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Scheduling in the South African construction industry

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A research report submitted to the Civil Engineering department, at the University of the Witwatersrand, in part fulfilment of the requirements for the MSc Civil Engineering degree.

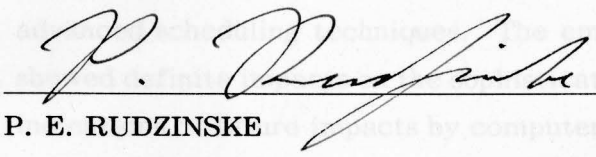
SCHEDULING IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

P E RUDZINSKE

DECEMBER 1989

DECLARATION

I, Paul Eric Rudzinske, do hereby declare that this research report represents my own unaided work. It is being submitted to the Civil Engineering Faculty, at the University of the Witwatersrand, Johannesburg, in part fulfilment of the requirements for the MSc Civil Engineering degree. It has never before been submitted for any other degree or examination, at any other University.



P. E. RUDZINSKE

ABSTRACT

This research report investigates the use and sophistication of scheduling by the South African construction industry, by means of a postal survey and personal interviews. Furthermore, the construction industry's past and present use of scheduling is comparatively analyzed with that of selected overseas countries. A brief description of the various scheduling techniques is provided, together with the histories of these techniques.

The primary conclusion of the research work was that the larger companies showed greater dedication to their scheduling, as well as implementing more advanced scheduling techniques. The emergence of cheaper computer systems, showed definite impacts on the sophistication and effectiveness of scheduling, and indications of future impacts by computers were also found. The use of network-type scheduling techniques had also expanded, and further growth in the use of network-type schedules was indicated.

To my Parents

For always caring and for providing me
with the financial security during
my years of study.

ACKNOWLEDGEMENTS

My sincerest thanks and gratitude to the following people, without whom this research report would not have been possible.

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NOMENCLATURE

BIFSA	-	Building Industries Federation of South Africa
CPM	-	Critical Path Method
CSPC	-	Cost and Schedule Planning and Control
GERT	-	Graphic Evaluation and Review Technique
HP	-	Hewlett Packard (Registered trademark)
IBM	-	International Business Machines (Registered trademark)
LoB	-	Line of Balance
PDM	-	Precedence Diagramming Method
PEP	-	Program Evaluation Procedure
PERT	-	Program Evaluation and Review Techniques
PMI	-	Project Management International
RAMPS	-	Resource Allocation and Multi-Project Scheduling
SAFCEC	-	South African Federation of Civil Engineering Contractors

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CHAPTER 1

INTRODUCTION

I. Outline

This section very briefly details the objectives and structure of my research report, with further detail being provided in the subsequent chapters.

The principle objective of this research, was to investigate the scheduling being undertaken in the South African construction industry. In broad terms, the aim of my research was to identify the level of sophistication of scheduling, the relative success of the scheduling being undertaken, the overall commitment to scheduling within the construction industry, and the identification of any problem areas that may exist.

This report provides a brief introduction to the various main techniques employed for scheduling. It must, however, be noted that no discussion on how to produce the various techniques has been included, as this would have been beyond the scope of this research report; furthermore, a detailed knowledge of the different techniques is not required for the discussions presented.

Details of the literature survey conducted at the outset of my research have been included, to facilitate drawing comparisons between previously conducted research work, both local and overseas, and my own findings.

This is then followed by a discussion of the results of the nationwide postal survey that was carried out, together with the relevant conclusions. This leads to a detailed discussion of the results obtained from the personal interviews conducted with the larger contractors on the Witwatersrand, and once again concludes with the relevant observations.

The sixth chapter deals with the results of the interviews conducted with the Project Management companies on the Witwatersrand.

The seventh chapter is allocated to the discussion of all the results obtained in the literature survey, the postal survey, and the personal interviews.

This then leads to the final two chapters, which detail all the conclusions inferable from the research, as well as the speculation on possible future paths for scheduling within the construction industry in South Africa.

II. The History of Scheduling

The word "scheduling" is defined by Webster's Dictionary as:

> "A timed plan for a procedure or project".

This definition begs a further description, namely that of the word "plan". This is defined by Webster's as meaning:

> "A scheme for making, doing, or arranging something; a project; a program; a schedule".

From these definitions then, we can define scheduling as an activity that induces one to logically think through a construction process step by step, and allocate time durations, and sequencing, to the various components of the project. This mental process will then hopefully ensure that all activities are completed in the correct sequence and within the time allocated. Ultimately, with diligence and dedication to the schedule, one can then hopefully prove Cheops' Law incorrect.

> Cheops' Law : "Nothing ever gets built on schedule or within budget."
> (Source unknown)

The importance of scheduling is intuitively clear to us all. However, this intuitive clarity is rarely noted on paper. Hence, the following quote is a rare exception to the rule, as well as conveying the importance of scheduling.

> "Scheduling, is one of the fundamental triumvirate of - cost, time and quality - for successful projects."
> (Ormerod, R.N.; 1988)

The first ever use of scheduling has become obscured by the passage of time, although we can assume that scheduling has been a fundamental part of projects since man first started to build structures, even if the scheduling in the early times was merely a mental process. It was not until the end of the 1800's, that a man named Henry Lawrence Gantt devised the first formalized scheduling technique. His scheduling method was to become known as the Gantt chart, or more commonly as the Bar Chart. It was from this point in time onwards, that scheduling became a formalized and specific process. The invention of the Bar Chart coincided well with the heightened industrial activity of the early 1900's, and provided a rapidly progressing world with a new and highly effective scheduling technique.

(Moder, J.J; Phillips, C.R. & Davis, E.W.; 1983)

By 1942, a spin-off of the Bar Chart was developed by the United States Navy. The technique was to become known as Line of Balance (LoB). The method was found to be particularly good for repetitive projects, but it never found widespread acceptance in the construction industry, except where repetitive construction processes were encountered.

Following the Second World War, technology accelerated at an ever increasing pace. This rapidly accelerating technology brought with it new demands on scheduling, and in 1957 the Du Pont Corporation developed a new scheduling technique, known as the Critical Path Method (CPM). In a parallel effort, the United States Navy developed a similar scheduling process that was named Program Evaluation and Review Techniques (PERT).

(Aras, R.M. & Surkis, J.; 1979)

After the publication of these two new methods of scheduling, a host of variations and extensions of the original methods were launched. Most of these were known by such acronyms as CSPC (Cost and Schedule Planning and Control); PEP (Program Evaluation Procedure); PERT/COST; RAMPS (Resource Allocation and Multi-Project Scheduling); GERT (Graphic Evaluation and Review Technique); and a host of others. These new techniques were to find varying success in the future.

(Arditi, D. & Albulak, M.Z.; 1979)

The vast quantities of literature that were published on these techniques in the early 1960's, can be attributed to the over-enthusiastic initial selling of the techniques as a solution to all of managements problems.

After this initial phase of over-emphasis on the techniques, a period followed which saw industry becoming very wary of the techniques on offer. During this time a general decline in PERT and CPM usage was noticed, and it is not until the mid-1970's that the techniques once again enjoyed widespread use in the industry.
(Vazsonyi, A.; 1979)

During the 1960's, it was only large companies that were able to use computer technology to produce their PERT or CPM schedules. The primary reason for this being, that computers during this period were still mainly of the mainframe type, and hence the costs associated with these machines was astronomical. Furthermore, the use of these mainframe computers often proved very cumbersome and slow, hence further contributing to the minimal use of computers during this time.
(Burr, D.; 1979)
(Barnes, M.; 1986)

However, during the 1970's and early 1980's, computer technology made large advances, and in particular the advent of micro-computers heralded an increase in commercially available scheduling software. Initially, a lot of the software available was simplistic and numerous problems were experienced with it's use.
(Smith, L.A.; 1976).

Initial problems with computer aided scheduling were two-fold in nature. Firstly, the software was generally not of a dedicated nature, and hence its applicability was in most cases minimal. Secondly, the advent of computers heralded its own problems, such as a resistance to the use of computer aided scheduling.
(Campbell, J.Y.; 1979)

By the mid-1980's, the problem of the software being inappropriate and simplistic, had by and large been solved. However, the problem of computer illiteracy was still a factor.

To sum up the past fifteen odd years in the history of CPM and PERT scheduling, it can be said that the advances made in computer technology, have supplied CPM and PERT with a new lease on life, and ensured their continued support and use in industry.

Presently, it would seem that the most readily used scheduling systems are as follows:

- The Bar Chart; which has never really lost its popularity

- The CPM/PERT type of system

- The Precedence system; which was developed from the CPM/PERT type systems and mimics them closely, except for a couple of its own peculiarities

- The LoB system, which is used in isolated cases on repetitive type work.

The above-mentioned points are substantiated in the following chapters.

Where the future for scheduling lies, only time will tell. However, I hope to be able to shed a little light on this elusive future, by means of this research report.

III. Modus Operandi

The first phase of my research report, was to obtain a sound literature base, details of which are provided in the following chapter.

The second objective, was to obtain an overview of the scheduling undertaken in the construction industry. After some deliberation, it was decided that the only practical method for obtaining such an overview, would be by means of a postal survey addressed to most of the contractors nationwide. Addresses for these contractors were obtained from the SAFCEC and BIFSA membership rolls. Not all the contractors listed in the membership rolls were approached, as this would have meant approaching approximately 2000 contractors. Hence, it was decided that only those members listed as Limited, Proprietary Limited or Close Corporations were to be approached. A total of 1029 companies were finally extracted.

Once all the companies names and addresses had been captured onto a mailing list, a suitable questionnaire and covering letter had to be designed (finalized letter and questionnaire are shown in Appendix "A" on page 159). Specific details of the reasons for including the various questions in the questionnaire are given under section II of Chapter 4 on page 45.

Approximately two months after the mailing of the original questionnaire, a return level of 31% had been achieved. The returns from the building contractors was large enough to constitute a representative sample, but the civil contractor returns were relatively low. Consequently it was decided that a follow-up letter should be sent to the civil contractors who had not yet replied, together with a copy of the original questionnaire (see Appendix "B" on page 166). A total of 180 reminder letters were mailed.

After a period of six months, since mailing the original questionnaires, the computer data base containing the results of the survey was finally closed. The final return figure reached 41%, with representative samples of both building and civil contractors being obtained.

The third objective of the research report, was to obtain a detailed viewpoint of scheduling from the larger contractors. The contractors that were to be approached, were chosen from the respondents of the initial survey. A further criterion for choosing the contractors was that they all had to be within the Witwatersrand area, so that they could all be interviewed on a personal basis. A total of 30 individuals were finally chosen and interviewed. Guideline questions were designed for the interviews, as shown in Appendix "C" on page 168.

At this stage, the data collection of the research report should have been complete. However, the contractors that were interviewed often mentioned project management companies, and their respective roles in frequently providing schedules for contractors. In order to give the project management companies a chance to respond to some of the comments made, interviews were conducted with eight project management companies on the Witwatersrand. Once again the interviews were conducted with the aid of guideline questions, as depicted in Appendix "D" on page 172. This finally concluded the data gathering process.

Work then commenced on the writing phase of the report. The report itself was structured very much in the order that the data was collected. In other words, the literature work, problem identification, and the description of the different scheduling techniques were dealt with in the first three chapters. The remaining chapters were then dedicated to the findings of the postal survey and the personal interviews, followed by a detailed discussion of the results, and ultimately conclusions covering all my findings.

It should be noted, that throughout this report the word "schedule" or "scheduling" is used to depict the use of a technique such as PERT, CPM, LoB, PDM or bar charts. The word "planning" is often used by the industry to denote the same, but this practice is in no way followed in my report. Furthermore, it should also be noted that the names of companies and individuals were not mentioned, at the request of these companies and individuals.

Finally, all opinions expressed are purely those of the author and do not necessarily represent those of any institution, company or person.

CHAPTER 2

DETAILED PROBLEM STATEMENT

I. Detailed Problem Statement

During the past few years, planning in the form of scheduling has become ever more important. The three main reasons for this being:

- Firstly, money has become more expensive, ie. interest rates are higher than before. This has led to shorter construction periods being specified, and hence lower margins for error and general inefficiencies have been allowed;

- Secondly, projects have become more complex resulting in a larger number of activities. Furthermore, these activities are often performed by specialists in their particular field, placing a large co-ordination function on the main contractor, and

- Lastly, more construction projects are being undertaken annually.
  (Popescu, C. & Borcherding J.D.; 1979)

In the light of these three factors, we can then assume that most contractors are using advanced scheduling techniques, in order to cope with the greater demands being placed on them! Or can we?

During the late 1950's and throughout the 1960's, an abundance of literature was published on how the new scheduling techniques operated, and how they were to be used effectively. In other words, the literature was very much of a "teach yourself CPM/PERT" variety. Furthermore, the literature also spelt out all the advantages of the new techniques, with very little attention being given to the inherent and extrinsic problem areas of the newly developed scheduling systems.

By the early 1970's, people started asking questions, such as:

- How many companies use CPM/PERT?
- Are they successful in using these techniques?
- What are the true benefits of CPM/PERT?
- What are the construction industry's attitudes toward scheduling?

as well as similar queries.

The result of this inquisitive period, was a series of surveys conducted on the construction industry in both the United Kingdom and the United States of America, in an attempt to provide answers to some of the questions posed. The details of these surveys are presented in Chapter 3, ie. the literature survey section. These surveys were an indication of the industry's desire for more practical literature, in preference to additional theoretical papers on scheduling.

Throughout the 1970's, numerous research papers were published in the United States and Europe, detailing the construction industry's use of scheduling. By the early 1980's, the flow of research work in this field had abated, and the minimal amounts of post 1970's literature available, proves the declining interest in this field.

During my discussion with Professor Thompson, the head of the Project Management department at UMIST in the United Kingdom, he voiced the opinion that literature of this type was vital to the development of the construction industry, and that it aided the academia in developing improved systems. However, it was his belief that the construction industries in the U.S.A. and Europe, had progressed to a stage where such research was no longer necessary. Based on my personal experiences of the European construction industry in comparison to the local one, I must differ with Professor Thompson with regard to the progress made in Europe, although I do concur with him on the importance of such research. Ultimately, the Professor did feel that research of this type should be carried out at least once in a country, so as to provide a foundation for future research into scheduling and other areas linked to scheduling, such as claims procedure, risk analysis, cash flow analysis, and numerous others.

This then leads me to the problem statement for this report. In the literature on the South African construction industry, there is no information on the uses and accomplishments of the various scheduling techniques within the construction industry. That is to say, there is no information on any of the following points:

- Types of scheduling techniques used?
- Do larger companies use more sophisticated techniques?
- How successfully are the techniques implemented?
- Does the size of a company influence the type of scheduling used?
- Is scheduling used at all?
- Is scheduling purely an advanced planning tool, or is it used in aiding control?
- Who does the scheduling?
- Have the advances in computer hardware affected scheduling?
- Has commercially available software affected scheduling?

Ultimately, and arguably of the utmost importance.

- What are the general feelings and opinions of the industry, about scheduling in South Africa?

and

- How does the construction industry view the future of scheduling, and what are industry's expectations of scheduling in that future?

