted in, among other things, the mis-understanding of the needs and desires of the work force by the management. To compound this, the work force has little understanding of the workings of the capitalistic society in which the construction industry operates. Further, the culture of the capitalistic society clashes in many ways with the supposedly preferred traditional and socialistic oriented culture of the majority of the work force. With these abundant, complex, and basic differences existing among the components of the industry, it is hardly surprising that productivity is low, and is often considered separately and of lesser importance than mere organizational survival. One of the consequences of these differences is the role adopted by the various construction unions. It is generally recognized that the unions are not in themselves a "Bad Thing", but it is the attitude adopted by many of them which causes unnecessary disruptions in the industry. Construction managers often complain that agreed procedures and regulations are only adhered to by the construction organizations, and when there are complaints emanating from the workers, there is no adherence to the agreed formalities. Many managers are also of the opinion that the unions harp on the above mentioned differences to achieve their own power oriented ends with little concern for the true needs of the workers and the financial stability of the institutions for which the labourers work. One recent example was when certain South African unions encouraged their members to cash in their pensions before switching to a subsidized pension scheme which was being implemented throughout most of the industry. However, they did not inform the workers properly that they would lose the benefits of the old scheme, and upon retirement would only benefit from the new scheme. Most of the labour, for obvious reasons, did not

realize this themselves, and they do not generally plan for their retirement anyway. As a result, recently retired labourers, who have been contributing to a pension scheme for their whole working life are now only reaping the benefits of five years worth of contributions which, as one personnel manager put it, "is not even enough to starve on." The irony of the situation is that the workers blame their loss on the companies, and not on the unions.

Another commonly mentioned cause of lost productivity is the cyclical variance of work load, often attributed to poor planning by the government. Combined with this is the dominating effect the few large concerns have over the construction market place. As these contractors often import their equipment, materials and expertise to the project site, they tend to eliminate small, localized contractors, and as a result, financial benefits are removed from the contract area after completion of the project. This in turn limits the skills and the value of the learning experience gained by the local people involved in the project. The dominance and cyclical work availability curbs the potential of smaller contractors to implement long term productivity improvement schemes as the time and money invested in such schemes may well be wasted in hard times if trained personnel have to be retrenched.

Other factors deterring productivity improvement in Southern Africa include the shortage or unavailability of some materials, the technological isolation, and the geological and competitive distance the local construction industry is from its overseas counterparts. In the face of these difficulties, productivity improvement is a daunting task, but because of these difficulties, productivity improvement is becoming more necessary and increasingly urgent.

3. APPLICATION OF PRODUCTIVITY IMPROVEMENT PRINCIPLES IN SOUTHERN AFRICA (The Literature Review in Context)

One of the main pre-requisites to productivity improvement is the establishment of a measuring system which is simple, understandable by all, able to supply all necessary information, and which is congruent with existing accounting and other established systems. Occasionally, it will be beneficial to alter existing systems to a certain degree. It is then necessary to study the production process analyzing the symptoms so as to treat the root causes of productivity loss. Improving the system necessitates its change, a process which is very likely to come up against resistance from some of those affected. People sometimes regard a request to change their usual methodology as a direct insult and erect personal barriers which further hinder the improvement process. These inhibiting mental attitudes must be anticipated and repressed before they frustrate the change efforts. As the improvement process requires new methods, a spirit of constructive innovation should be fostered, and all plans carefully examined for any potentially detrimental side effects that may arise. It will often be found that the symptoms of many specific problems can be traced back to one cause, and the treatment of this cause, or a few causes, will solve many of the productivity problems. It is important not to acquire "tunnel vision" or to elect the managers "pet subject" when choosing the methodology to treat ailing production. A useful tool showing most of the major factors affecting employees' job performance and productivity is Sutermeister's model, an adaptation of which is illustrated in volume 1, figure 2.4.

Major obstructions to productivity improvement are the natural and erected communication barriers between the generally white managers, and the work force. These consist of the natural language and cultural differences, and of the well known politically and racially fabricated dissensions. The construction managers must overcome these barriers before they will be able to successfully implement and perpetuate productivity improvement. The style with which to manage plays an important role in the success of any improvement program. It

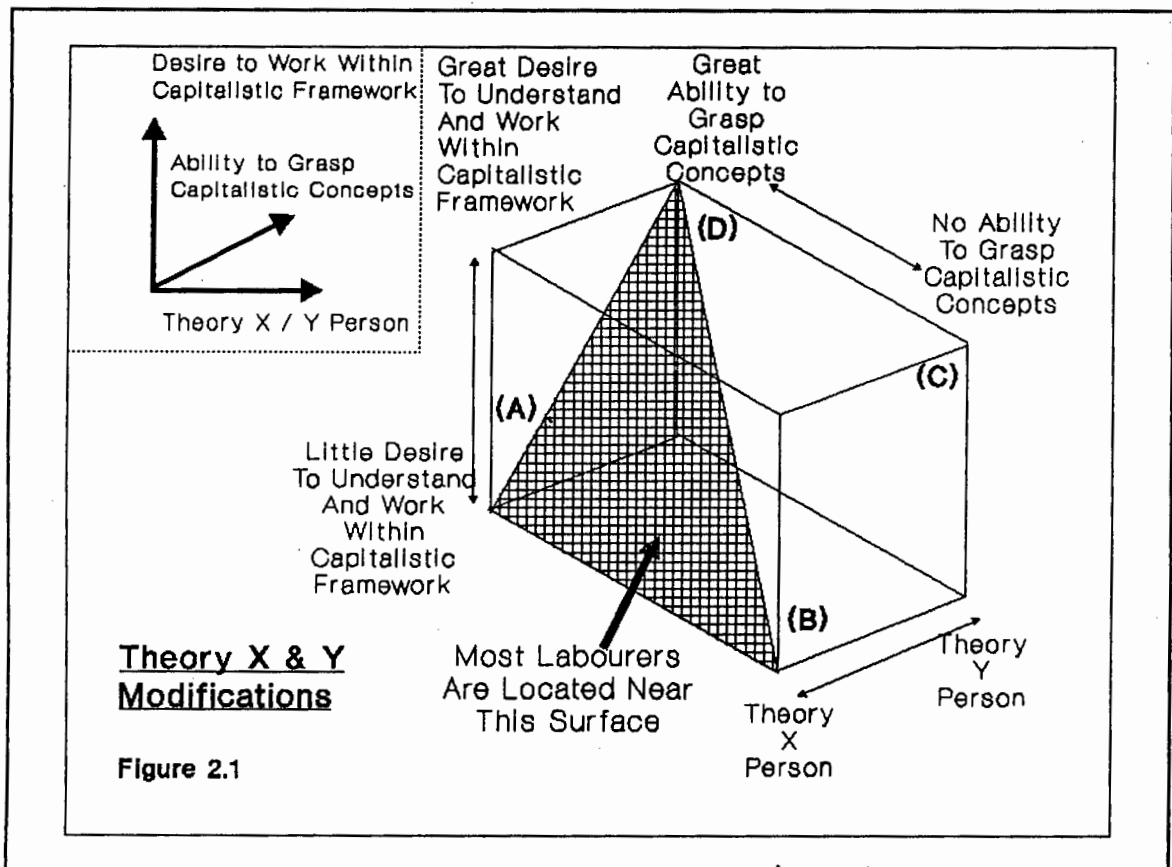
is recognized that the members of the labour force are generally influenced by peer pressure to a far greater extent than the managers. Indeed, it is to a large degree, subversive methods which encourage the work force to sustain a 100% stay-away in the face of considerable financial hardships, but it is also a strong natural desire to conform to the norms of the society to which they belong. It is up to the manager to find a multi-socially acceptable way to tap this ultimate respect for power, and the will to conform. Generalizing to this degree borders on reckless, and although each person is an individual, with their own needs and aspirations, a comparatively inferior education instills a respect for those with power, and limits the confidence needed to state ones' individuality. It is therefore important to regard the work force as individuals, but also to invest a healthy amount of time into the study of their behavior as a group.