Without answers to these questions, it will become ever more difficult for contractors to maintain a competitive edge as projects become more complex and demanding. Furthermore, completion times for these projects will be kept to a minimum, as the cost of capital steadily rises in tandem with increasing inflation rates, causing time control to play an ever increasing role in projects.
(Cass, D.J.; 1976)

Finally, without answers to these questions, academia will be unable to address the correct and appropriate issues that may plague the industry in the future. Hence, without academia addressing the correct issues, contractors will not be able to benefit from future research. This situation was eloquently described by the Assistant Professor of the Structural Design Department, at the University of Illinois in Chicago, Prof. A E Naaman, in his article on "Networking Methods", where he stated:

> "The construction industry has always shown a great inertia to new developments, and consequently significant delays are observed between development and practical implementation. However, in order to be as productive as other industries, the construction industry will have to reduce the delays through a continuous and dynamic communication with the research progress."
>
> (Naaman, A.E.; 1979)

It is then my sincere hope, that this research report will open these communication channels, and encourage closer communication between the construction industry and the academic world.

Hence, the objective of my research is to provide answers to as many of the stated questions as possible. The report presents an overview of the construction industry as a whole, with detailed attention being given to the larger contractors. Therefore, in some areas a host of new questions were uncovered and as such, this report also provides a foundation for possible future research into other areas of the wide spectrum of scheduling.

CHAPTER 3

LITERATURE SURVEY

I. Introduction to Chapter

This chapter is divided into three main sub-sections; the first being this introduction, the second section giving a brief overview of the various scheduling techniques, and the third section representing the literature on industry based surveys, from the United States of America, Europe and South Africa respectively.

It should be noted, that there is by no means an abundance of literature pertaining specifically to surveys conducted on scheduling in the construction industry, although literature about scheduling in general is plentiful. This situation is best summed up in the following two quotes:

> "Despite the great popularity of PERT and CPM, the bulk of the literature on these subjects is either of a descriptive nature addressed to management level readers and the "informed layman", or of a highly technical and mathematical nature, directed to the systems and operations research analysts".
> (Aras, R.M. & Surkis, J.; 1979)

> "Despite the tremendous interest in network methods during the past decade, there have been very few user-orientated studies".
> (Davis, E.W.; 1976)

However, the problem of probing industry's attitudes and feelings towards scheduling, has occasionally been addressed, and the results of these surveys are presented in the third sub-section of this chapter.

II. Overview of Scheduling Techniques

A) Prefatory Note

It is necessary to stress at the outset, that this sub-section is not a "how to" section, and the objectives of this section are purely to present an overview of the various, most established, scheduling techniques. If any person reading this research report should require more information on the techniques discussed herein, I recommend looking at any one of the relevant books in the Bibliography.

This section will detail five scheduling techniques, namely:

- Bar Chart
- Line of Balance (LoB)
- Critical Path Method (CPM)
- Program Evaluation and Review Techniques (PERT)
- Precedence Diagramming Method (PDM).

The history of each technique will be briefly reviewed, followed by a brief description of the technique. Any further points that may be of interest from the report point of view, will also be listed.

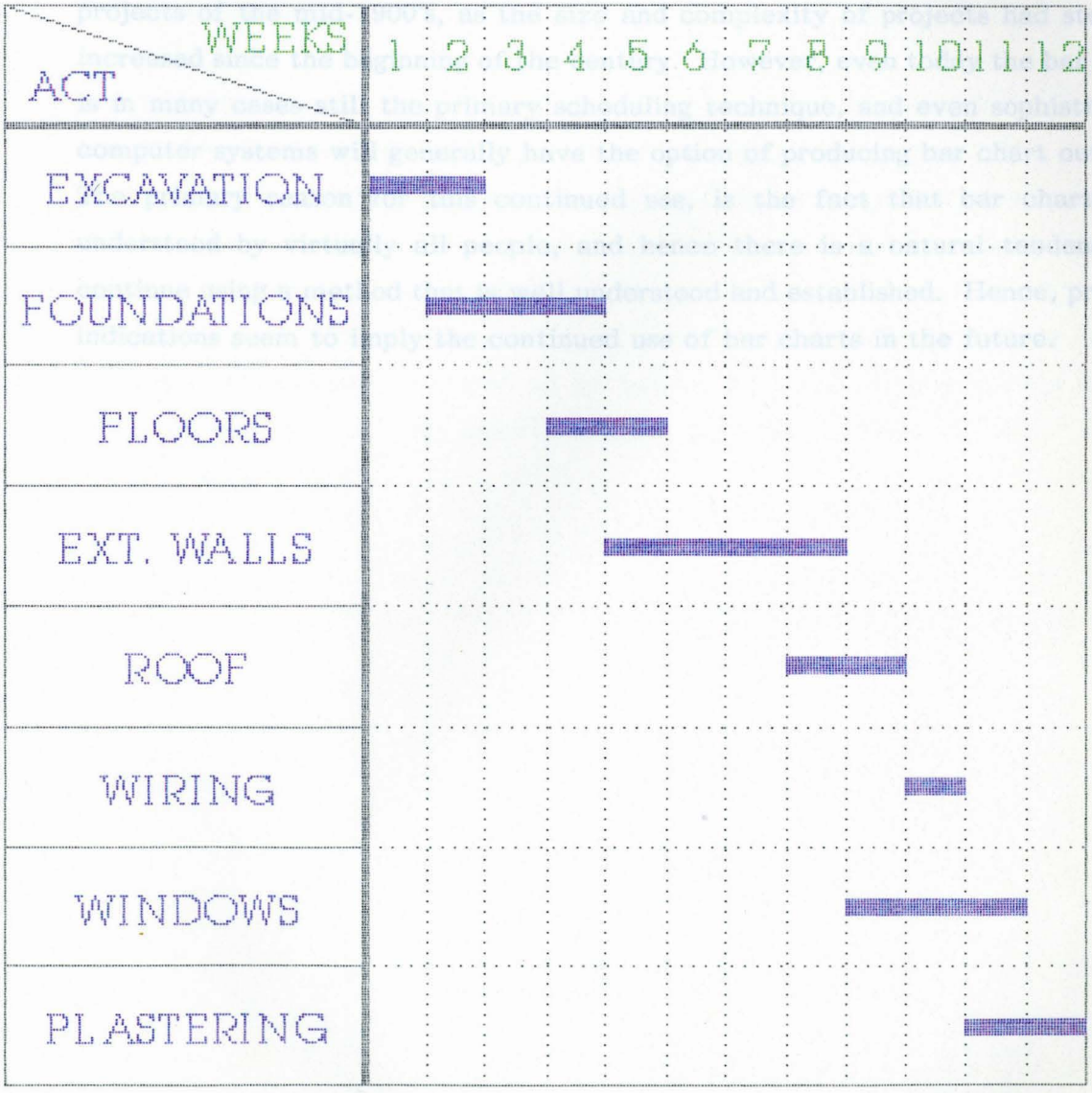
B) The Bar Chart (Gantt Chart)

The bar charts's origin can be traced to the period between the late 1800's and the early 1900's, and more specifically to a man named Henry Lawrence Gantt. Mr Gantt was associated with Frederick Winslow Taylor and Frank Bunker Gilbreth, who during this period worked on extensive studies to improve management. Mr Taylor went on to become known as the "Father of Scientific Management".
(Pilcher, R.; 1976)

However, returning to Mr Gantt, his primary contribution to management was the creation of the Bar Chart or Gantt Chart, as it is also known. The principals of the technique are in essence very simple. Activities required to complete a project are listed in a column on the left side of the chart. The items are listed in approximately the order required by the construction sequence. A time estimate is then made, with a bar presenting the time required on the horizontal time scale. This is very clearly illustrated in the example of a typical bar chart, as shown on the following page.

FIGURE 1

EXAMPLE OF BAR CHART



The technique has become firmly entrenched in management philosophy, due to its simplicity and ease of use.
(Lang, R.; 1982)

Possibly its largest drawback, is the fact that it does not show any interdependencies between the various activities. This is sometimes remedied by connecting the bars to one another by means of lines, showing this interdependence. However, on a large project with numerous activities, this procedure becomes difficult to use, due to the resulting lack of clarity. It is probably due to this factor, that the bar chart started to become unsuitable for projects of the mid-1900's, as the size and complexity of projects had steadily increased since the beginning of the century. However, even today the bar chart is in many cases still the primary scheduling technique, and even sophisticated computer systems will generally have the option of producing bar chart outputs. The primary reason for this continued use, is the fact that bar charts are understood by virtually all people, and hence there is a natural tendency to continue using a method that is well understood and established. Hence, present indications seem to imply the continued use of bar charts in the future.

C) Line of Balance (LoB)

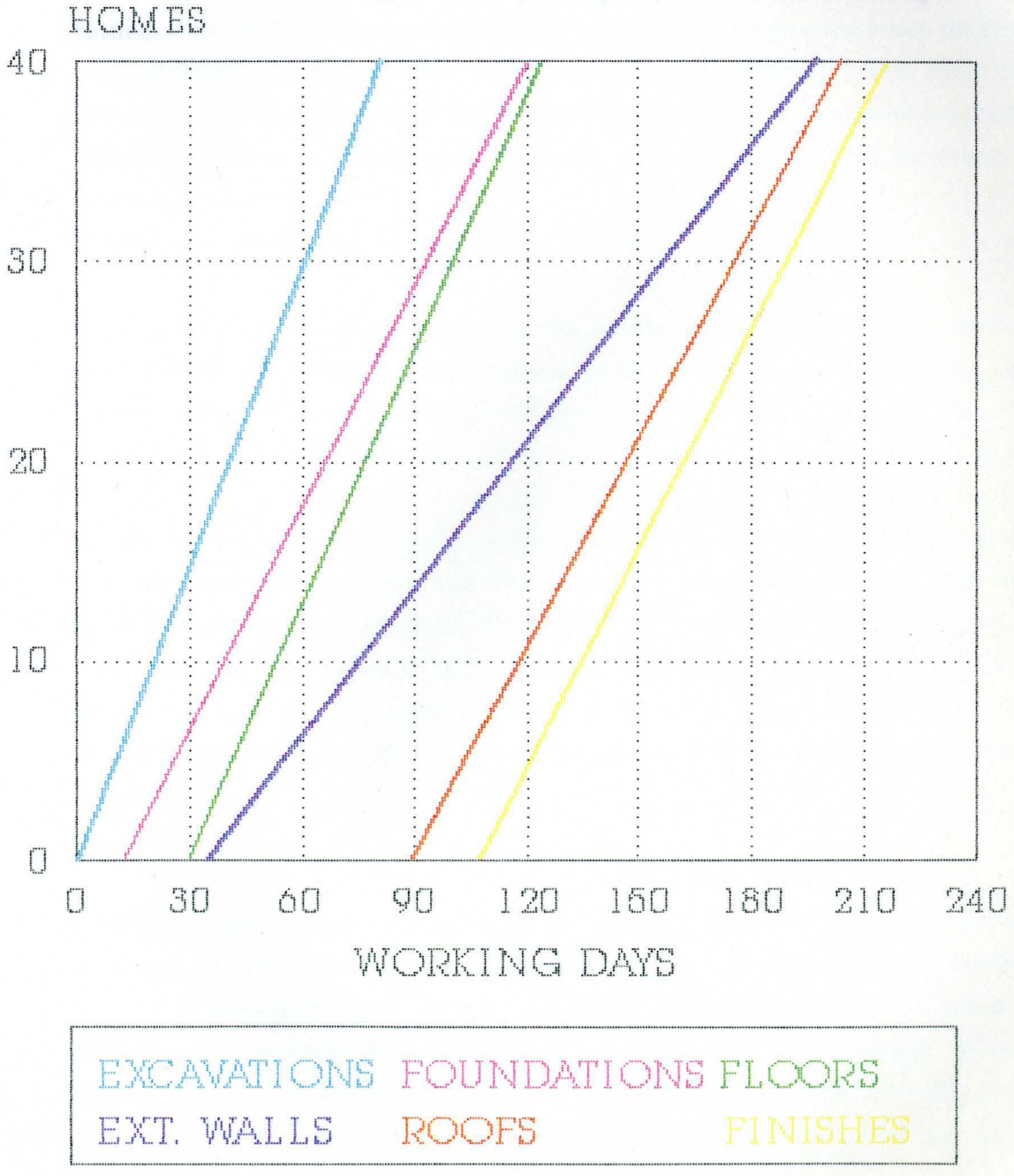
It should be noted, that this technique is sometimes also referred to as the Sloping Bar Chart. For the purposes of this report however, the method will be referred to as the Line of Balance method, this being its original name.

The LoB method had its origins at the Goodyear Company in the early 1940's, and was developed into a fully operational scheduling technique by the United States Navy in 1942.
(Arditi, D. & Albulak, M.Z.; 1979)
(Turban, E.; 1976)

The technique consists primarily of an activity list located horizontally along the top of the chart, with a time scale being placed along the bottom. The duration of the activities are then presented by sloping lines, the slope being dependant on the duration. The right or left hand vertical axis is labelled with the number of the repetitive tasks being undertaken. This repetitive task could be the number of floors in a building, the stretch of road being constructed, or as in our example, the number of houses to be built. In the example provided on the following page, the activity descriptions are provided by means of colour coding with the actual bars.

FIGURE 2

EXAMPLE OF LINE OF BALANCE (LoB)



The advantage of this technique, is that it shows the interdependencies between activities. The use of this method in the construction industry was generally only encountered in highly repetitive contracts, such as road construction or mass housing projects.
(Zarr, R.I. & Meyer, W.L.; 1979)

The future of this technique appears to be limited to that of repetitive tasks. It is possible, however, that if an effective computer based method of producing the schedule were introduced, it would possibly expand the use of the system in the future.

D) Critical Path Method (CPM)

The earliest form of the network based scheduling system, was a system known as the Harmonygraph. It was developed and published in 1931 by a Polish scientist named Karol Adamieski. The system was very simple and exhibited numerous networking advantages. However, the method never really caught on and is today buried in obscurity.

(Moder, J.J; Phillips, C.R. & Davis, E.W.; 1983)

In 1957, the Du Pont company faced problems of time overruns when performing routine overhauls, maintenance, shutdowns and construction work on their plants. Together with the Remington Rand UNIVAC group, work began on a scheduling system that was to incorporate both the planning and control functions of a project.

(Popescu, C. & Borcherding, J.D.; 1979)

An excellent detailed description of the development process of the method, is available by the two people attributed as the founders of the system, namely Mr J.E. Kelley (Jnr) and Mr M.R. Walker.

(Kelley, J.E. (Jnr) & Walker, M.R.; 1976)

By late 1958 and early 1959, the system had progressed to the testing stage. Du Pont implemented the method at their Louisville plant in an attempt to minimize downtime during maintenance. The initial schedule produced at the plant, cut downtime from 125 hours to 93 hours. On revising the schedule and attempting different scenarios, downtime was finally cut to 78 hours. With this initial test of the CPM procedure, and its subsequent success, the method was set to be used in industry.

(Levy, F.R.; Thompson, G.L. & Wiest, J.D.; 1976)

CPM was initially very well received by industry. However, there was an initial tendency, by overenthusiastic sales personnel, to oversell CPM as a method to cure all of managements problems. After the initial successes, the method went through a slump, during which time CPM's shortcomings were realized. After this slump, peoples' attitudes matured, as both the advantages and the possible problem areas of the system were realized. From then on, the use of CPM steadily grew.

During the 1970's, a number of bastardized versions of CPM were launched. Most of these were based on the CPM principles, but incorporated new or revised ideas. These methods met with varying success.