Management Style

The scientific management theory is discussed in volume 1. It shows little concern for the human aspects associated with production, and has a lot in common with the authoritarian management style. This style assumes that employees are lazy, have little ambition, and dislike and avoid work whenever possible. They have to be strictly supervised in order to get any useful work out of them. This attitude still prevails among many construction managers and is illustrated by one manager in South Africa by his comments on how to improve productivity : "i) Cut down on labour to a minimum, ii) Pay labour well based on attendance, quality, and productivity, and iii) supervise labour well." This clearly shows his authoritarian approach, and his mis-use of the two lower levels on the Maslow Hierarchy of needs. Results of a survey^(3.1) clearly show that his employees are less productive than average for a company of that size. Whether the lack of employee productivity is attributable to his authoritarian style cannot be deduced from the data. At the

3.1 The Construction Productivity Survey. See Volume 2.

other side of the well known theory is the democratic leadership style which encourages managers to regard each employee as the organizations' "blue-eyed boy." Obviously these two styles have their place, although it is usually said that the best style to adopt is somewhere in between the two extremes. However, with the complex educational and cultural situations that face the construction managers in the third world, this could be too simple a view to take. In the light of the abovementioned difficulties a model was developed to aid management in their attempts to modify their management style to suit the local conditions. This model modifies the well known theory X and Y model by adding two dimensions. It is illustrated in figure 2.1 below.



The manager should modify his choice of theory X or theory Y style according to the employee's ability to grasp the concepts of the capitalist society in which the construction industry

operates. This includes the basics of the free market economy, the purposes of the financial organization, profit and loss, and the relationship between productivity and financial well-being. He should further modify his management style by the degree of desire the employee has to understand and work within this capitalistic financial framework. Most employees should naturally tend towards the shaded surface across the diagonal of the modified theory X - theory Y model:

Consider position (A): This person has the ability to understand the framework in which he works, but for certain reasons, personal, political, or otherwise, he has little desire to work within the framework. This person will be a theory X person - one who seems to dislike work, and needs to be coerced and directed. They will seem to have little ambition and wish to avoid responsibility.

The person at position (B) will not have ability to understand the circumstances which have led him to his current situation. A common example can be seen in the labourers who resent having a supervisor who is many years their junior, both in age and experience, giving them orders, and receiving remuneration far in excess of that of the labourers. These labourers will have little desire to grasp the concepts of the capitalist workings, and will most likely have little desire to work within a framework which they do not understand. For the same reasons, it will be unusual to find a person in position (C).

The person in position (D) could be regarded as the "blue-eyed boy". Here, the person has both the ability to understand, and the desire to work within the capitalistic framework.

It is obviously desirable to employ people who are in position (D), as they are self motivated. However, such people are few and far between, and the managers should "educate" their employees so as they willingly move towards this position.

Organizing the Organization

Much productivity is lost due to poor organizational design, especially of the site organization. Situations on site often

call for fast communications and rapid decision making, and it is therefore essential to have well defined job tasks and channels of communication. It is also necessary to force decision making as far down the hierarchical structure as is responsibly possible. The practicalities of organizational design are presented in vol.1 ch.3.3, and to reiterate, it is not acceptable to adapt an organizational structure from another project. It is also non-productive to hang a diagram of the supposed structure on the office wall, without providing detailed job descriptions, and ensuring that the site personnel know about and agree with the structure. Many incorrect decisions are made because it is the wrong person who makes the decision, or because the communications system has not provided the person with the necessary information to enable that person to make the correct decision. Detailed job or responsibilities descriptions will curb the overlapping of responsibilities, and therefore the issuing of counter-productive instructions.

A well thought through plan provides a useful aid to decision making. With reference to vol.1. fig.3.6, "Influence and Cost of Planning with Respect to Time", it can be seen that, the earlier the decisions are planned, the less they cost. It is because of this that "fast track" projects tend to increase the overall costs of projects. If the whole project is not well defined at the stage when it goes to tender, major decisions cannot be planned for in advance.

Motivation

It is particularly difficult for a construction manager in the third world to correctly guess the most appropriate motivational factors for their work force. Looking at the economic and political situations in most third world countries, "motivational" factors can probably be found in the lower two levels of Maslow's hierarchy of needs, that is, physiological, and safety needs. However, tampering with these basic rights can be considered to be almost immoral, and frustrates the advancements of the standards of living. It is obviously best to ask the labour what it is that they want out of their jobs.

It is worth putting a lot of effort into job design, as this defines the tasks and necessary abilities of each job. It enables the selection of qualified personnel, and further, a well planned job in itself provides a lot of motivation. The job should be planned to allow the worker a certain degree of decision making freedom, provide him with instantaneous feedback, and allow him to complete a significant portion of the project. This provides a feeling of having achieved something noteworthy, and lets the labourer see a finished piece of work for which he is responsible.

There is much controversy about the effectiveness of money as a motivator. However, with the scant "living" wages received by many labourers, there may be more potential for using money as a motivator in the third world than in other first world countries. Financial incentive schemes are known for raising the productivity of a company, but it is questionable whether they are able to sustain the higher levels of production and quality over an indefinite time period. The implementation of a monetary incentive scheme is fraught with dangers, many of which are discussed in volume 1. ch.4.3.1, but it may be well worth braving the dangers if the type of work, its climate, and its situation lend themselves to this form of incentive. However, it is not up to the managers to decide the best form of incentive, but up to those who will be receiving it.

Communications

One of the biggest problems encountered in site communications is that of the language differences. To be an effective site manager, one has to be able to communicate with the labourers in their own language. Many labourers have a basic understanding of English or Afrikaans, but not enough to receive specific or detailed instructions. Sometimes their partial knowledge of the language is used as an excuse for their errors or omissions. The importance of fast and accurate communications on site must be conveyed to the work force. The significance of information sharing must be stressed, and the importance of this function increases with height in the managerial hierarchy. The

clarification of activity-related communication channels is often ignored, as is their importance. For instance, the use of an unmarked superseded drawing could have serious financial and legal implications, as well as resulting in an unsafe structure.

Quality

In the construction industry, the main cause of poor quality can be attributed to human error. Theoretically, this is an assignable cause which means that it can be eliminated. The various ways to improve quality fall into two categories - prevention and inspection. The costs of quality should be minimized by striking a balance between the prevention, and the control costs. This relationship is illustrated in vol.1 fig. 6.1. The quality control function provides a major form of feedback throughout the organization, and extra control over the processes occurs with the implementation of the necessary strict measurement systems. Zero defects programs and quality circles are well known methods for improving the quality of output in manufacturing organizations. These systems are proving to be successful in the Japanese construction industry, and to a small extent in the United States industry. However one company in South Africa recorded less of a success, as implied with their comment: "Our attempts to improve productivity by the creation of sub-contract teams [quality circles] have failed due to the inability of the team leaders [to cope] with supervisory roles in which they are required to assess their own productivity, quality control, and the financial implications thereof." Obviously, the culture, state of education, and attitude are not yet developed to the stage where quality circles can be directly implanted into the industry. However, the concept is likely to work if introduced with considerable planning, training, and complete commitment from all involved. The migratory nature of the labour in this industry makes it difficult to introduce such an attitude- and training-reliant system into a company, as the labour turnover would destabilize the base upon which such a system is dependent.

Safety

Studies show that 88% of South African construction accidents are due to unsafe acts caused by ignorance, distraction, and even laziness, and a further 10% are due to unsafe conditions.(4) It is therefore theoretically possible to considerably reduce the accident rate by making the employees more aware of the dangers which naturally exist on construction sites, and motivating them to a higher level of safety consciousness. To achieve this, a safety program should be implemented which educates workers to recognize and report hazards located in the work place, to build hazard control into systems, and to provide an inspection routine aimed at reducing unsafe conditions. The attitude that no job is so urgent that it cannot be accomplished safely should be incorporated into the work environment.

An extremely important, yet relatively new aspect of any safety program should be an AIDS awareness campaign. Although aware of the disease, many people who may come into contact with an injured worker do not know, or do not care about the safety precautions which should be taken to prevent themselves from contracting the disease. All construction sites in the third world would most likely be classified as "high risk" areas with respect to AIDS, and even small injuries such as grazes should be treated by the site safety officer as extremely dangerous. The employment of a person in the position of Safety Officer who is not fully aware of the dangers and precautions associated with the disease highlights poor managerial ethics.

Materials Management

The existing materials management systems are designed for situations in which the availability of materials poses little problem, and the vendor competition is relatively high. However, in Southern Africa, the availability and quality of materials is comparatively low, as is vendor service. This implies that the existing materials management systems cannot be directly established, but it also increases the need for a superior materials management system. Many delays are due to the non-

availability, poor quality, or late deliveries of construction materials, and even if the situation could only be improved slightly due to the implementation of a management system, the financial gains would probably warrant the initial expenses.

Implementation of Productivity Improvement Plans

Any major changes to existing methodology or construction systems is likely to be met with resistance and suspicion. The success of any productivity improvement plan is dependent on the support given to the improvement by those affected by it. Here, the management style is very important, and the best style is likely to be one of a participative nature. In some cases, it will be beneficial to involve the unions in the planning and implementation stages of the change. However, if the worker is convinced that the change will in no way threaten him or his peers, and will make his work easier, he will be less likely to oppose the change efforts. Critical measurements before and after the change has taken place will provide a control over the process, and aid in making directional adjustments to the new process.

Conclusions: The threat of becoming financially dependent on foreign aid is forcing the Southern African economies to develop to a stage where they can compete on the world markets. However, the political turmoil and its' consequences associated with developing countries continually frustrates change efforts. The melding of many cultures requires education, understanding, and time, all of which place burdens on a country's financial generators. The improvement of productivity is essential to aid the development process, and to provide a competitive base with which to enter the global markets. The basics of productivity improvement are well documented, and it is the responsibility of the managers to incorporate the principles of improvement into the situations facing the construction industry in the third world.

4. CONCLUSIONS DRAWN FROM THE CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

The 122 returned surveys represents a return of 27.3%, and the fact that just over one third of the respondents took the trouble to add their own comments in question 14 indicates that the construction industry is generally concerned about productivity. The unedited comments can be found in appendix III of volume 2. The best return obtained during one of the previous U.S.A. surveys was 24.7%. The following section refers to a number of illustrations, all of which have been reproduced in Volume 1, Appendix V.

4.1 Conclusions Drawn From Part 1. Questions 1 to 9.

As can be seen from V2,fig.3.3 (see V.1.,App. V) the South African construction market is dominated by the larger contracting companies. The large difference between the median revenues, which are less than R10 million, and the average revenues, which are more than R40 million, shows that the minority, consisting of the larger contractors, have by far the majority share by value of the construction projects. This has been mentioned often in the comments included in question 14. Several contractors suggested that the large projects be broken into smaller units to enable the smaller organizations to compete. However, it is shown in V2,fig. 3.11 (See V.1.,App. V) that the large contractors generally use their equipment far more productively than do the smaller contractors. This is partly attributable to the larger size of their average contract enabling them to achieve a greater economy of scale. It is probably also attributable to their considerable experience and well organized systems. Whatever the cause, the fact remains that one large contractor will probably be able to complete a large project more economically than could a few smaller contractors. One further disadvantage when employing many companies on one project will be the necessity to communicate across many company boundaries. The communication function is generally in need of much improvement when confined to one organization, and the problem will be magnified when there are

many organizations all trying to achieve their own goals, and who are not really interested in problems which do not directly affect them.

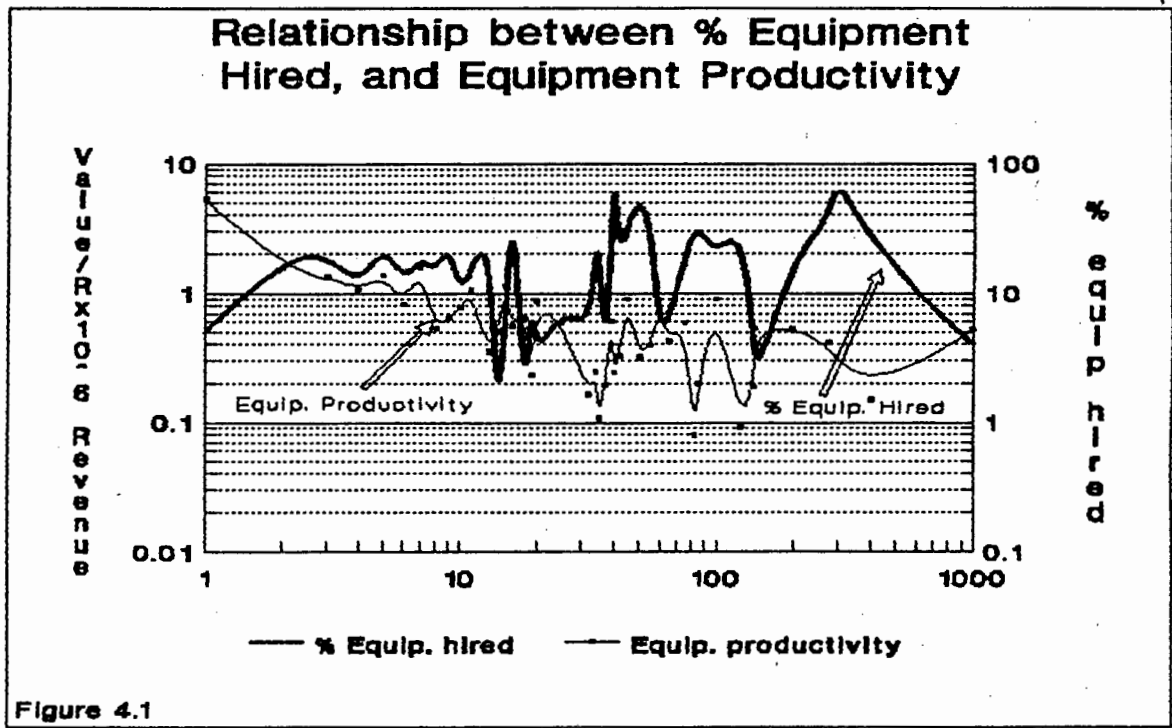
V2,figs. 3.4 and 3.5 show the number of employees working for companies of different sizes. It can be seen that company policy directly affects the number of permanent and temporary employees, but that the total number of employees (shown in V2,figs. 3.6 a & b) is almost directly related to the annual revenues of the company. Again, V2,fig. 3.7 shows that the larger companies have a slightly more productive labour force than do the smaller companies. However, the difference is not as marked as the corresponding difference in equipment productivity.

It is suggested that the small companies concentrate their efforts on fewer, larger projects so as to achieve increased control over their resources. Granted, this is more easily said than done, but the financial returns from a possible doubling in equipment productivity will cover the increased risks costs. The increased risk however, will not be directly proportional to the increased contract size, as the corresponding increase in control which will be achieved with the concentration of resources, will reduce the assumed risk.