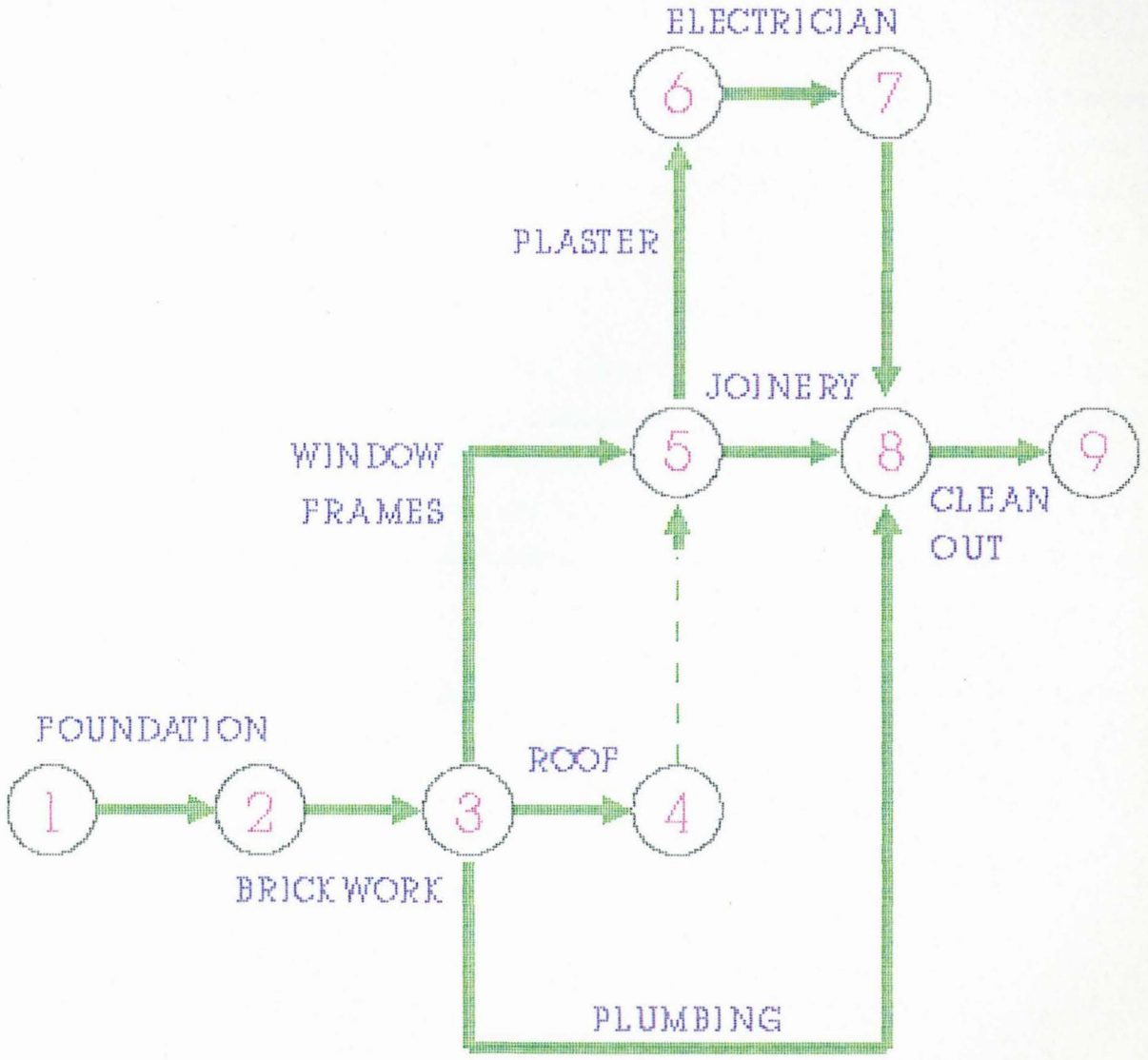
The advent of micro-computers at the outset of the 1980's, presented a new era for CPM, as the technique now became readily available in the form of user friendly software packages.

As with all new systems, CPM requires dedication from upper management, as well as a planned implementation phase. This is obviously true for the success of any scheduling system. However, often companies neglect this initial setup procedure, resulting in long term problems with the system. Hence, the more readily people accept the necessity for correct implementation and firm commitment, the greater the benefits of CPM, or any other scheduling technique will be.
(Diplock, C.; 1979)

The primary feature of the technique, is the presentation of all the activities of a project on a network. This network is essentially a flow chart, representing the order in which the activities have to be completed, in order to reach a final completion by a specified date. An example of a typical critical path network is shown on the following page.

FIGURE 3

EXAMPLE OF CRITICAL PATH METHOD (CPM)



As seen from the example, the flow chart indicates the interdependency of the various activities. Furthermore, the example also clearly shows the activity-on-arrow presentation. When actual time periods for the activities are added, the chart will also display the critical path. The critical path represents those activities which will cause an overall project delay, if they are delayed. CPM uses a deterministic approach to derive the time durations for the various activities. Hence, the time durations are defined in exact time periods.

E) Program, Evaluation and Review Techniques (PERT)

The historic development of PERT, very closely mimics that of CPM. The respective developments of CPM and PERT took place at about the same time, in parallel efforts.

In 1958, the Program Evaluation Branch of the Special Projects Office of the United States Navy, together with the consulting company of Booz, Allen and Hamilton, and the Lockheed Missile Systems Division, were directed to study and formulate improved methods for the planning and control of the development of the Fleet Ballistic Missile program, known as Polaris.
(Malcolm, D.G.; Roseboom, J.H. & Clark, C.E,; 1976)

A technique known as PERT was duly developed and used on the Polaris project. PERT has been widely credited for helping to shorten, by nearly two years, the original time estimate for the completion of the engineering and development phase of Polaris.
(Levy, F.K.; 1976)

From its inception and use on the Polaris project, PERT followed CPM through an initial period, where it was marketed as a super product. Its use flourished, until industry experienced problems with the technique, heralding a period of discontentment with the method. As soon as people realized the true nature of the system, with all its advantages and disadvantages, its popularity once again grew.

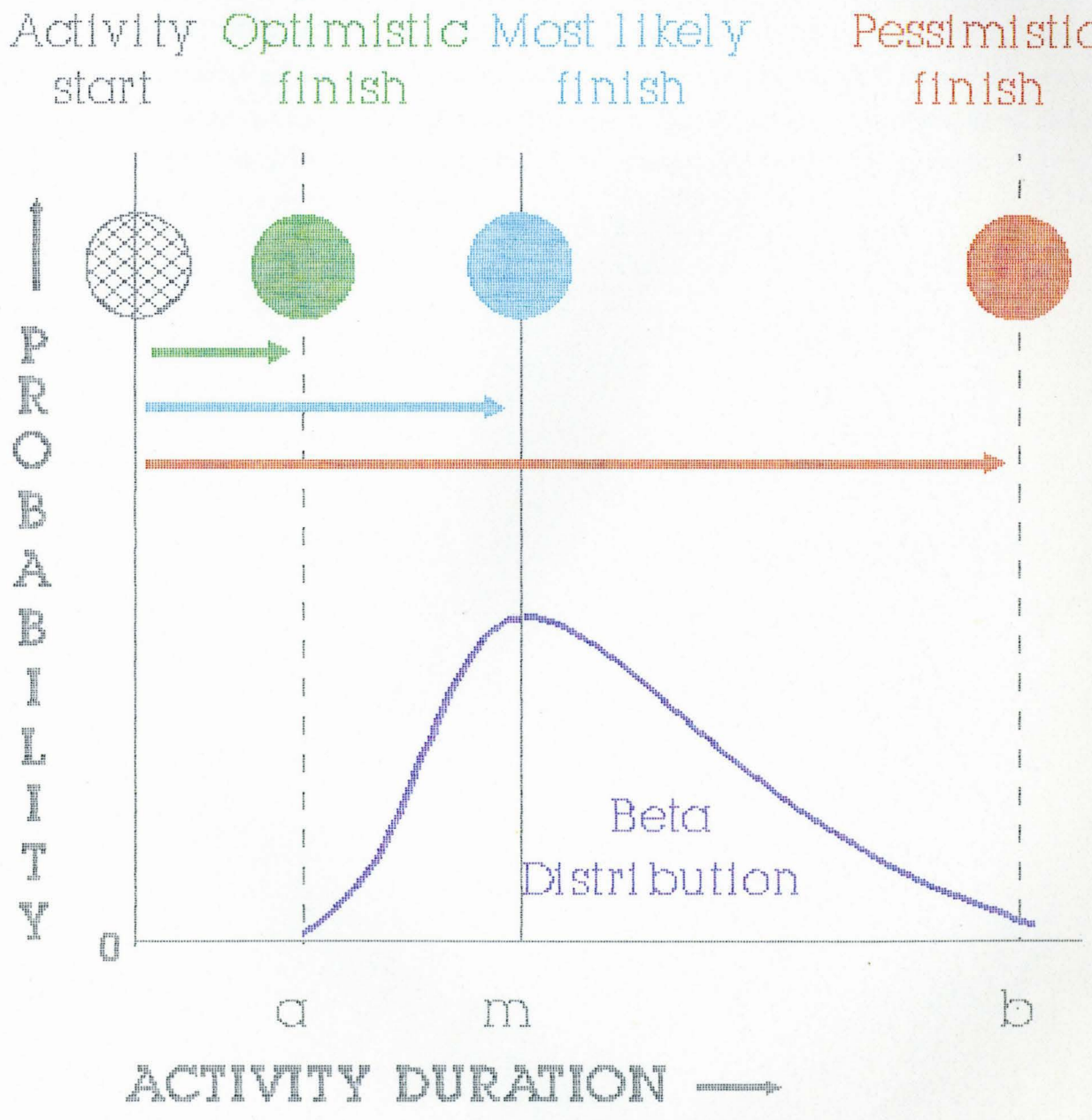
Numerous variations of the original concept have been developed. The initial ones, such as PERT/COST and PERT/TIME remained fairly faithful to the original PERT system. Later versions, such as GERT, became more complex and the capabilities of the system were increased.
(Taylor, B.W. (III) & Moore, L.J.; 1976)
(Decoster, D.T.; 1976)

The advent of mini and micro-computers, gave management a new perspective on PERT. The complex networks could now be produced by a computer printer and simulations of various scenarios for a project could be achieved, at virtually no extra cost.

The principles of PERT are very similar to those of CPM, and as such will not be repeated here, as they were presented under the section on CPM. It must however be stressed, that the primary difference between the two techniques, lies in their method of allocating time durations to activities. PERT, in contrast to CPM, uses a probabilistic distribution for activity durations, which causes three distinct durations to be allocated to each duration, namely a optimistic, pessimistic and realistic duration. This process is clearly illustrated in the figure on the following page.

FIGURE 4

DETERMINATION OF PERT ACTIVITY DURATIONS



This probabilistic determination of activity durations in the PERT schedules, makes them extremely useful in projects of a revolutionary nature; that is, projects that have never been attempted before and as such have a high "unknown" factor.

F) Precedence Diagramming Method (PDM)

I will keep my discussion on PDM as brief as possible, as the technique is nothing more than an extension of CPM/PERT.

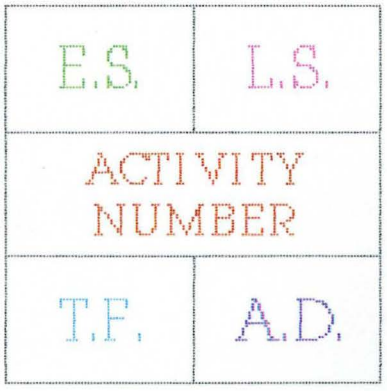
The term Precedence Diagramming first appeared in an IBM 1440 computer program, user manual.
(Moder, J.J; Phillips, C.R. & Davis, E.W.; 1983)

The major difference between CPM/PERT and PDM, is that the PDM network, functions on an activity-on-node basis, in contrast to CPM/PERT's activity-on-arrow. This allows computers to easily produce outputs, and due to this, the popularity of the technique has steadily increased in the last couple of years, in line with advances in computer hardware and software. An example of the two most readily used activity nodes, is presented on the following page.
(Wiest, J.D.; 1976)

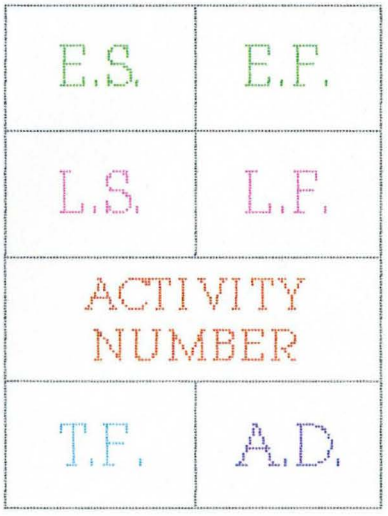
FIGURE 5

EXAMPLE OF PRECEDENCE ACTIVITY NODES

TYPE 1



TYPE 2



E.S. = EARLY START

E.F. = EARLY FINISH

L.S. = LATE START

L.F. = LATE FINISH

T.F. = TOTAL FLOAT

A.D. = ACTIVITY DURATION

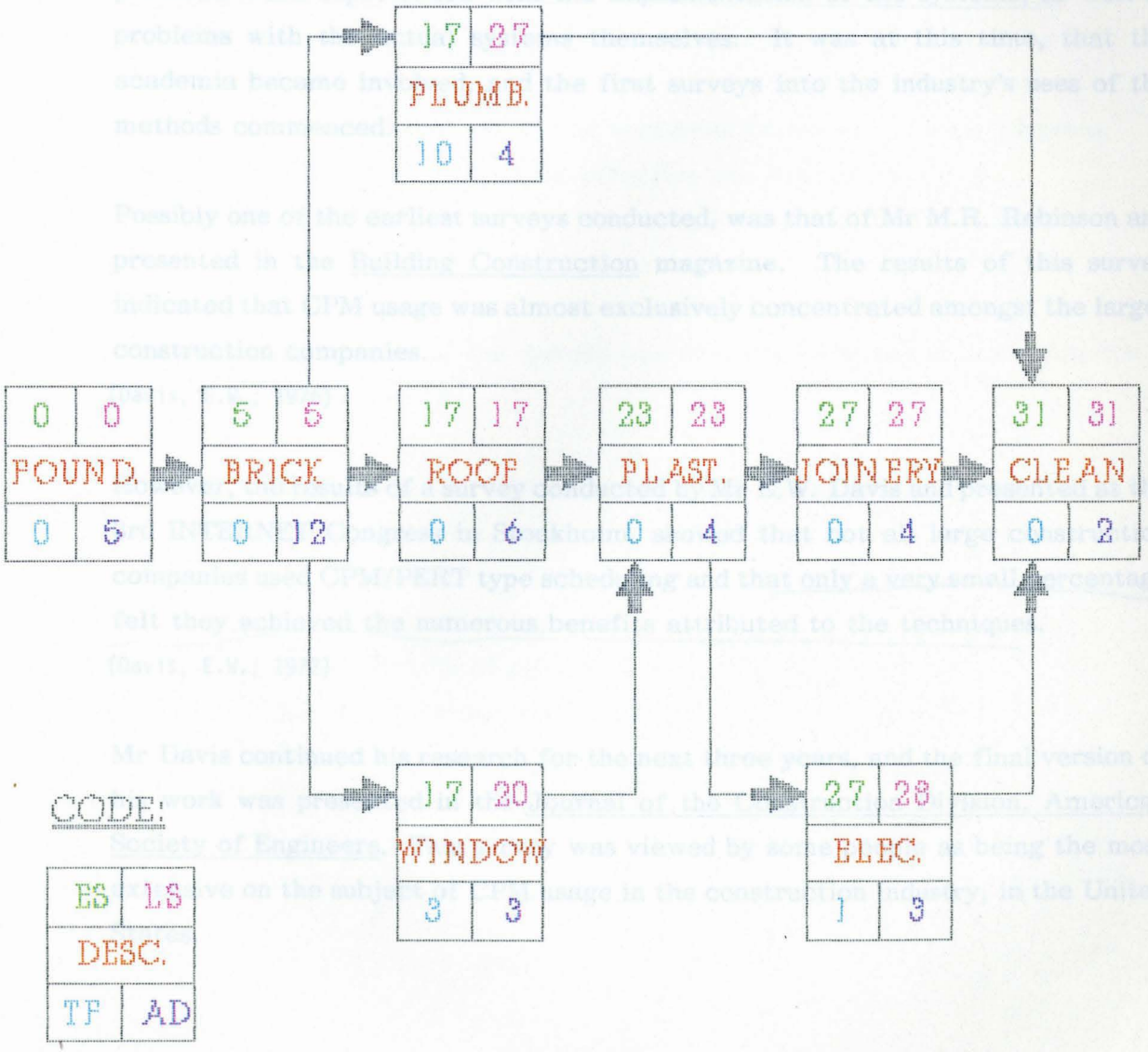
As can be seen from the previous figure, the node in a precedence network provides the user with numerous items of information. The difference between the two nodes, is purely the degree of information provided.