V2,fig. 3.10 shows that the percentage of equipment hired is very dependent on company policy, with the average being 20.7%. The larger companies seem to hire proportionally slightly more equipment than do the smaller companies.

The diagram overleaf illustrates the relationship between the percentage of hired equipment, and the equipment productivity for companies with differing annual revenues. As can be seen, the medium to large companies show increased equipment productivity with increased percentage hired. However, the small companies show the reverse relationship. This may be due to the complacent attitude commonly found in large organizations. That is, if the project uses internal equipment, the hiring rates are generally cheaper than if the equipment is hired from outside sources, and therefore, controls are relaxed slightly. However, if the

project managers can see the direct expense of "losing" the money to the companies from which the equipment was hired, they ensure that full use is made of the hired equipment.



V2,fig. 3.14 shows the geographic distribution of the respondents companies. The majority of companies operate in the Transvaal area, followed by Natal, and the Western Cape. The number of companies operating in these three locations far outweigh the number operating in any other part of the country or neighboring states. The number of companies operating in the smallest geographic location, i.e. the PWV area, is greater than in any other single location. Also, most companies, especially the smaller ones, restrict themselves to one location.

4.2 Conclusions Drawn From Part 2. Question 10.

Question 10 of the survey asked the executives to rate the importance they believed their employees attached to certain motivational factors. Later, employees will be asked the same questions, and the executive, and employee rankings will be compared. A similar study has already been done in the U.S.A.

Good wages, job security, and good working conditions were all rated highly by both the U.S.A., and the South African executives. The "feeling of being in on things", and "interesting work" were rated lowest on the current survey. It is interesting to note that these two factors were rated third and first by the U.S.A. employees. Table V2,3.1 lists the rankings of the motivational factors, and it clearly illustrates the disparity between what the executives believe their employees want, and what the employees really want. Figure V2,3.19 shows the relative importance the executives believe their labourers attach to the factors, and it shows that, according to the managers, good wages are by far the most important factor with an average rating of 4.4 out of 5, followed at a distance by "financial incentives" with a rating of 3.9. The importance of these figures will be to show the local disparity between the South African managers' beliefs and the workers' wants.

4.3 Conclusions Drawn From Part 3. Question 11.

This section of the questionnaire was concerned with the potential for improvement of some "head-quarter" type functions. According to the results of the survey, most of these functions are well performed, with their average potential for improvement well below 2.5. In fact, the functions of "drafting" and "estimating" were rated in the five factors possessing the least potential for improvement out of the forty-five functions listed in the questionnaire. However, at the other end of the scale was "communications" which was rated 6th (3.39/5), and "planning" which was rated 14th (3.13/5) overall for possessing the most opportunity for improvement. The larger companies seem to have more of a problem with communications than do the small companies, probably due to their physical size, geographical distribution, and the increased complexity of their projects. It is generally found that inter-departmental politics plays a major role in ruining communications efforts.

4.4 Conclusions Drawn From Part 4. Question 12.

This section of the questionnaire was concerned with the potential for improvement of some site-type functions.

Materials Functions: These generally showed less potential for improvement than the corresponding ratings did in the American surveys. The exceptions were "standardization", "new products", and "product availability", which scored overall rankings of 7th, 11th, and 13th respectively. The problems of "new products", and "product availability" are common in Africa, and can be associated with the problem of "foreign technology" which also scored a comparatively high rating. The apparent lack of standardization among the available materials will further complicate construction problems thereby reducing productivity. Materials packaging is the "materials" function requiring least improvement and is rated among the five functions possessing least potential for improvement.

Management Functions: This category consisted of three functions, supervision, cost control, and labour relations, which achieved overall rankings of 3rd, 4th, and 5th. The industry is therefore calling for a drastic improvement in the management of their labour force. These ratings are comparable to those obtained in the previous surveys.

Equipment Functions: The utilization of equipment is the most crucial of these functions according to the present survey. The overall ranking of 8th is consistent with the expressed need to train and supervise the labour. Equipment maintainability ranks 12th overall. This high ranking could be partly due to the lack of preventative maintenance plans which are in more common use overseas.

Engineering Functions: Both the improvement of design and standard specifications is necessary for productivity improvement. These functions could be aided by an increase in communications between the contractor and the design team during early stages of design. It is at this stage of the project life

cycle that the constructibility is improved with least cost, and with most effect.

Regulatory Boards: The verbal abuse of the unions is much greater than the figures on the survey suggest. The most common complaint is that the unions are too politicized, and are not serving the best needs of the workers. This is illustrated by the fact that CAWU ranks 9th overall for potential for improvement. The unions which are not politically oriented do not seem to require much improvement. It is generally the large companies which indicate that the unions need much improvement.

Labour Functions: Labour training and quality control were ranked 1st and 2nd overall in terms of potential for improvement. The availability of labour was ranked low, but many companies indicated, in question 14, a general lack of skilled labour. The framework in which the construction industry exists forces companies to be wary of investing in labour training, but this is proving to detrimental in the long run. The situation will only improve when there is a predictable economy, allowing long term strategic planning and a stable work force, resulting in the investment by companies in their employees.

Construction Techniques: There was little desire to improve the construction techniques, with current ratings below those of the previous surveys except for the function of "foreign technology."

4.5 Conclusions Drawn From Part 5. Question 13.

Part 5. of the questionnaire asked the respondents to express their interest in participating in activities relating to productivity improvement. These included undertakings such as developing, conducting, or evaluating projects, attending meetings, and the like. The activity that participants had least interest in was the contributing of funds towards programs aimed at improving construction productivity. This function also rated lowest out of the 45 questions asked on the survey. The fact that three out of seven of these activities rated among the five overall least scorers shows the complete lack of interest that the industry has in doing something about improving productivity.

One reply illustrated that company's poor attitude by rating most of the functions in sections 3 and 4 very high, but showed no interest whatsoever in participating in activities which may help to improve the situation. As mentioned earlier, there seems to be a misguided understanding that productivity will improve as a result of a solitary, noncontinuous event.

4.6 Conclusions Drawn From Part 6. Question 14.

Question 14 asked the respondents to include their comments relative to productivity improvement. These comments have been set out in appendix III of volume 2. These comments suggest that poor productivity is recognized as a big problem in the South African construction industry. The areas mentioned most frequently were the poor economic climate resulting in extreme work-load cyclicality, the inefficiency and political orientation of the unions, and the "poor" attitude of the workers. Many of the smaller companies were asking for some form of protectionism to be introduced to allow them to compete more easily against the larger contractors which are "dominating" the market. However, any form of protectionism will reduce productivity in the long run in a free market economy. If competitive protection is implemented, such as subsidizing smaller companies on local contracts, it will have to be applied on an individual and therefore "unfair" basis, and should be removed at the earliest possible opportunity.

4.7 Summary

The South African construction industry is generally concerned about the low levels of productivity prevalent in the country. The poor state of economy and the turbulent political situation hamper efforts to improve productivity. The six factors regarded as having the most potential for improvement are training, quality control, supervision, cost control, labour relations, and communications. These functions are closely related through the lack of basic education predominant in the third world. It will take time for the various sectors of the industry to find an equilibrium via the current economic, educational, and political

reforms. As suggested by one respondent, productivity relies heavily on a change of attitude throughout the whole company.

5 CONCLUSIONS DRAWN FROM FURTHER INTERVIEWS WITH EXECUTIVES
FROM THE CONSTRUCTION INDUSTRY

Table 5.1 below lists the eight factors that, according to the South African construction executives, possess the most opportunity for productivity improvement. It was these factors that formed the topic outlines for discussion in the interviews conducted with construction personnel.

TABLE 5.1

THE EIGHT FACTORS POSSESSING THE MOST OPPORTUNITY FOR
IMPROVEMENT.

(Rating out of 5)

RANK		AVERAGE RATING			
		ALL	SM'L	MED.	L'RG.
1	Labour Training	3.72	3.92	3.63	3.61
2	Labour Quality Control	3.68	3.73	3.62	3.68
3	Management Supervision	3.59	3.46	3.53	3.78
4	Management Cost Control	3.58	3.59	3.68	3.49
5	Management Labour Relations	3.43	3.44	3.32	3.51
6	Communications	3.39	3.15	3.57	3.48
7	Materials Standardization	3.27	3.37	3.12	3.29
8	Equipment Utilization	3.25	3.28	3.30	3.17

On close inspection of the first six factors, the reader will notice that they are inextricably interwoven, and form a part of a larger problem. It will be found that the root cause of each of these problems is the same, and that the treatment of this one cause will help to solve all of the problems. Applying the problem solving technique commonly known as "Ask Why Five Times", one is likely to find that sooner or later, each of the problem factors can be attributed to the lack of education prevalent in the third world, and more importantly, to the large differences in the levels and issues taught in the dissimilar worker and

manager educational systems. Therefore, in order to improve these six functions, managers must try to eliminate the disparities between the existing systems in the work place, and the people who have to work within the systems.

These non-conformities between the people and the organizational systems have arisen in two ways:

The systems may have been designed without the user in mind. A good example of this is the controversial pension schemes which are now being amended. Previously, the average worker did not understand the workings of a pension scheme, and therefore did not want to contribute towards it. Further, the benefits of the scheme did not suit the average workers' lifestyle. It has been found, for instance, that the workers desire a greater funeral benefit, so that the recipient can be buried with more style than was possible under the benefits of the old scheme.

Progress has raised the general level of education and standard of living, and will continue to do so. Unless the current systems are constantly updated to keep abreast of the progress, disparities between the people and their systems will never be eliminated.

It is obvious, therefore, that the above mentioned disparities can be rectified either by changing the systems, or changing the people, or both. Productivity improvement necessitates change, but in this game, there are no rules or correct answers, and a slight error can often be the cause of irreparable damage.^(5.1)

The above discussion formed an underlying aspect of all of the interviews and should be borne in mind when productivity improvements are at issue. There were several, more direct problems and concerns common to all the companies with which

5.1 A good example of this is Company No. 3 (See V.2 Ch.5.3) whose management changed the pay interval from fort-nightly to monthly, causing the labour to strike. As a result, most of the labour was fired, and the company had to start the productivity process over again with new workers.

interviews were held. These problems are elaborated on in the following text.

Every company realized that poor productivity was a major problem, and it was only the routes taken to improve it that were different. One of the major concerns was that the average worker does not understand the business systems or the role that he plays in the organization. Another major obstacle to productivity improvement is the poor communications between the management and supervisory levels, and the supervisors and the workers. Poor quality is often caused by this lack of communications.

The companies are generally taking one of two approaches to solving their productivity problems:

The first, and probably less effective approach to productivity improvement, is to concentrate improvement efforts at the supervisor level. Companies adopting this approach are training their first-line supervisors along the lines of the standard N.P.I., or C.E.I.T.B. courses. They are hoping that these courses will improve the business understanding and leadership skills of the supervisors. In turn, the supervisors should be able to motivate the employees and to supervise quality and productivity into the final product. Those organizations which approach one of the official training boards for assistance will be advised to adjust or upgrade their existing measurement systems to enable easy record keeping of relevant information with which to provide feedback to the supervisors, and with which to measure productivity levels in general. These companies are actively encouraging the management to pursue a participative style, although that style is sometimes not extended right down to the worker level. The workers are generally excluded from any training except if particular skills are required for a certain project, in which case a team is trained in that particular skill.

The second approach to productivity improvement requires significantly more effort, and should be regarded as a long term investment. The companies following this approach

concentrate improvement at all levels of the company. There is still an emphasis on the supervisory levels, but it is not nearly as marked as in the approach outlined above. Here, the aim is to create an environment in which each person is self motivated. This requires the general labourers to understand the role they play in the smooth operation of the company, and therefore to understand and appreciate the framework within which the companies function. This approach also requires management to understand the position of the labourers, and to adjust the systems so as to create a mutually satisfactory work environment. Using this approach, everyone in the organization is involved in a learning process, and the participative management style will become part of the process without it being forced.

The interviewees all agreed that the participative management style was becoming more effective, and would continue to do so in the face of the rising education levels. It is obvious that the general work force would flounder in the face of a purely participative management style, but the effectiveness of the authoritarian is being eroded by the progressive forces emerging within the modern work force. The management style model proposed in chapter 3 may help to clarify a suitable approach.

The lack of communications at the lower levels is a major contributor to lost productivity. There are two main barriers hindering improvements in this area:

The first, and most significant hurdle, is that to improve communications, personnel have to make an extra effort. The low level workers often lack a general understanding of "complex" issues. This lack of understanding excludes them from an explanation, and results in a complacent managerial attitude. The end product is that workers opinions are often not sought, or are ignored when decisions on worker-related issues are sought. Extra effort needs to be made by management, above the level of supervisor, to explain relevant issues to the workers, and to obtain their points of view. Many of the interviewees stated that worker

motivation is substantially increased by simply showing them an architect's sketch of the project at hand, and letting them know the duration of the project. This should be followed up by simple explanations of the purposes of each major task, and how that task fits into the project as a whole. (See Box) Apart from increasing worker motivation, these explanations form an effort to include the workers in issues which are important to them.

The second main obstacle to improved communications is the fear that some supervisors have of imparting too much information to their subordinates. Supervisors are worried that if a worker becomes too knowledgeable, he will take over the supervisors' job. As a result, the labourers are often working "blind", that is, just doing the job without knowing why, or how long it will take, or where it fits into the project as a whole. It is not difficult to imagine how frustrating and demotivating it is to work under such conditions. This lack of low-level communications is also directly responsible for much of the poor quality, as the labourers are often not given sufficient information to allow them to successfully complete the technical side of their task.

It is necessary to consider communications from a motivational point of view as has been done in the above discussion, but if

A South African construction company recently won a major building contract in Swaziland. As part of the contract agreements, the company had to employ local labour for unskilled tasks. These people had never worked in the construction industry before. A gang was instructed to dig a hole. The supervisor never explained to the labourers that the hole was to accommodate a column base. In due course, the reinforcing was placed, and the base was poured. The next morning, the labour went on strike, reasoning that their efforts expended while digging holes were pointless if the holes were just going to be filled up again. A simple explanation of their task would have avoided unnecessary strike action.

the company's formal communications are in a state of disorder, any efforts towards improving motivation through communications are likely to be wasted. The interviewees who described their internal formal communications as "good" were employed by companies which had planned their communication channels in depth. Those companies which had never paid any attention to communication, or which had never defined formal systems, generally had nagging communications problems.

One of the first stages in the N.P.I. productivity improvement process is the implementation of measuring systems. The purpose of these are to ascertain the current levels of productivity, and to form the basis of permanent measuring systems which are inexpensive and easy to operate, while providing a wide range of meaningful information. It is difficult, if not impossible, to control a process if one cannot measure it. The implementation of measurement systems is therefore a prerequisite to any productivity improvement process. The units in which productivity is measured should be chosen so as to provide meaningful feedback to those labourers whose productivity is being measured. Training can account for a large portion of a company's "profits", especially if the company has to pay certain levies to various training boards. Training should therefore be regarded as an investment, and the returns should be measured.