The other peculiarities of PDM, such as the added interdependencies of activities in the form of "Finish to Finish" and "Start to Start" relationships, as well as the lead-lag factors that may be introduced, are of no great relevance to my research and as such will not be discussed.

So that the reader may identify a precedence schedule, a typical example of a PDM is provided on the following page.

FIGURE 6

EXAMPLE OF PRECEDENCE DIAGRAMING METHOD (PDM)



III. Literature Pertaining to Survey Type Work Conducted in the Construction Industry

A) Literature from the United States of America

In the United States, the initial literature that was published on CPM/PERT type scheduling was all of a highly descriptive nature. By the early 1960's, the new scheduling techniques had found their way into the construction industry, but still the literature was very much of an educational nature.
(Arditi, D. & Koseoglu, H.; 1982)

By the late 1960's, the use of CPM/PERT type scheduling methods had become firmly entrenched in the construction industry. At the same time, the first problems were experienced with the implementation of the systems, as well as problems with the actual systems themselves. It was at this time, that the academia became involved, and the first surveys into the industry's uses of the methods commenced.

Possibly one of the earliest surveys conducted, was that of Mr M.R. Robinson and presented in the Building Construction magazine. The results of this survey indicated that CPM usage was almost exclusively concentrated amongst the larger construction companies.
(Davis, E.W.; 1976)

However, the results of a survey conducted by Mr E.W. Davis and presented at the 3rd INTERNET Congress in Stockholm, showed that not all large construction companies used CPM/PERT type scheduling and that only a very small percentage felt they achieved the numerous benefits attributed to the techniques.
(Davis, E.W.; 1972)

Mr Davis continued his research for the next three years, and the final version of his work was presented in the Journal of the Construction Division, American Society of Engineers. This survey was viewed by some people as being the most extensive on the subject of CPM usage in the construction industry, in the United States.

Mr Davis' survey was conducted into 235 of the top 400 construction companies, by means of both postal questionnaires and personal interviews. The results of the survey were numerous, and only the most important results have been quoted below, in point form:
(Davis, E.W.; 1976)

- About 80% of the companies sampled were using CPM-type systems.

- The schedules were used significantly more for planning than for control.

- 88,7% used the schedules at project or site manager level, with 40% using them as high up as upper management.

- Management concerns about CPM-type scheduling were as follows:

  i) The efficient use of the schedules produced, was questionable;
  ii) The time required for effective use was very high;
  iii) The input/output was too complex and often too much paper was generated.

- Evaluating success of the system was almost impossible to ascertain, due to its' subjective nature.

- The reasons given for the success of the system were attributed to the following five factors in order of importance:

  i) Good computer programs
  ii) Good training of personnel
  iii) Good top management support
  iv) Interest shown by people using the system
  v) Other diversified reasons

The following two comments made by the respondents at the time were also very interesting:

- "CPM was oversold to the construction industry as a cure-all panacea and too many of us expected too much too soon; now we have a much better perspective of it and feel that we're just beginning to use it properly".

- "CPM is a very effective tool in our company for getting jobs completed on time in the most efficient manner. But it requires a lot of work and top management support. Most construction people we've seen who aren't benefitting from CPM don't really understand this - and they'll continue to find fault with its use".

The results of this survey are clearly of great interest to my research for comparative purposes. As such I will be referring to this survey at numerous times in later chapters.

B) The European Literature

To a large extent the European literature on scheduling, mirrors that of the United States. The major difference being, that the European literature seems to lag it's American counterpart by some 2 to 4 years. Hence, I will only discuss two particular articles under this section. The first being an article written by Mr D. Arditi and Mr H. Koseoglu and presented at the 7th INTERNET Congress in 1982. The research conducted by these two gentleman, revolved around a survey detailing the scheduling undertaken by large construction companies in Turkey. The second article was written by Dr D. Arditi and was presented at the joint PMI and INTERNET conference in 1981. This article researched the similarities between the Turkish and British construction industries; once again the survey only quizzed the large contractors in both countries. The reason for my particular interest in these specific articles, was that my own survey was modeled, to some extent on these two surveys. Hence, it was my intention to elicit comparisons between these surveys and my own.

The surveys were conducted by means of two sets of questionnaires. The first set was directed at head office planners, while the second was addressed to site agents.

Once again, the survey results were very extensive, and only the major findings are cited in point form below. It should be noted, that only the findings applying to both Turkey and the United Kingdom, have been listed.
(Arditi, D. & Koseoglu, H.; 1982)
(Arditi, D.; 1981)

- 35% of Turkish companies used network-type scheduling, and 70% of British contractors used network-type scheduling.

- In Turkey, no companies made use of precedence diagramming systems, whereas in Britain 37% of the companies used PDM.

- 63% of companies in Turkey used a bar chart method, and in the U.K., 67% used bar charts's.

- 57% of Turkish contractors used computers to schedule, whereas only 38% of British contractors used computer aided scheduling.

- In both countries, head office planners felt it very difficult to make computer printouts legible to site staff. This attitude was backed by the site staff respondents, who indicated that computer printouts were difficult to read, took too much time and that they were ultimately unnecessary.

- In Turkey, all companies surveyed stated that a central planning department was used for planning. 57% of the site staff voiced irritation at this setup. A similar situation seemed to prevail in the U.K., although no figures were provided.

- In both Turkey and the U.K., no provisions were made within the companies for the education of the personnel in networking techniques.

C) The South African Literature

After extensively searching through the South African literature, no evidence of past surveys or research into the scheduling undertaken by the South African construction industry could be found. As such, this report represents the first step in filling a gap in the presently available body of knowledge.

In order to compensate for the lack of South African literature and to allow for a comparative analysis, considerable use of the United States, Turkish and British surveys, as outlined in the previous sections, has been made in the concluding chapters.

CHAPTER 4

ANALYSIS OF POSTAL SURVEY

I. Introduction to Chapter

As stated previously, the first objective of my research, was to achieve an overview of the scheduling undertaken by the construction industry in South Africa. On considering the large number of companies in the construction industry, it became apparent that a survey of all these companies could only be accomplished by means of a postal questionnaire. Hence, this is the route that was chosen.

The first and foremost problem of the postal survey, was a question of the availability of postal addresses for the various construction companies nationwide. After some deliberation, the various branches of the M.B.A., as well as the S.A.F.C.E.C. Head Office, were approached. These organizations were very obliging in providing me with copies of their membership rolls.

After an initial perusing of these membership rolls, a total of approximately 1700 building contractors and 280 civil engineering contractors were counted. From these figures, it was obvious that a very large number of contractors are operating in South Africa, and that it would have been unreasonable to approach all these contractors. Furthermore, it was also assumed that a large number of these contractors would be "small" companies. Hence, in order to shrink these numbers to more acceptable levels and so as not to approach an excessive number of smaller contractors, but still maintaining a representative sample, a selection criteria had to be established.

It was decided to attempt the inclusion of all civil engineering contractors, but to limit building contractors to those registered as "Limited", "Proprietary Limited" or "Close Corporation". This criteria was chosen, as it was felt that very small contractors would not fall into any one of these categories, and hence would not bias the results towards the smaller contractors. Ultimately, the selection criterion proved to be successful, as it resulted in only 1029 of the initial 2000 contractors being approached in the survey.

A mailing list was then extracted and transferred to a computer database. During this period, a suitable questionnaire was also compiled (a copy of which is depicted in Appendix "A" on page 159).

The next step, was to photostat the required copies of the questionnaire and covering letter. Once this was completed, self-addressed envelopes were produced, and together with the covering letter and questionnaire, these were sent to the various contractors throughout the country. The letters were addressed to the "Project Director". This ensured that nearly all the returned questionnaires were completed by upper management, and in some cases even as high up as the Managing Director.

The final count of letters mailed, was 767 questionnaires to M.B.A. members, and 262 questionnaires to S.A.F.C.E.C. members. The fact that almost three times as many building contractors as Civil Engineers were addressed, stems from the situation that far more building contractors are operative, as evidenced by the numbers presented on the preceding page.

Approximately two months after the mailing of the original letters, the returns had reached 31% of the total amount mailed. At this point, it was decided that a return level in excess of 40% might be achieved, if reminders were sent to the companies who had not yet replied. Furthermore, the returns from the Civil Engineering contractors had been slow, and it was hoped that a reminder would prompt further returns. With these two objectives in mind, a new covering letter was compiled (see Appendix "B" on page 166). A further batch of questionnaires were photostatted with distinctive markings on them, so as to identify them as follow-up questionnaires. Hence, a total of 180 reminders were posted to 150 civil contractors and 30 building contractors. The reason for only approaching 30 building contractors, was that the returns for builders were already sufficient to represent an overview of the building industry. The 30 builders that were approached, all appeared to be very large contractors, and it was hoped that they might still reply; in so doing, aiding the second phase of the report.

After a further four months, the database containing the results of all the returns, was finally closed. The returns from the original mailing totalled 343 or 35,4% and the returns from the follow-up totalled 53 or 29,4%. This then equated to a total return of 40,5%. The response from the M.B.A. members was 31,2% and from the S.A.F.C.E.C. members 60%. The significantly higher S.A.F.C.E.C. return figure, can probably be attributed to the fact that S.A.F.C.E.C., as a co-ordinating organization for civil contractors, mailed the questionnaires directly to their members, as well as giving the survey a mention in their monthly magazine.

Of the final return figure of 417, 93% were used for the analysis. The remaining 7% were made up of duplicate returns, return to senders, incomplete questionnaires and blank questionnaires. Hence, it is the analysis of the remaining 369 useable questionnaires, that is presented in the following sub-sections.

II. Overview of the Questionnaire

This section will detail, as briefly as possible, the objectives of the questionnaire. A detailed discussion, referring to the reasons for the inclusion and the desired objectives of each question, will be presented together with the analysis of each question, in the next sub-section.

The primary objective of the questionnaire, was to obtain as much detail as possible about scheduling in the construction industry. This objective, however, conflicted with the known fact, that long questionnaires almost invariably have a low return level. Hence, considering that the questionnaire was to represent a first phase, wide spectrum overview of the industry, and ultimately lead to the detailed second phase, it was decided to opt for a questionnaire of approximately 10 questions, comprising both multiple choice and detailed questions. The final product turned out to contain 12 questions, of which 10 were multiple choice and the remaining two requiring detailed answers. It was estimated that the questionnaire could be completed in 5 to 10 minutes, provided that all the required information was at hand. Hence, it was decided that the questionnaire was short enough to be completed in a reasonable time, and long enough to provide an adequate overview of the industry.

The original covering letter accompanying the questionnaire was kept to a brief minimum, and primarily conveyed the objective of the questionnaire.

The follow-up letter was compiled on the same basis. It simply conveyed the fact that the returns had been good, and that it was hoped to further improve on the present return level.

The confidential nature of the questionnaire was stressed throughout, and the request for names and position was purely used to provide identification of the relevant personnel, during the personal interviews.

III. Discussion of Survey Questions and Analysis of the Accumulated Data

A) Introductory Note

This sub-section primarily presents the analysis of the data collected from the postal survey, but also provides a brief overview of the reasons for including the relevant questions, and the desired objectives of each question. The original question have been reproduced at the beginning of each section using a different type face, so as to circumvent the necessity of the reader continually having to turn to Appendix "A" while reading. The results for each question will be presented individually. A final concluding overview of the results is given in sub-section IV of this chapter.

In the graphical presentations, each graph presents three distinct results; the data for building contractors only, the data for the civil engineering contractors only and a figure for the total construction industry. This "total" category shown, represents an industry total; that is to say that no distinction between building and civil engineering contractors is made in this category. It should also be noted that two distinct types of graphing techniques were employed.

- Firstly, the traditional Bar Graph was used.

- Secondly, a Trend Graph was produced. This was done by plotting the actual values and then placing an optimized curve through the points, to exhibit a trend with varying X-axis values.

Finally, when referring to the per annum turnover of the companies, mention is often made of the category of turnover. These categories mentioned are represented as follows:

- Category 1 ie. Less than R 1 Million pa
- Category 2 ie. R 1 Million - R 5 Million pa
- Category 3 ie. R 5 Million - R 20 Million pa
- Category 4 ie. R 20 Million - R 100 Million pa
- Category 5 ie. Greater than R 100 Million pa

B) Question 1

Type of company:

- Building ..... ☐
- Civil Engineering ..... ☐
- Both ..... ☐

If your answer to Question 1 is "Both", please specify preferred category of work:

- Building ..... ☐
- Civil Engineering ..... ☐

The reasoning behind this question was to try and establish a category distinction between building and civil engineering contractors. The objective of the question was to create a category base for the analysis of the data.

The results supplied by the respondents were as follows:

- Building - 189
- Civil Engineering - 90
- Both - 90.

The companies who indicated that they would approach both types of construction, voiced their preferences as follows:

- Building - 38
- Civil Engineering - 43
- Both - 9.

If one now adds these preferences, to the original building and civil engineering categories, the final split is as follows:

- Building	-	227	(61,5%)
- Civil Engineering	-	133	(36,0%)
- Both	-	9	(2,5%)

This result is in no way surprising when one considers that the number of building construction projects are normally more numerous than civil engineering projects, and that the number of "small" building contractors in operation, also exceeds the number of "small" civil contractors. That is to say, the building contractor community is made up of a large number of smaller contractors, with only a few large ones, whereas the civil engineering community is composed of the reverse. This fact will be further emphasized when viewing the results of the turnover category question under Section (D).