Opinion was divided as to the size of the problem caused by the lack of skilled labour, indeed, one interviewee suggested that there was no shortage of skilled labour. The cause of divided opinion could be that some management regard skilled labour as artisans who can not only perform the required tasks to set specifications, but who can also work without direct supervision. The available training schemes completely separate the skills training from the development training, resulting in a skilled artisan with little understanding of the work environment, and little knowledge of management techniques. However, the fact that the training schools are busy in an economic slump suggests that there is a shortage of trained labour. All of the interviewees were adamant that training in any form, provided that it was properly carried out, increased worker motivation

considerably. One of the serious flaws in the training programs is that the unofficial training is poorly managed. A trainee artisan is required to gain practical experience in his field as part of the training. The problem arises when the trainees' supervisor realizes that the trainee is particularly good at one task, and delegates all similar jobs to him. At the end of the apprenticeship period, it is found that the trainee can only perform the tasks which he has practised many times, but that he cannot adequately perform any of the other duties for which he has supposedly trained. This poor training management leads to artisans of inferior quality.

The Unions play a major role in labour relations. These relations seemed to reach their worst point in 1988, and have been slowly improving since then. Although there are still many issues to resolve, the unions are becoming more reasonable with their demands. Only one out of the five interviewees has had recent "Union Problems", and only one other company has specifically approached the unions for assistance.

The last two topics discussed were "equipment utilization", and "materials standardization." The companies did not have any major problems with either of these issues as the labourers generally know the materials and equipment fairly well. Any problems encountered with bad equipment utilization have been solved through training and planned maintenance. Strict adherence to a planned preventive maintenance scheme is difficult in the construction industry where the equipment is mobile, and tight deadlines are often only met by crisis management and overtime. Planned preventive maintenance in its pure form will probably never succeed in this industry, but an adaptation of the principle is needed to ensure high levels of productivity can be maintained.

The fact that topics rated 7th and 8th did not pose any major problems suggests that factors rated below these on the construction productivity questionnaire do not seriously affect productivity.

Summary: The concepts of "productivity" and "quality" are products of the free market environment of which the construction industry is part. It is known that there is no concept or word for "quality" in the Xhosa language, and so these concepts have to be taught to the general labour from first principles. The problems of poor quality and bad productivity arise from the fact that there is a cultural and educational gap between the managers and the workers. Indeed, if there was no gap, everybody would perform at the same productivity level, and there would be no problem. Productivity improvement is therefore a management problem which can only be solved by motivating the entire organization to perform at one level. To remain competitive in the market, this level will have to be above that of the organizations' competitors. However, productivity for competition is not the whole story, anything less than perfect productivity is a waste of time, effort, money, and other resources.

Improvement necessitates change, and this is only possible if initiated by management and fueled by efforts towards education and understanding from both the management and the labourers. Communications channels must be prepared so as to handle the information flows generated by the changes. Communications in the third world have unique barriers (language, educational, and cultural) which must be overcome if the communications are to be completely effective. Lastly, the changes must be controlled and efforts channeled towards common goals, and this can only be accomplished if the necessary information is available. Measurement systems need to be established to collect this information. Productivity improvement is an on-going process which can be likened to "learning how to learn." (1)

6. TRAINING IN PERSPECTIVE

Training can take on one of two forms: skills training and development training. Skills training enables the recipient to adequately perform the technical aspects of his job. It enables the worker to take pride in producing a top quality product, it increases productivity, and it is renowned for increasing worker motivation. The results of an investment in skills training are comparatively easily measurable. In certain cases, such as when a new or unusual skill is required for the completion of a certain project, skills training can be considered necessary. On the other hand, development training is hardly ever considered as necessary, the results are very difficult to measure, and they have no direct influence on a labourer's work. Again, development training is renowned for increasing worker motivation, but there is no direct proof of this. There is little direct proof that development training increases productivity either. It is therefore hardly surprising that many managers do not want to invest in development training as it is time-consuming, expensive, risky, and requires the input of much sustained managerial effort. The risk associated with an investment in this training could be considerably reduced if there was documented evidence on the returns one could expect over a certain time period.

A manager cannot however, base all his decisions on the answer provided by a financial tool, and one's "gut feeling" about the results of development training must be taken into account. Not every good manager is born as such, and most people have to be taught managerial skills along with the necessary associated knowledge. As tomorrow's foremen are most likely already in the construction industry working as labourers or section leaders, these people must be moulded correctly over time so as to be able to assume the responsibilities associated with a higher position. Further, general labourers will never be able to fully understand complex issues such as strike actions and retrenchment if they have a warped knowledge of the workings of a business and its environment. They will never know the meaning of, or importance

of productivity and good quality if they have not been told about it.

There seems to be a general opinion that the work force is of poor quality, but companies are unwilling to invest in training as the market is unstable, and training is a long term investment. However, the standard of the work force will not improve if the members are not trained.

Much time, expense, research, and effort has gone into the design and development of the existing training courses which are readily available to the industry. These courses have a good reputation, and the user companies are pleased with the results. It is difficult to partition and attribute the good results to their particular causal actions, which may simply be the Hawthorne effect, or the fact that the company is accurately measuring and controlling progress for the first time. In other words, the increased productivity may not be directly attributable to the training, but more generally due to the fact that the company is involved in a productivity improvement drive.

7. DEVELOPMENT OF PRODUCTIVITY IMPROVEMENT

It has been said that to improve productivity, one must work harder, work smarter, or increase capital investment.(3) Those managers who have tried to improve productivity will appreciate that this is a very simplified view to take. Simple as it is, this proposal bears much truth, and is testament to the common sense and practical nature of productivity improvement.

The recent increase in buzz-words associated with productivity improvement illustrates the magnitude of this issue's importance. Much literature has recently been published on the topic. However, much of it is academic and therefore of little direct use to the average contractor. Many researchers have developed enlightening productivity models explaining how different factors affect an organization's productivity. Notable here are the models proposed by Hershauer and Ruch (1978), by Adam, Hershauer, and Ruch (1981), and by Sutermeister (1969). These (productivity) models are complemented by various motivation models such as the well known Porter and Lawler model (1968) and the Porter, Lawler, and Hackman model (1975). Of special interest to the Southern African environment is the motivational model proposed by Orphen which is based on Porter's and Lawler's work. Orphen developed the model aimed at "Black" worker motivation, placing emphasis on feedback and pressure.(2) Unfortunately, these productivity models are not accompanied by a guaranteed formula for productivity improvement. Management cannot just stir well, bake at 180°C for 90 minutes and sit back to watch productivity rise in an isolated environment. However, much productivity improvement, especially in Southern Africa, can be accomplished by the skilful application of common sense. There is one condition that is absolutely vital to productivity improvement: the organization must nurture a learning and questioning environment dedicated to the improvement of their productivity.

7.1 Development of a Productivity Improvement Process.

The study of a productivity model such as that proposed by Sutermeister in 1969, (See V.1. Fig. 2.4) will give the reader a comprehensive guide to the factors which affect productivity in the work place. Such models are of limited use to the construction manager as they do not emphasize the factors which are of major importance in the Southern African context. The process proposed here is not intended to cover the minutiae of possible productivity improvements, but to present a more practical approach to setting the foundations which will result in an organization being able to compete in the first-world markets.

Productivity improvement in the South African construction industry is largely an industrial relations exercise, but specific effort concentrated in the following areas is necessary:

- i) Training and Education
- ii) Communications
- iii) Construction Site Organization
- iv) Motivation

These issues cannot be tackled separately, and the success of the plan is largely dependent on manager commitment.

Measurement System: A good start to the productivity improvement process would be to implement measuring systems for the major aspects of a project. Details of measuring systems have been covered in Volume 1, but it is important to remember the following points:

- i) The system must be easily administered.
- ii) It must provide information understandable by the people whose productivity is being measured.
- iii) The processed information must be available soon after the raw data is gathered.
- iv) The results must be a true measure of the effort input.
- v) The system must be able to identify the individuals, groups, or other causes of particularly good or poor productivity. Demotivating aspects and "dissatisfiers" should be detected and removed at this stage.

The systems should be designed to be able to accommodate any future developments such as the implementation of an incentive scheme, or a second phase of the project. Control of the productivity improvement process will be directed through the measurement system, so any flaws in the system will have far reaching effects. The data gathered by the measurement system can have a major motivational effect if used skillfully, and the system must be designed to provide timeous feedback.

The implementation of a comprehensive measuring system prior to any other productivity improvement actions is advisable for the following reasons:

- i) It allows the users to fine tune the systems and to become accustomed to them while there is little pressure on the systems.
- ii) Productivity figures will enable the management to direct future improvement effort at the areas most in need of it.
- iii) Initial productivity figures will form the base mark against which future productivity can be gauged.

Materials Management: Full details of complex materials management systems are provided in chapter 8 of volume 1. However, most projects do not require such elaborate efforts. A simple system which ensures that the necessary materials are available, on time, and with the expenditure of little effort, is all that is required. The system must provide for the small items such as survey pegs and steel nails which can at times be as important as plant fuel. The system should be time efficient: for example, if a person has to complete a particular form for the issue of every-day equipment such as a spade, and then to collect the item from distant stores, the system needs revising. Double handling of consumables can be greatly reduced through an efficient materials management system. Although a good materials management system is unlikely to increase worker motivation, a badly run system will certainly demoralize those workers who are constantly being delayed through lack of materials or equipment. Part of the measurement system should be able to record the productivity improvements attributable to an improved materials management system.

Site Hierarchy: The hierarchy should be custom designed for every project. It is important that the definition does not end at the junior foreman, or similar level, but that it is continued right down to the bottom levels, and includes the names of the general labourers. Each level and position should be accompanied by a short description of the relevant responsibilities and tasks. There are several reasons for this arduous process:

i) The listing of individual labourers will force the management to group the workers into productive units. This must not be done arbitrarily, and in fact it will be beneficial to allow the labour to group themselves. A guideline to the size of each group dependent on their task is given in table 4.3 of volume 1. (For example it is suggested that a team responsible for bricklaying is comprised of 4 members). This grouping is beneficial in a number of ways:

- a) The workers will group themselves into teams consisting of members who get on well and who can work well together. Over time, they will form a cohesive team which will be more productive than a team comprised of non-compatible members who have not worked together before. The self-forming of teams will automatically remove many of the demotivating aspects of the work environment. For instance, the workers will tend to group under a favoured superior, and away from work-mates with whom they do not get on.
- b) The choice to work alongside one's chosen friends will be of major motivational value.
- c) It enables management to keep track of the tasks that each group has completed so that the group can be assigned to similar tasks allowing them to utilize their acquired experience. This is a direct application of the principles of the learning curve. It is hardly necessary to add that a team performing a task for the second time will be more productive and less likely to make a mistake than a second team who is performing the task for the first time.

- d) Productivity can be measured for individual teams which may form a starting point for an incentive scheme. The individuality that small teams create will instill a competitive environment which will benefit both productivity and motivation.
- e) It is easier to control teams than it is to control each individual. The formation of individuals into teams effectively reduces the number of productive units on a site, thereby easing control. It will be found that productivity will increase according to the rule " $1 + 1 + 1 + 1 = 5$ ".
- f) It is easier to assign a significant portion of the project to a team who will be held responsible for its completion, and who will gain intrinsic feedback from successfully completing a sizeable task.
- g) The number of necessary communications channels is considerably reduced by the formation of teams.
- h) The records for each team will enable management to assign tasks according to the teams' ability.
- ii) The tracking of each team will provide a useful tool to aid management in forming a core of stable labourers. This will be discussed in more detail later.
- iii) The formal, detailed definition of the site hierarchy will enable each employee to know the person to whom he is directly responsible, and to know the people who are responsible to him. This is important as it prevents employees from taking conflicting orders. It also helps to ensure that all managerial levels are being utilized. Too often, it is found that one person is overworked because he is not fully utilizing the managerial levels underneath him. Effective delegation is a managerial skill which has to be developed.
- iv) A short job description will aid in the definition of formal communication channels, in the delegation or sharing of responsibilities, and in the assigning of tasks. This is important as it helps to prevent employees from making decisions that they are not qualified to make, or that require more information than is available to that person.

Communications: Communications are a major barrier to productivity improvement in Southern Africa. The problem should be tackled on four fronts:

- i) The most obvious barrier to good communications is the language and understanding barrier that is prevalent in the third world. This barrier can only be overcome through multi-level education and this will take time. Development training plays a large role in this aspect.
- ii) Most organizations have poor communications because they do not give the company a chance to improve them. Those companies which describe their communications as good have spent time planning the channels through which information is processed, and cultivate a wide network to serve the informal communications.
- iii) Managerial politics can ruin efforts to improve communications. If this attitude exists in the upper echelons of a company, a productivity improvement process is unlikely to succeed as it needs the full commitment of an undivided management.
- iv) The fears that supervisors have of losing their jobs to subordinates if they impart too much information can be allayed by development training. Many companies have suggested that productivity is badly influenced by the poor communications in this area.

The importance of good communications cannot be overstressed. Communication channels can be regarded as the nervous system of an organization. If the system is malfunctioning, the organization will be slow to react, or if insufficient or incorrect information is passed, the organization will react incorrectly.

The above actions are all tangible steps that can be executed with relatively little managerial skill, especially if the systems are initiated on a new project where there are no established norms. The following actions however require a delicate managerial touch as their success relies on the human aspect. In order to further improve productivity, motivational aspects should be introduced, complemented by training and a

thorough examination of the new situation in order to find the new areas in most need of improvement.

Motivation: It has been stated earlier that productivity improvement in Southern Africa is largely an industrial relations effort. Taking this point of view, it will be realized that motivational factors assume an all important role in any improvement process. Motivational factors are, by their very nature, subjective, and managers must consult with those receiving the motivation to ascertain which factors are most effective. The previous research has shown that good wages are not completely dominant over other worker motivational factors.

The Expectancy Theory and Maslow's hierarchy of needs are useful guidelines to follow when designing motivational factors. One should however, only use these as guidelines as they have some important limitations. These theories have been discussed in depth in volume 1. As Orphen pointed out, pressure can be regarded as an important parallel to motivation.

The manager should design all of the new systems from a motivational point of view. For example, the grouping of employees into distinctive production teams must be done so as to gain maximum motivational benefit from the exercise. Likewise, measurement systems should be able to provide the workers with timeous, meaningful feedback. Teams should be assigned significant tasks which will provide instantaneous intrinsic feedback upon successful completion. The assigning of a task to a specific team will force that team to take most of the responsibility for the completion of that task to acceptable quality standards, and within an acceptable time period. If a certain task is completed by a number of unrelated, untraceable individuals, the feeling of personal responsibility is reduced, causing a drop in quality. It was stated earlier that a team should be assigned to tasks with which the members have had recent similar experience. The purpose was to allow the members to utilize their recent learning experiences. However, if the team is constantly repeating the same arduous task, the benefits accrued from the learning process may be offset by boredom.

However, most construction tasks are not of a repetitive nature to the degree of many manufacturing tasks, and the boredom and alienation barrier^(7.1) is less likely to be reached.

Financial incentive schemes are often regarded as the ultimate motivational factor. There is no doubt that this incentive does increase productivity, however, there is doubt that the increased productivity can be sustained. Measurement methods, bonus rates, feelings of pay inequity, rate "busting", and cheating the system are common examples of other areas in which to expect problems from incentive schemes. The intricacies of payment by results have been covered in section 4.3.1 of volume 1.

Although there is no documented evidence, managers feel that well planned and executed training has a large motivational effect on employees.