C) Question 2

The company's preferred category of work, as well as other groups of work also accepted.
(eg. Roads, Industrial Building, Housing, Earthworks,Concreting, Platelaying, Pipelines, etc)

Preferred Work: _____

_____

Other Work Accepted: _____

_____

The objective of this question was to try and provide sub-categories within the building and civil disciplines. However, a mistake was made when no rigid categories were provided, and the category choice and definition were left to the discretion of the person completing the questionnaire. The result of this, was that the data collected was made up of a profusion of categories. A further problem was encountered, due to the fact that some companies placed themselves in a whole variety of finely detailed categories, whereas others saw themselves in one broad category only. As a result of these grey areas, with no clear categories being mentioned, it was decided to discard the data collected from this question. This decision in no way affected the analysis of the remaining questions, as the turnover question, as detailed in the following section, provided distinctive sub-categories into which the civil engineering and building contractors could be sub-divided. Furthermore, by scraping this question it was ensured that the practice of creative data manipulation was avoided.

D) Question 3

Approximate annual turnover:

- Less than R 1 Million ..... ☐
- R 1 Million - R 5 Million ..... ☐
- R 5 Million - R 20 Million ..... ☐
- R 20 Million - R100 Million ..... ☐
- Greater than R100 Million ..... ☐

The objective of this question was to provide sub-categories within the type of companies, as defined under Question 1. Furthermore, in the European and United States surveys, turnover as a means of defining the size of a company had always proved itself as being the most accurate.

The categories were chosen due to their appropriate representation of small; relatively small; medium; large and very large companies. It should be stated, that from a statistics point of view, the categories are unsatisfactory as they overlap and are not of an equal size. However, no satisfactory alternative for fitting turnovers ranging from a couple of thousand Rand per annum to a couple of hundred million Rand per annum, into five categories, could be found. The only alternative, would have been to ask companies to include their actual turnover figures, but it was decided that this would most likely not have been complied with, as that type of information is usually highly confidential.

The results from this question, as well as those of Question 1, were used extensively throughout the analysis of the data, to delineate categories against which the remaining questions were analyzed.

The overall results of this question are shown in Table 1 below.

TABLE 1

TURNOVER CATEGORY (RAND PER ANNUM)	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Category 1 Less than 1 million	49	13,3
Category 2 1 - 5 million	118	32,0
Category 3 5 - 20 million	101	27,4
Category 4 20 - 100 million	79	21,4
Category 5 Greater than 100 million	22	5,9

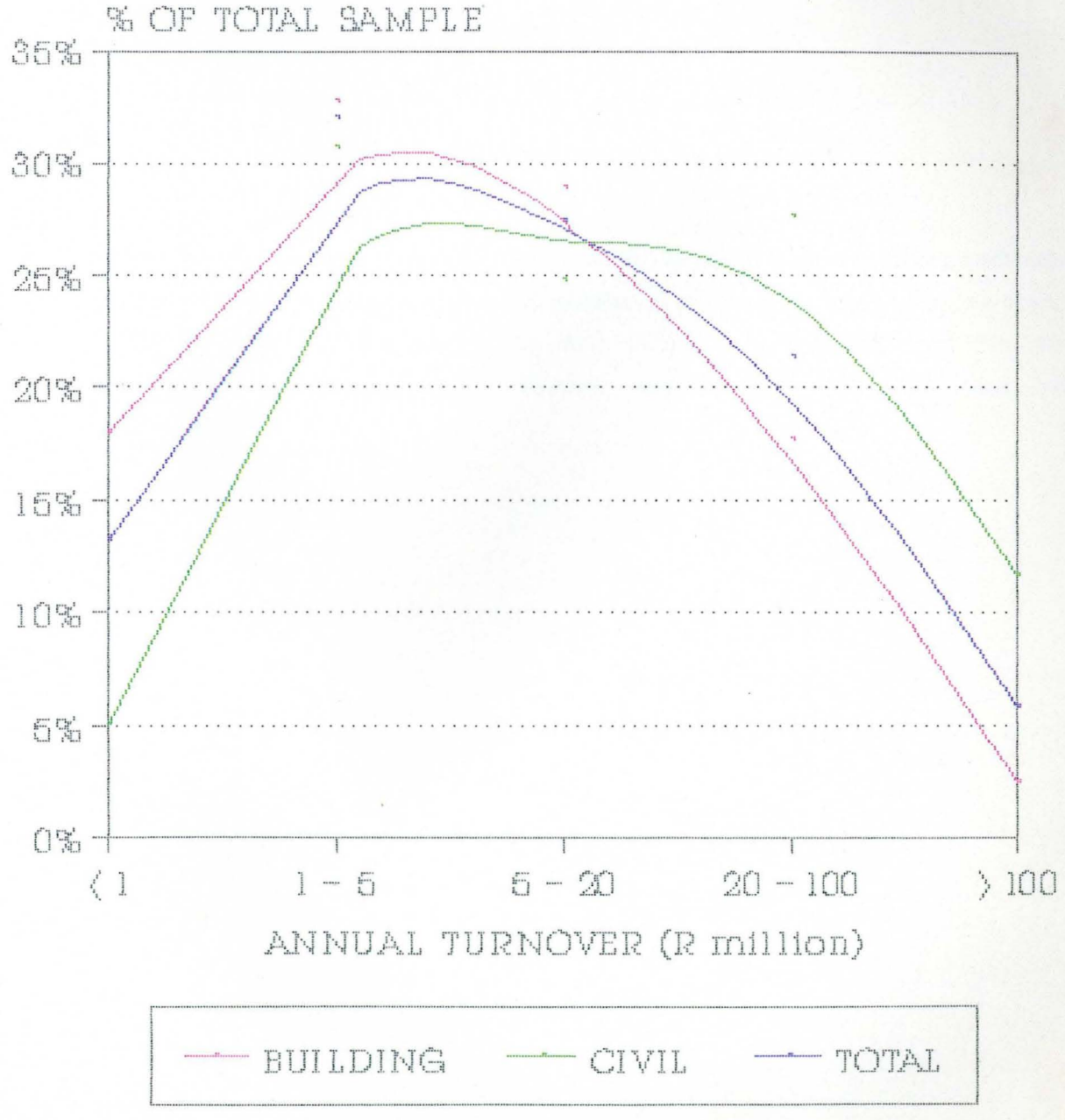
Number of respondents within each turnover category

This data was then split into building and civil contractors. The results of this split are shown in Graph 1 on the next page.

GRAPH 1

TREND PRESENTATION

TURNOVER TO TYPE OF COMPANY



From the foregoing graph, it became very clear that there were more civil engineering contractors within a turnover exceeding R20 million per annum, than there were building contractors within the same turnover category. This was by no means surprising, when one considers the nature of civil engineering work. Further confirmation of this was obtained through the calculation of the approximate mean building turnover, which resulted in a figure of approximately R20 million per annum, while on the other hand, the civil engineering mean turnover resulted in a figure of approximately R38 million per annum; nearly double that of the building figure.

E) Question 4

The company's usual role in projects:

- As Main Contractor ..... ☐
- As Sub-Contractor ..... ☐
- Joint Ventures ..... ☐
- As Project Managers ..... ☐
- Other (please specify) ..... ☐

_____

_____

It was hoped, that this question might reveal that different scheduling techniques would be used by the different categories of companies. However, as seen in Table 2 on the following page, the data fell so predominantly into the "main contractor" category, that no further computations with this data were undertaken.

TABLE 2

COMPANY USUAL ROLE IN PROJECTS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Main Contractors	345	93,5
Sub-Contractors	21	5,7
Joint Contractors	1	0,3
Project Managers	2	0,5
Other	0	0

Number of respondents within each project role category

F) Question 5

Scheduling technique used:

- Bar Chart (Gantt Chart) ..... ☐
- Critical Path Management (CPM) ..... ☐
- Precedence Network ..... ☐
- Program Evaluation & Revue Technique (PERT).. ☐
- Line of Balance ..... ☐
- None ..... ☐
- Other (please specify) ..... ☐

_____

_____

This question represented the primary question within the survey. The choice of techniques to be included in this question, were based on the most widespread and familiar techniques in use today. Once again the "Other" category was included, to make provision for any other techniques that may be in use.

The data collected from this question was distributed as shown in Table 3 on the following page:

TABLE 3

TYPE OF SCHEDULING TECHNIQUE USED	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Bar Chart (Gantt Chart)	318	55,2
Critical Path Method (CPM)	100	17,4
Precedence Diagramming Method (PDM)	64	11,1
Program Evaluation & Review Techniques (PERT)	37	6,4
Line of Balance (LoB)	28	4,9
None	21	3,7
Other	8	1,3

Number of respondents using each type of scheduling system

It must be noted, that the total number of respondents amounted to more than the 364 questionnaires used, due to the fact that numerous respondents used more than one type of scheduling technique.

Presenting this data in an alternative format:

- 55,2% of the respondents used bar charts
- 34,9% used a form of network scheduling
- 4,9% used the Line of Balance method.

The figures mentioned above, do not convey any details about the scheduling techniques used by the different categories of respondents. Hence, the remainder of this sub-section will be devoted to a detailed analysis of the use of each specific scheduling technique. More specifically, the use of each technique related to the type of company using that particular technique. An alternative graphical analysis is presented in Appendix "E" on pages 177 to 181, where each turnover category for the companies, is related to the type of scheduling executed within that category.

Commencing with the usage of bar charts, Graph 2 on the following page clearly shows the increased use of bar charts when approaching the R20 million per annum figure, and the gradual decline in bar chart usage after the R20 million per annum figure. The use of bar charts at lower turnovers was to be expected, as the technique is simple to use and performs adequately on smaller projects. The fairly low bar chart usage among Category 1 companies can be explained by viewing Graph 1A in Appendix "E" on page 177. From this graph, it can be seen that a very large number of respondents within this category, did not schedule at all. A further point of interest about bar chart usage, was that the usage peaks at about 70% usage with the R5 to R20 million per annum turnover category, and then falls sharply. This Category 3 turnover group, appears again at numerous times, as a natural dividing line.

GRAPH 2

TREND PRESENTATION

BAR CHART USAGE VS TURNOVER



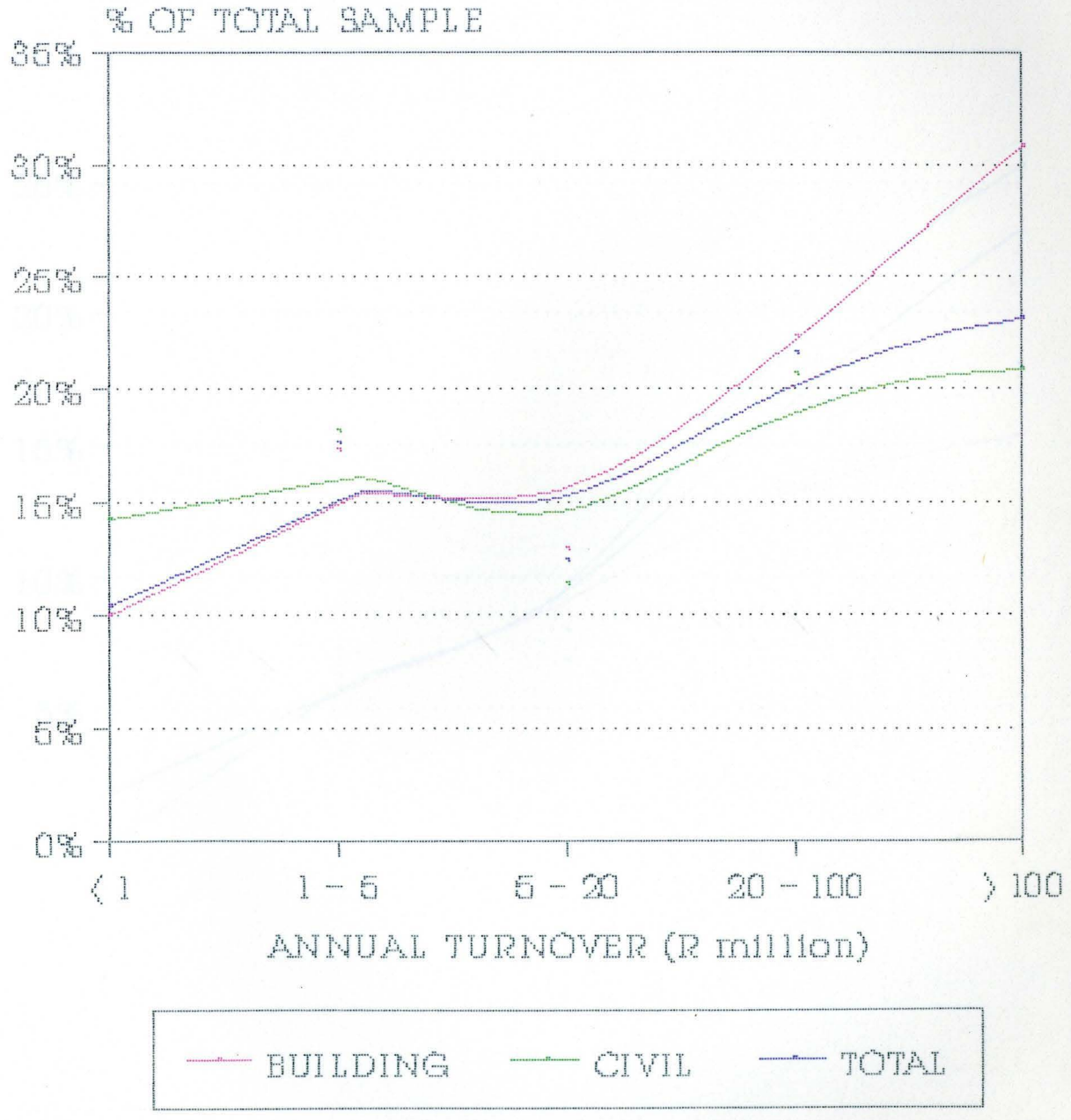
The final noteworthy point about bar chart usage, was the closeness with which the civil and building industries relied on bar charts, ie. there did not seem to be much difference between civil and building construction, when one looked at bar chart usage.

Moving on to the use of CPM, PERT and PDM. These three techniques will be reviewed together, due to their similarity and also due to the similarity in their usage patterns. Trend graph presentations of each of these three techniques are given on the following three pages.