Training: Aspects of training have already been discussed at length in this document; however, its importance in a productivity improvement scheme cannot be ignored. Every improvement process must be conducted in an environment of learning and questioning. Its ultimate success depends on the active participation of all those involved, and the employees need the tools with which to participate. The managerial levels can only improve productivity up to a point by implementing increasingly efficient systems, and after that, the workers must motivate themselves to achieve higher levels of productivity. Most low level employees do not have the ability to think through, or to create new processes, and many do not have the knowledge required to form a base from which to launch such a process. The only way to provide these people with the necessary ability and knowledge is through training.

One of the problems associated with training is that it is an expensive and long term investment. The traditionally migratory work force in the construction industry magnifies the risk element involved. It is therefore necessary to form a core of

7.1 See V.1, Fig. 4.3 for explanation of Boredom and Alienation barrier.

stable labour. This stable core will reduce the risks involved in training, and will also help to perpetuate the new systems between projects. "Promotion" to this core can be used as a motivational factor, and it will be from this core that employees are chosen for training courses. This core will also aid management in their retrenchment policies in poor economic times, or when the labour cannot be transferred to a new project after the completion of their current one. Every person on this core should have completed the basic business appreciation course or an equivalent. This will provide them with the knowledge of how the construction industry is structured, the role that they play in the organization, and a basic appreciation of the financial aspects of contracting.

Further training is necessary to fully realize the leadership potential of the lower management. To reiterate, many managerial skills have to be taught, and the problem solving techniques will be useful in setting groundwork for the implementation of a form of quality circles. These training schemes are readily available through organizations such as the C.E.I.T.B. Possibly the most important training will occur in the ranks of the top management where it is essential to enlist their support for a productivity improvement process. Training will bring employees closer to the same intellectual level which will make participative management more effective.

Discussion and Examination: It is at this stage that the continuous nature of productivity improvement asserts itself. The managers should now return to step one and examine the situation anew. Training should have prepared the employees for the third factor of productivity improvement - increased capital investment. The employees should at this stage be more receptive to the changes that an injection of capital, or a major technological improvement would demand. The measurement systems would have to be continually updated to provide controls over every change that is made. The learning and questioning environment that must surround every productivity improvement process will ensure that the process continues to strive for increased levels of productivity and quality.

Summary: An examination of the current literature and productivity models will provide a comprehensive understanding of the academic aspects of productivity improvement. This chapter has suggested some simple practical actions which may form the basis of a productivity improvement process. The suggestions cover a number of steps which cannot be separated. Top management commitment is necessary to ensure the successful continuation of the process.

The starting point for the process is the implementation of a measurement system which is simple to operate and provides timeous feedback to those who are interested in the information. The system should be flexible and must be designed from a motivational point of view.

A materials management system should be established which ensures that all necessary materials and equipment are available when they are needed, and where they are needed. The system should be simple and inexpensive to operate.

The site hierarchy should be defined down to the lowest levels, and the labourers grouped into productive teams. This aids communications efforts, and control over teams is easier than control over separate individuals. The grouping of employees boosts productivity by increasing motivation and by utilizing the teams' enhanced ability to work together.

The communications network should be formally defined to ensure that all the necessary information is obtained by those who need it, and to prevent employees from having to decide between two conflicting orders.

Motivational aspects should be planned for and introduced into the process from the start. It is important to consult the recipients of these schemes before implementing them, as the managers idea of what his employees want may not be correct.

Training is necessary to realize the full leadership potential of the management levels, and to realize the full motivational and productive potential of the general work force. Low level

management usually originates in the general labourer level, and these future managers will not achieve their potential if they have no access to developing their managerial techniques.

The process must be continued through the learning and questioning environment which is itself fueled by the intrinsic motivation obtained from increased productivity levels, and the academic abilities initiated by training.

8. SUGGESTIONS FOR FUTURE RESEARCH

Much research is being performed in the field of productivity improvement. This field is relatively new, and it offers many topics for further research, especially in the field of productivity improvement as applicable to Southern African conditions.

With reference to the topics covered in this thesis, research should be continued in three areas:

- i) Probably the most important area is that of worker motivational factors. The researcher needs to find out the applicability of the classic productivity and motivational models, and to ascertain the specific motivational factors which are most effective in this part of the world. The researcher will first have to overcome the language, cultural, and educational barriers before he will be able to collect any useful information. Another barrier is that companies do not often allow research to be performed using their labour as subjects as it tends to agitate the manager - worker relationships and disturb the company's productivity.
- ii) The motivational effect of training needs to be documented. Managers at present feel that training motivates the work force, but the extent of the motivation is not known. Many companies have policies that a certain amount of money should be spent annually on training. This training is not necessarily related directly to the tasks, and could cover subjects such as AIDS. This training is done mainly for motivational purposes, and may be a complete waste of time. On the other hand, training may be an excellent motivational factor for the average worker.
- iii) The third area requiring further study is the measurement of returns from an investment in training. If the returns are minimal, or even negative, then managers may pursue other options by which to improve their productivity. It is unlikely that all forms of training will produce the same returns, and this aspect should form part of the future research.

9. CONCLUSIONS

This volume of the thesis has shown that poor education is a major hindrance to productivity improvement in Southern Africa. There is a lack of understanding between the labourers and the management which is aggravated by poor communications. The educational systems have not equipped the general labourers with the knowledge of the workings of the capitalistic system, nor with the ability to control the system. As a result, management has tended to use an authoritarian style which, in the face of rising education, is becoming less effective. Communications are affected by the difference in educational levels, cultural backgrounds, and a language barrier. These basic differences between the labourers and management should be taken into account when motivational schemes are designed. In the light of the previous statement, it is obvious that a manager is basically different from a labourer, and can therefore not decide what the most effective motivational factor is. Many of these differences can be alleviated through development training if it is properly organized. A poorly prepared trainee will not benefit from a course as he will not know why he is being trained and may regard it as a waste of time. A properly prepared trainee is likely to be motivated after having completed a course.

Results of the survey showed that the South African construction industry is dominated by a few large companies. These large companies tend to use their equipment more efficiently than do the smaller companies. The survey showed that six productivity factors stand out as needing urgent attention. These factors are: labour training and quality control; management supervision, cost control, and labour relations; and communications. These factors can all be related through their root cause which is the large difference in the levels and issues taught in the dissimilar educational systems producing worker and manager education. The survey also ascertained that although the industry is aware that there is a large productivity problem, companies are generally not keen to help to solve the problem.

Further research showed that many companies are trying to solve their internal productivity problems through training. Some companies are taking the approach whereby they concentrate their training efforts at improving the communications at the supervisor - worker interface. Other companies are treating the root problem; that is, they are training the general workers in business appreciation, as well as training all levels of management in applicable leadership skills and other management techniques.

A productivity improvement process has been suggested. It is initiated by implementing measurement systems designed to provide a measure of control over the project's productivity as well as to be of motivational benefit. The labour should be grouped into productive units for motivational purposes as well as for ease of control. Materials management should be accomplished through a formal procedure which ensures materials are available when and where they are needed with the minimum amount of time and effort. Both formal and informal communications should be well planned prior to the implementation of motivational schemes. Training should form part of the productivity improvement process so as to prepare the management of tomorrow in the best possible way.

Productivity improvement is vital to enable third world countries to compete in the international marketplace, and to raise the standards of living for those involved in the industry. Productivity improvement can only be achieved in a questioning and learning environment which is initiated by top management and perpetuated by successful productivity improvement and the learning experiences gained through these successes. Productivity improvement is a continuing process which builds upon itself and strives ultimately for perfection.

4) Rijkers J.

The Factors Influencing the Safety Environment. Technical Report for the Graduate School of Business, University of Cape Town, November 1977.