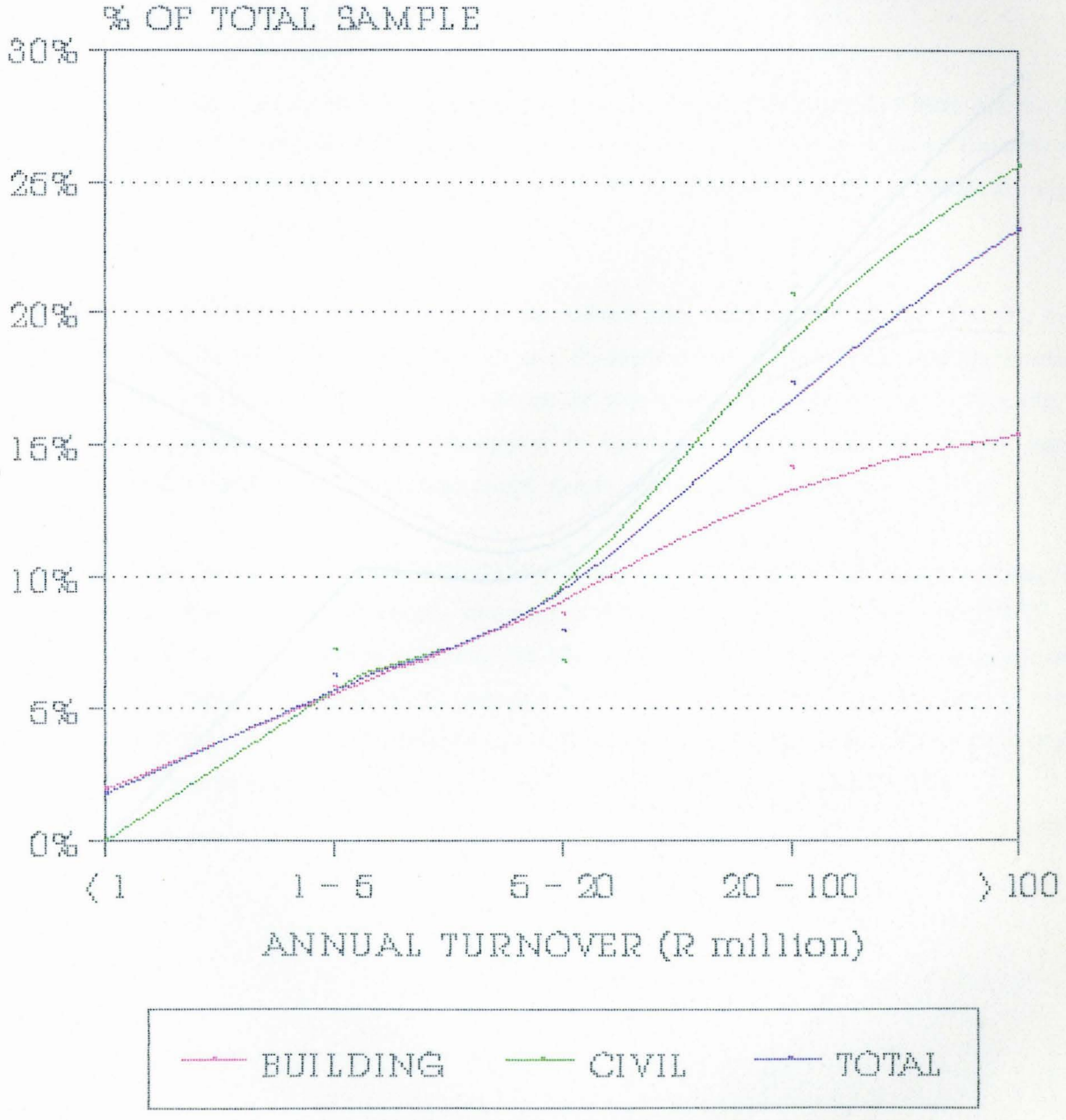
GRAPH 3

TREND PRESENTATION

CPM USAGE VS TURNOVER



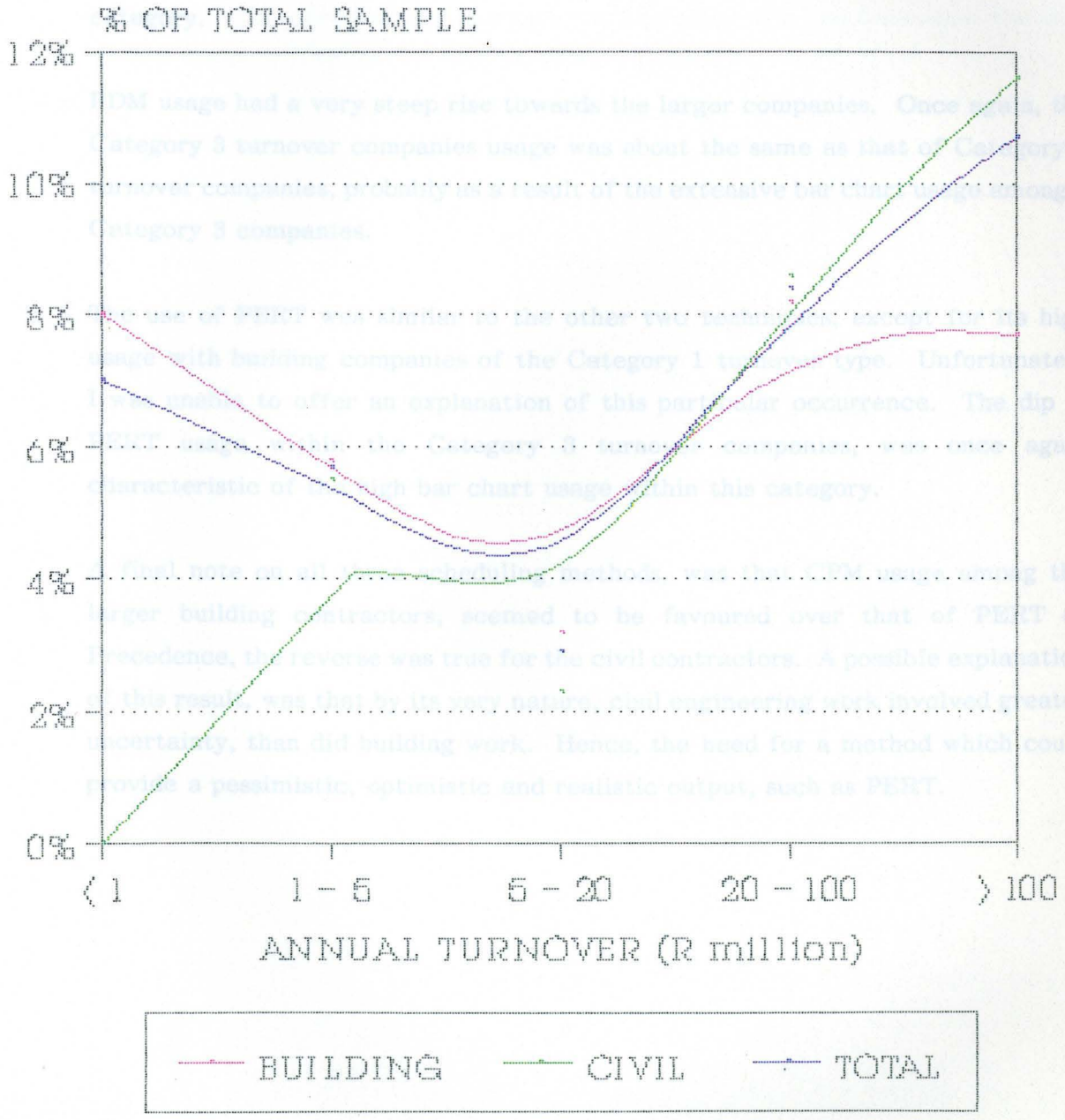
GRAPH 4
TREND PRESENTATION
PDM USAGE VS TURNOVER



GRAPH 5

TREND PRESENTATION

PERT USAGE VS TURNOVER



The similarity between the usage patterns of these three techniques, is apparent when viewing the graphs. All three techniques have fairly low usage up until the end of the Category 3 companies. That is to say, above R20 million per annum turnover the three techniques are used more frequently.

Viewing CPM usage more specifically. It enjoyed a fairly widespread use among the smaller companies, and its upward sloping line towards the larger companies, was not quite as steep as the other two techniques. The drop in CPM usage in Category 3 companies can be attributed to the high bar chart usage within this category.

PDM usage had a very steep rise towards the larger companies. Once again, the Category 3 turnover companies usage was about the same as that of Category 2 turnover companies, probably as a result of the extensive bar chart usage amongst Category 3 companies.

The use of PERT was similar to the other two techniques, except for its high usage with building companies of the Category 1 turnover type. Unfortunately I was unable to offer an explanation of this particular occurrence. The dip in PERT usage within the Category 3 turnover companies, was once again characteristic of the high bar chart usage within this category.

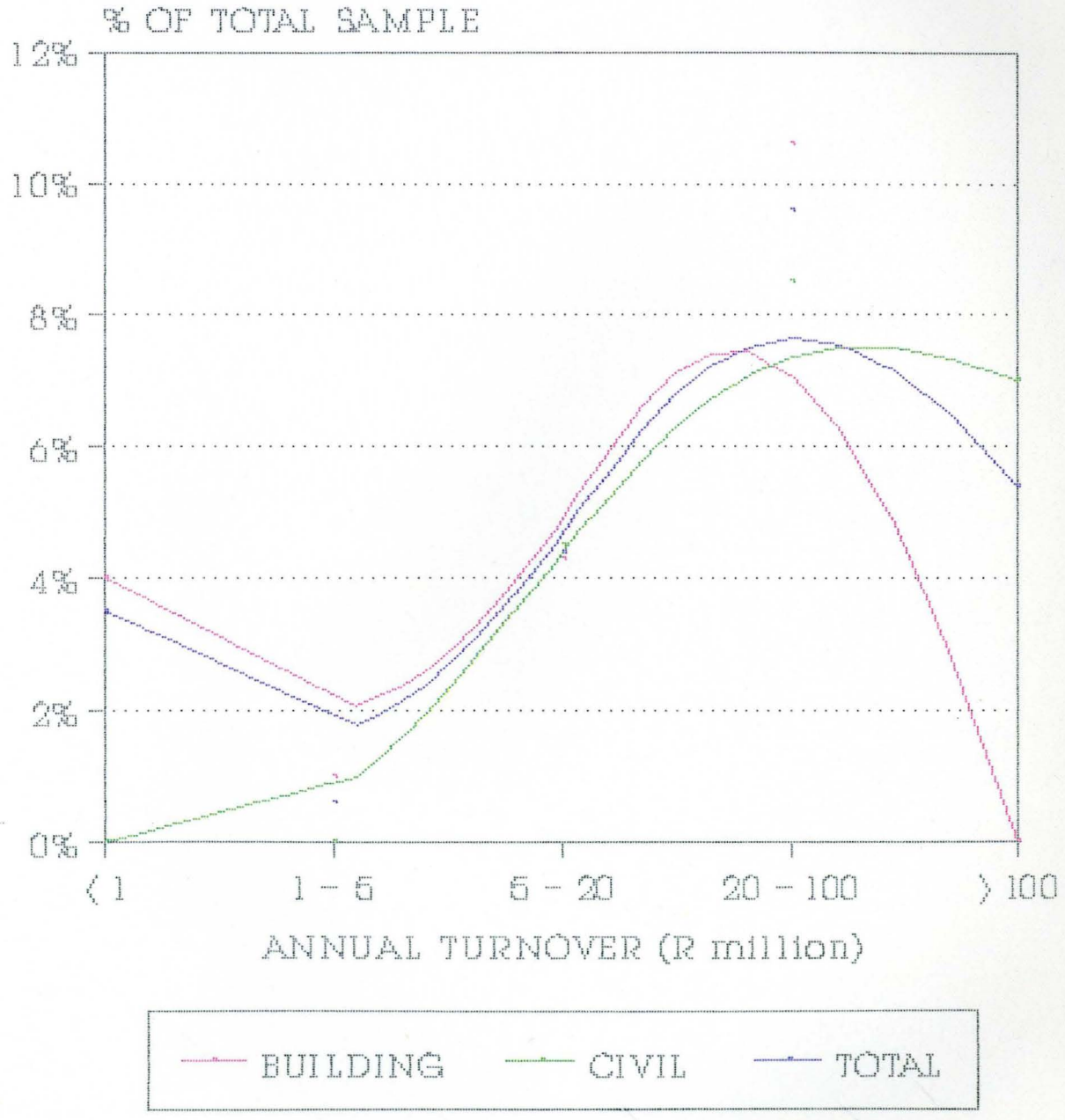
A final note on all three scheduling methods, was that CPM usage among the larger building contractors, seemed to be favoured over that of PERT or Precedence, the reverse was true for the civil contractors. A possible explanation of this result, was that by its very nature, civil engineering work involved greater uncertainty, than did building work. Hence, the need for a method which could provide a pessimistic, optimistic and realistic output, such as PERT.

Graph 6, on the following page, depicts the use of LoB. It was interesting to note that the building contractors seemed to use this technique occasionally, except in the case of very large companies. The civil contractors on the other hand, seemed to use LoB primarily in the larger companies. This phenomenon could probably be attributed to the fact that LoB was primarily suited to highly repetitive work, such as Road, Canal or Rail building. All of these activities being civil engineering in nature. The technique can also be used in building contracts, on high rise developments, but the data seemed to suggest that the very large companies did not employ this method at all. However, the peak in Category 4 turnover building contractors, suggested that the technique was used within these companies for certain types of repetitive work.

GRAPH 6

TREND PRESENTATION

LINE OF BALANCE USAGE VS TURNOVER



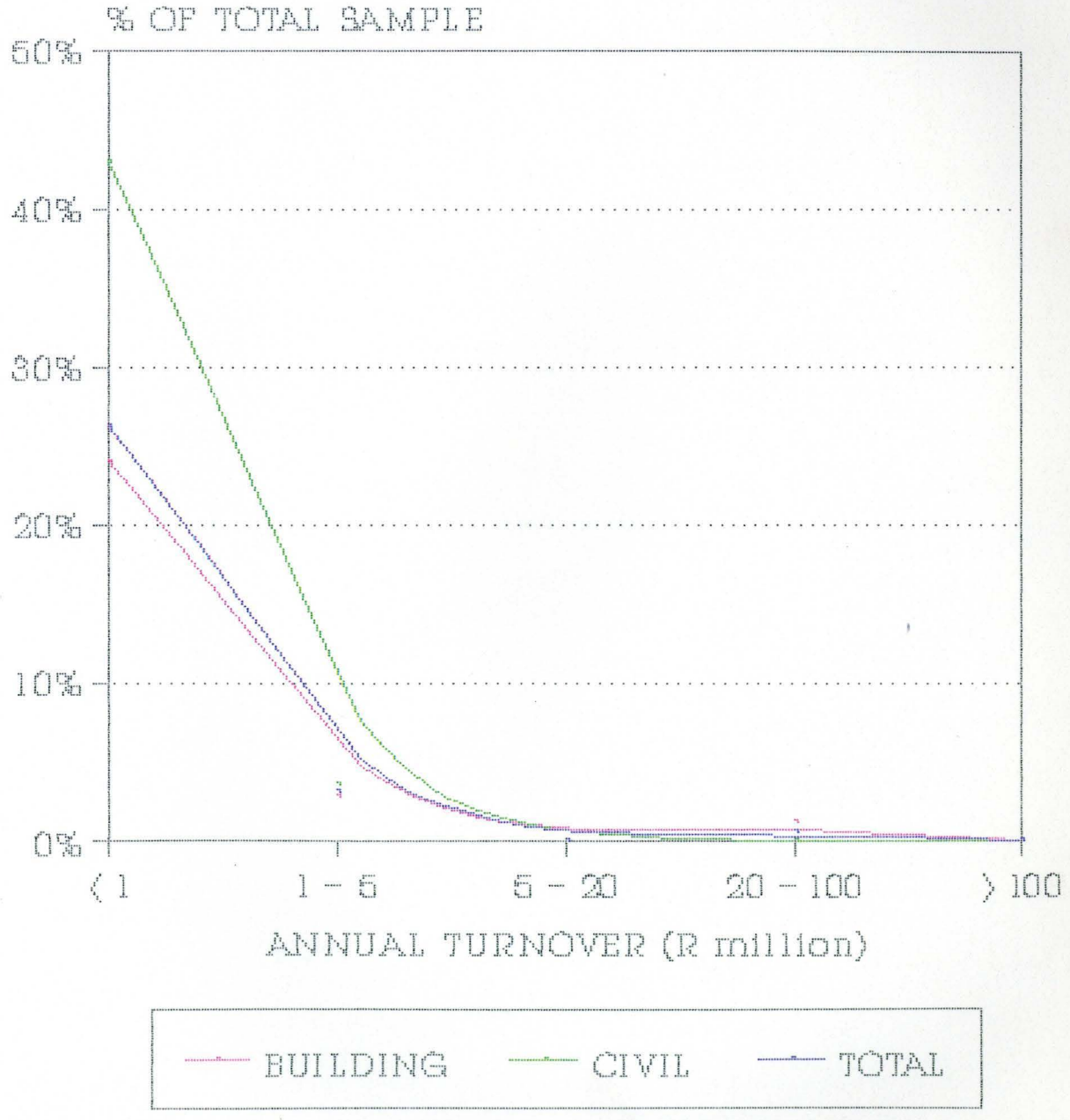
The occurrence of no scheduling being undertaken, is shown in Graph 7 on the following page. The graph speaks for itself, and it was very clear that virtually all companies having above R5 million per annum turnover, did some kind of scheduling. The only other point that can be made about the contractors who did not schedule, was that they have obviously never heard of the following maxim:

"By failing to schedule, you are scheduling to fail."
(Source unknown)

GRAPH 7

TREND PRESENTATION

NO SCHEDULING DONE VS TURNOVER

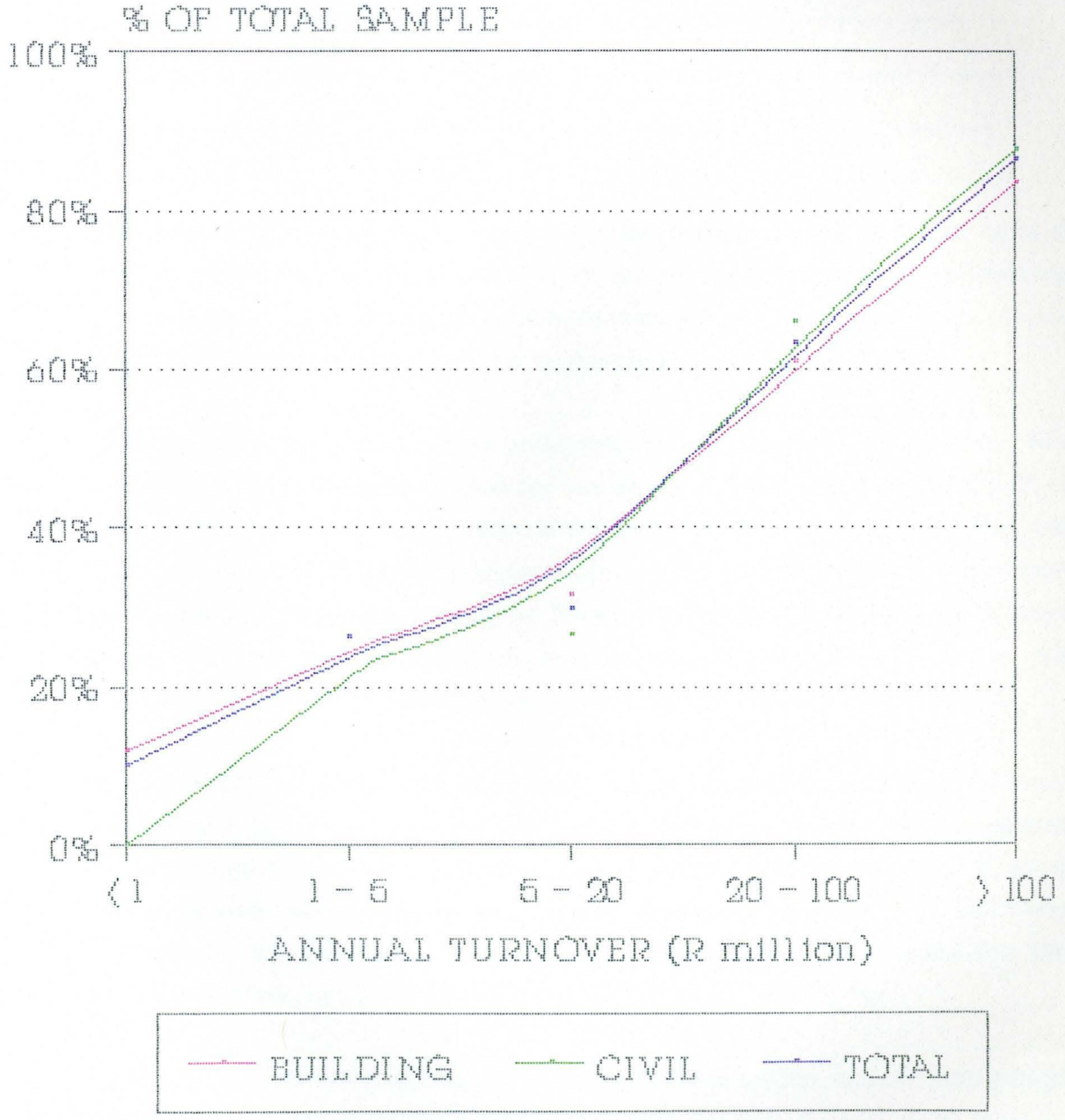


The final graph presented under this section, is Graph 8, shown on the next page. This graph shows the occurrence of more than one scheduling technique being used by a company. Once again the graph is self-explanatory, and it was very obvious that more than one method of scheduling was used as the size of the company increased. The Category 3 turnover companies seemed to indicate a natural divide, once again.

GRAPH 8

TREND PRESENTATION

MULTIPLE SCHEDULING DONE VS TURNOVER



Finally, should any person require more clarity about what type of scheduling can be expected from companies within each turnover category, they should view the graphs presented in Appendix "E", on pages 177 to 181. These graphs should provide a very clear picture of the increased number of network-type methods used by the larger companies.

G) Question 6

For approximately how long has the present technique been used?

_____

If a previous technique was in use, please stipulate the technique, as well as the approximate time span it was used for.

_____

_____

_____

The purpose of this question, was to try and determine the length of time the present scheduling technique had been in use within the company. Furthermore, it was hoped that if previous techniques were in use, that some form of trend could be established between older techniques and newer methods.

Unfortunately, the actual results collected, did not provide many answers. When calculating the mean usage period for bar charts, CPM, PDM, PERT and LoB, the time period for all of these methods fell between 12 and 14 years. The mean time period for no scheduling undertaken, equated to 18 years. No conclusive reason for this phenomenon could be found. When viewing the data on an overall basis, the time periods specified ranged from 6 months to 25 years. One respondent even stated having never used a schedule in the past 40 years!

In answer to the question about previous scheduling techniques used, the results were very scarce as most people neglected to complete this part of the question. From the results that were obtained, no real pattern could be established, except for a number of companies who stated having tried CPM and PERT-type techniques, but returned to bar charts. Regrettably, no reasons for their experimentation, or their returning to the bar chart, were given.

Generally, this question did not provide any definite trends, and the only possible conclusion was that companies commenced with the use of a particular technique and, in general did not experiment with other systems thereafter.

H) Question 7

Current method employed for preparing the schedule:

- Manual ..... ☐
- Computer ..... ☐
- Both ..... ☐

If network is compiled by computer, please specify type of computer system and the software package used.

_____

_____

_____

The proposed aim of this question, was to try and determine to what extent computers had made inroads into scheduling. The query about the type of systems and software was included to establish whether or not the micro-computer has in fact replaced the mainframe, for preparing schedules.

The results of the first part of the question were as depicted in Table 4 on the following page.

TABLE 4

METHOD USED FOR PREPARING SCHEDULES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Only Manual	211	61,0
Only Computer	31	8,9
Computer & Manual	104	30,1

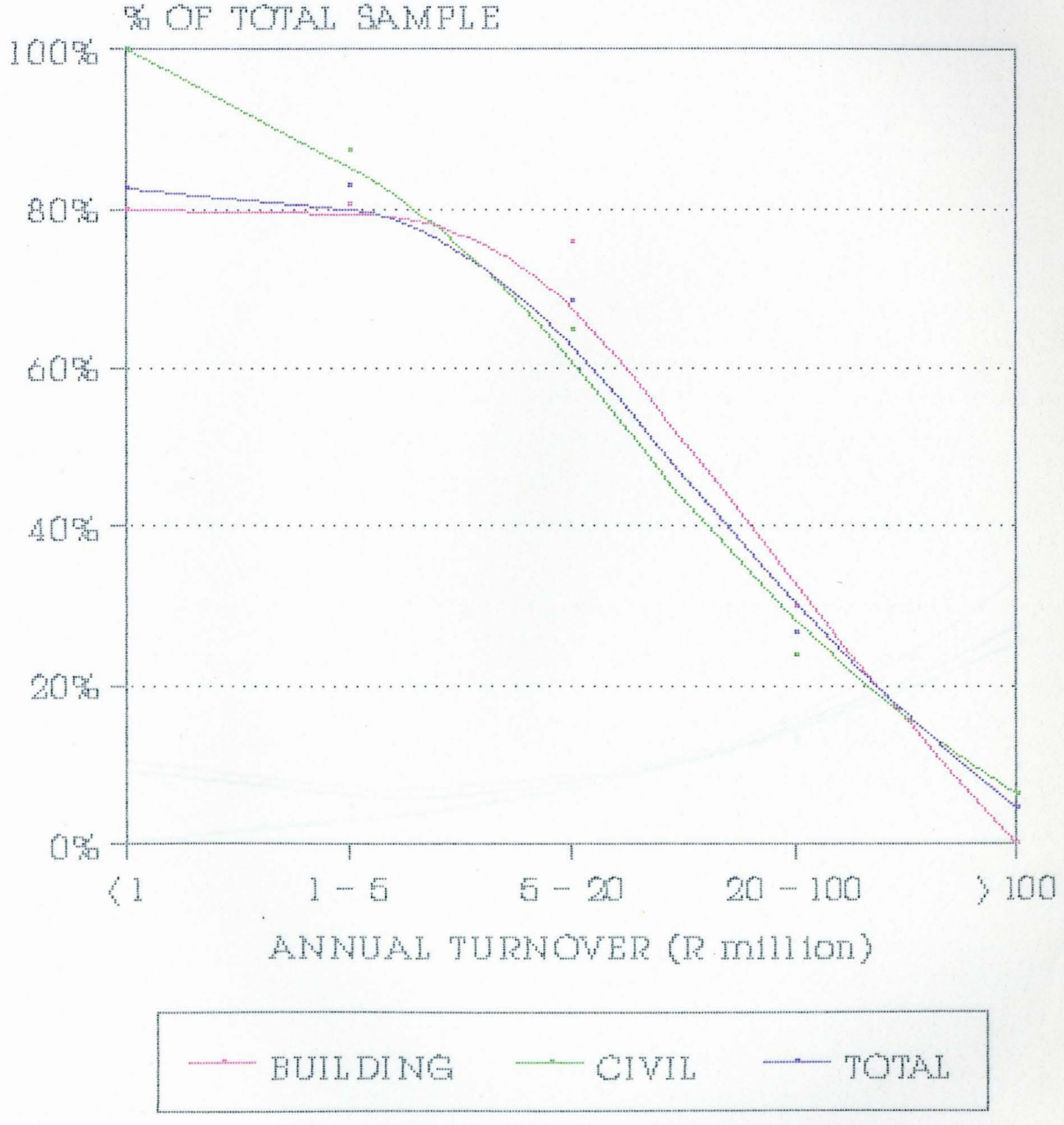
Number of respondents using each type of schedule preparation method (Postal survey)

To try and further clarify the results, the following three pages contain graphs, showing the type of scheduling preparation methods used by the different turnover categories.

GRAPH 9

TREND PRESENTATION

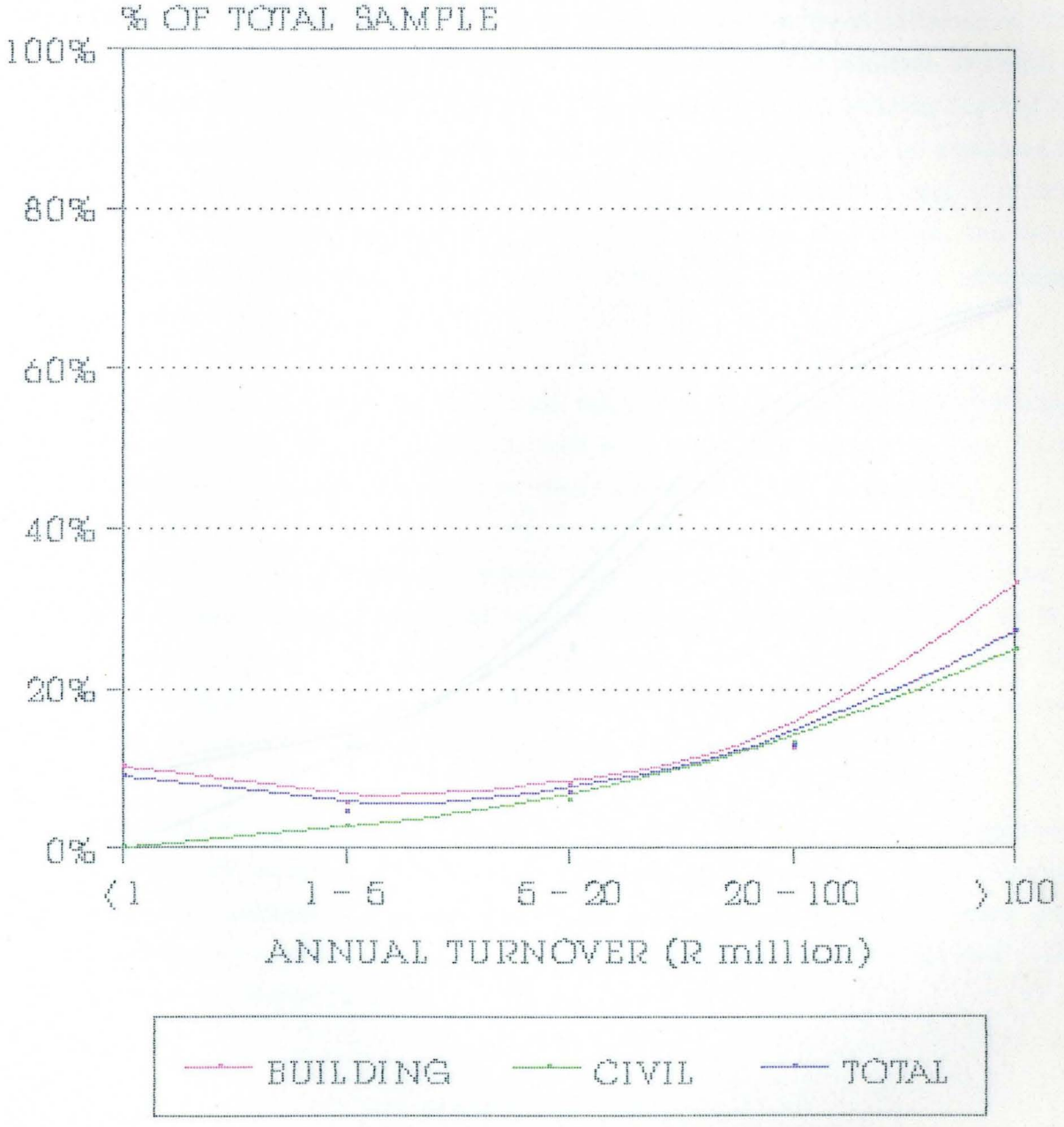
ONLY MANUAL SCHEDULING VS TURNOVER



GRAPH 10

TREND PRESENTATION

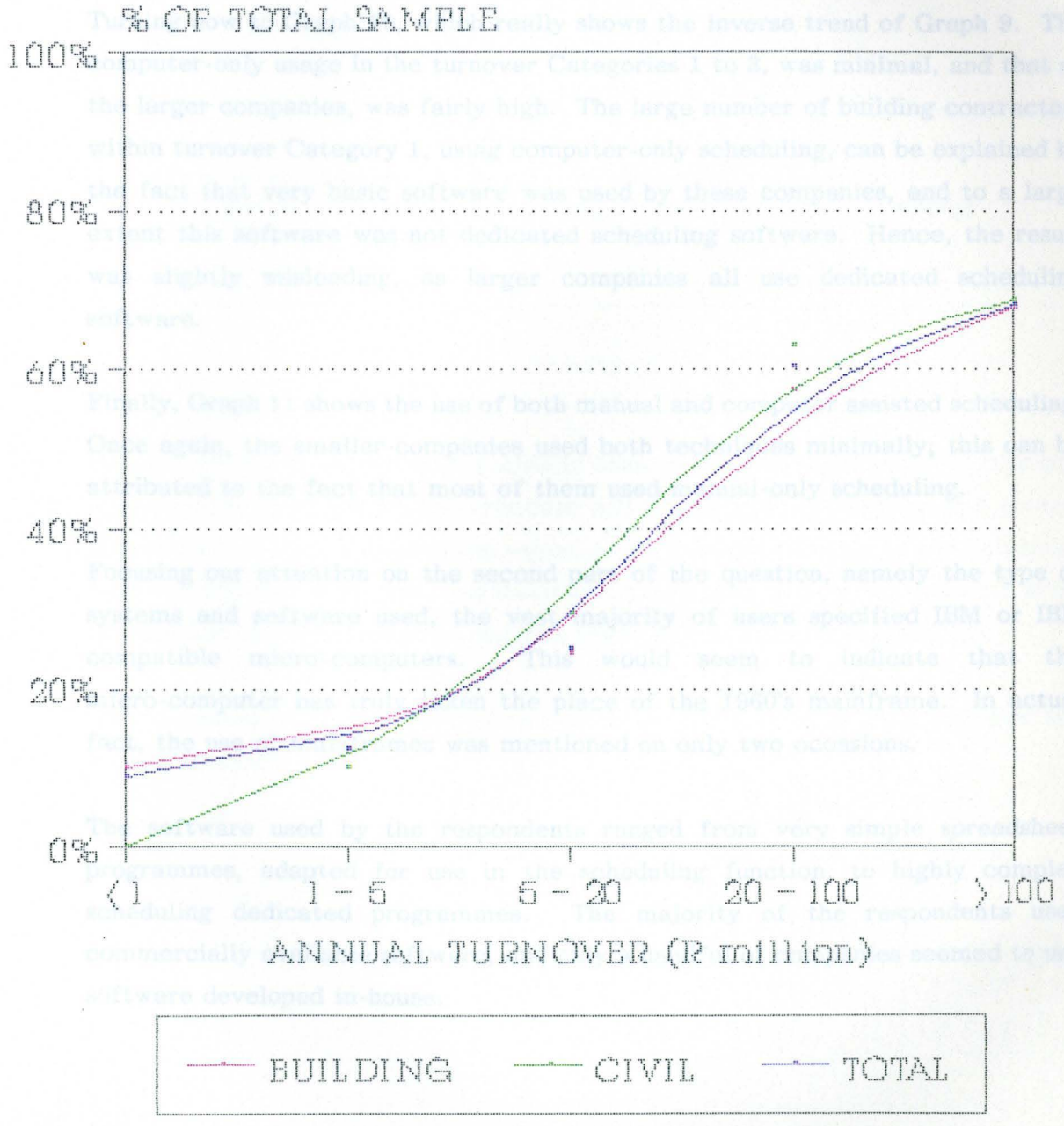
ONLY COMPUTER SCHEDULING VS TURNOVER



GRAPH 11

TREND PRESENTATION

MANUAL & COMP. SCHEDULING VS TURNOVER



The first graph (Graph 9), clearly shows the very high percentage of Category 1,2 and 3 turnover companies, using only manual means to prepare their schedules. In actual fact, 90% of the 211 manual-only users, fell within turnover Categories 1 to 3. Hence, it was only a very small percentage of the large companies that used manual-only scheduling. The majority of these larger companies using only manual means for preparing their schedules, were companies involved in housing construction, whether on an individual or mass housing basis. However, this particular phenomenon, will be discussed in depth in the following chapter.

Turning now to Graph 10, which really shows the inverse trend of Graph 9. The computer-only usage in the turnover Categories 1 to 3, was minimal, and that of the larger companies, was fairly high. The large number of building contractors within turnover Category 1, using computer-only scheduling, can be explained by the fact that very basic software was used by these companies, and to a large extent this software was not dedicated scheduling software. Hence, the result was slightly misleading, as larger companies all use dedicated scheduling software.

Finally, Graph 11 shows the use of both manual and computer assisted scheduling. Once again, the smaller companies used both techniques minimally; this can be attributed to the fact that most of them used manual-only scheduling.

Focusing our attention on the second part of the question, namely the type of systems and software used, the vast majority of users specified IBM or IBM compatible micro-computers. This would seem to indicate that the micro-computer has truly taken the place of the 1960's mainframe. In actual fact, the use of mainframes was mentioned on only two occasions.

The software used by the respondents ranged from very simple spreadsheet programmes, adapted for use in the scheduling function, to highly complex scheduling dedicated programmes. The majority of the respondents used commercially available software, and only a handful of companies seemed to use software developed in-house.

J) Question 8

Uses of the schedule:

- Planning ..... ☐
- Controlling ..... ☐
- Both ..... ☐
- Other (please specify) ..... ☐

_____

_____

If the schedule is used for control, please designate the main uses (eg. cost control, labour efficiency, time control, etc).

_____

_____

Popular literature on scheduling usually stresses that if the scheduling function is accomplished properly, the schedule will act as both a planning and control instrument. Hence, this question aimed at establishing whether or not schedules were used in this dual role. Furthermore, the second part of the question tried to establish the main areas of control, that the schedules were used for.

Hence, viewing the first part of the question, the following table provides the results obtained.

TABLE 5

USES OF THE SCHEDULE	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Planning	33	9,5
Controlling	14	4,0
Planning & Control	296	85,1
Other	0	0
Unspecified	5	1,4

Number of respondents with each schedule usage category

The results are self explanatory, and it was very clear that the vast majority of respondents used their schedules for both planning and control purposes.

The results of the type of control functions attributed to the schedules, are contained in Table 6 on the following page.

TABLE 6

CONTROL FUNCTIONS ATTRIBUTED TO SCHEDULING	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Time Control	197	57,4
Cost Control	106	31,0
Labour Control	82	23,9
Other	14	4,1

Number of respondents within each schedule control function

Within the "Other" category, such items as sub-contractor control and general resource control were mentioned. The remainder of the results are straight forward. A point to note, is that the percentages do not add up to 100, as some respondents indicated more than one control function.

A point of interest, when considering scheduling as being primarily a time control instrument, was the fairly low percentage of respondents who indicated time control. A possible reason for this, could be the fact that the time control function is so obvious that a number of respondents forgot to include it. The cost and labour control percentages are fairly high, when one considers that these control functions can only be achieved if a very detailed schedule was produced. There were indications, that a connection between computer usage, and cost and labour control did exist.

K) Question 9

When is the schedule updated:

- Daily ..... ☐
- Weekly ..... ☐
- Monthly ..... ☐
- Other (please specify) ..... ☐

_____

The perceived aim of this question, was to determine the acceptable time interval, in industry's opinion, between schedule updates. Furthermore, it was hoped that an "ideal" time period for updating might be established.

Once again the results are presented in a table, displayed on the following page. It should be noted, that the "Other" category mentioned in the question has been expanded to show the responses contained with that category.

TABLE 7

SCHEDULE UPDATING PERIOD	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Daily	12	3,5
Weekly	131	37,6
Monthly	147	42,4
When Required	30	8,6
Depends	1	0,3
Never	2	0,6
Fortnightly	17	4,9
Quarterly	1	0,3
Unspecified	7	2,0

Number of respondents within each schedule updating category

The average period for updating of the schedules, appeared to vary between weekly and monthly, a good compromise seemed to be every fortnight, as this then also coincided with the normal site meeting intervals.

The respondents who updated daily, all made use of computers for their scheduling. Similarly, the two respondents who never updated, used bar charts, and were both small companies.

It was very interesting to note, that the companies using a updating period ranging between daily and fortnightly, also indicated more than one control function being attributed to the schedule. This was not to say, that the companies updating less often did not use the schedule for numerous control functions, but rather that the occurrence of mentioning multiple control functions being attributed to the schedules, was less frequent.

Finally, whether or not there was an ideal updating period, would seem to be a matter of dispute. Ultimately, it could be said that the period chosen would probably never be the same, as the updating function was dependant on the nature of the construction project.

L) Question 10

Why is the schedule prepared:

- Required for Company use ..... ☐
- Required by Architect ..... ☐
- Required by Engineer ..... ☐
- Required by Client ..... ☐
- Other (please specify) ..... ☐

_____

_____

The logic behind this question, revolved around the reasons for scheduling, that is to say, why companies schedule. If companies scheduled for themselves, it stood to reason that they achieved some sort of advantage from the schedules.

The data collected was distributed as shown in Table 8 on the next page. It should be noted, that the respondents did not make use of the "Other" option; hence, all the answers fell within the four categories provided.

TABLE 8

REASONS FOR PREPARATION OF SCHEDULES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Required for Company use	317	91,1
Required by the Architect	143	41,1
Required by the Engineer	114	32,8
Required by the Client	125	35,9

Number of respondents within each reason for preparation of schedule category

The first point to note about the results, was that the percentages did not add up to 100, as the majority of respondents indicated more than one reason. The figure of 91,1% for the category "Required for Company use", indicated that scheduling was seen by industry as a valuable management tool. This is an encouraging sign, as the industry obviously believes in the benefits of scheduling, and hence there is evidently a commitment to scheduling.

When more than one reason was indicated, the norm showed company use as the primary reason, with either the Architect, the Engineer or the Client as the secondary reason. Very seldom was the Architect or the Engineer mentioned together with the Client. The reason for this can be traced to the fact that the clients requirement for a schedule was normally for the use of his in-house Project Managers or consultants. From the contractors point of view, however, the schedule was for the client and not specifically for his architects or engineers.

M) Question 11

In a personal capacity, please rate the presently used scheduling system:

- Excellent ..... ☐
- Good ..... ☐
- Average ..... ☐
- Unsatisfactory ..... ☐
- Terrible ..... ☐

The object of this question was to place some sort of quality criterion on the scheduling done. It stood to reason, that this type of question was fraught with bias and personal opinion. However, it did provide some sort of indication of the relevant satisfaction which was being derived from the presently used scheduling technique. Furthermore, when considering the fact that the vast majority of the questionnaires were completed by upper management, the answers to this question could be viewed as accurately representing the current status of the company in question.

The results obtained are presented in Table 9, on the following page.

TABLE 9

RATING OF SCHEDULING TECHNIQUE USED	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Excellent	24	7,0
Good	158	45,9
Average	148	43,0
Unsatisfactory	11	3,2
Terrible	3	0,9

Number of respondents within each schedule rating category

The results are self explanatory, and a single point that I would like to add, is that it was encouraging to see that the ratings were shifted towards the "Good" category; if one assumes the "Average" rating to be the neutral position. I would like to believe, that this was an indication of the fact that companies using scheduling, were in general satisfied with their scheduling techniques. Although, it was impossible to judge whether this satisfaction was present in both the planning and control functions of scheduling.

N) Question 12

Approximate number of employees:

- Permanent Direct Site Labour ....._____
  (Labourers, operators, artisans, etc)
- Temporary Direct Site Labour ....._____
  (Labourers, operators, artisans, etc)
- Permanent Managerial Staff ....._____
  (Contract Managers, HQ Managers, etc)

At the outset it was hoped that this question would be linked to Question 2, ie. the type of work done, to determine narrower divisions within the broader building and civil engineering categories. However, as Question 2 turned out unsuccessful, the data to this question became meaningless, except for the two results mentioned below.

The number of managerial staff members employed, was linked to the type of scheduling undertaken. The result of this analysis showed that in general the companies using networking type schedules, employed numerous managerial staff members. However, this point obviously did not prove that the companies employing a considerable number of managerial staff members, did this purely because the company in question used networking type scheduling. What this result did substantiate, was that the larger companies predominantly used network-type scheduling.

The only other result obtained from this question, was that a total of 180 000 permanent site staff, 40 000 temporary site staff and 13 000 managerial staff, were represented in this survey.

IV. Conclusions

In this sub-section, I will briefly outline the main results obtained from the survey, as well as providing an overview of the conclusions that can be drawn from the postal survey results.

From the point of view of this research report, the most important result was the type of scheduling undertaken within the construction industry. The foremost conclusion was that the R20 million per annum turnover category, seemed to indicate a watershed. Below this mark, the scheduling techniques employed were predominantly of the bar chart type, with minimal computer usage, and generally only one type of scheduling technique was used. Above this specified turnover, the scheduling used was primarily of the network-type, with the extensive aid of computers, and generally more than one scheduling system was in use. This particular result was not entirely unexpected, as European and American surveys in the past had concluded that the larger companies tended to replace bar chart scheduling with network scheduling sooner than the smaller contractors.
(Arditi, D.; Harries, T.W. & Trimble, E.G.; 1972)
(Davis, E.W.; 1972)

Hence, it is this later group, ie. companies with an annual turnover of more than R20 million, that were of primary interest to me, due to the extensive use of different scheduling techniques within this category. As will be discussed in the following chapter, it was this group of companies that I approached during the personal interviews.

Returning to the conclusions, a predominant result, was that the difference between building and civil contractors, with respect to scheduling, was minimal. Possibly the main difference, was that LoB use was a predominant feature of the larger civil contractors, whereas the technique was not used at all by this category of building contractor.

Also of interest, was that computer usage had shifted most positively towards the use of micro-computers. This was a definite departure from the trend experienced during the 1960's and 1970's, where mainframe computers were the only means of producing computer schedules.
(Baker, R.; 1982) (Trimble, G.; 1982)

However, what was strange was that the use of micro-computers was concentrated predominantly among the larger companies. The benefits of computer usage are well documented in the literature, and the relatively low cost of a present day micro-computer system, have been heralded as the advent of computer usage by small to medium sized contractors. This seemingly has not yet taken place in the local construction industry. A possible reason for this, may be the computer resistance and computer illiteracy still experienced amongst personnel.

(Andrews, D.; 1982)

(Halpin, D.W.; 1982)

The resistance to computers would be more readily overcome by a larger company, with a larger staff complement, than it would be by a smaller contractor. That is to say, larger contractors would surely find computer literate personnel amongst their staff complement, and could employ people specifically to operate their computer systems. Whereas, these options would not be available to a smaller contractor, with limited capital. This area of resistance to computer usage within the construction industry, may provide a topic for future research.

Furthermore, two very encouraging points were uncovered. Firstly, that in general the schedules were used both for planning and control purposes, and secondly that these schedules were primarily produced for the use of the contracting company. Both these points indicated a commitment to scheduling, and an obvious desire to reap the benefits generally associated with it.

Finally, the postal survey provided an excellent foundation for establishing an overview of the construction industry. However, the inherent weakness of a postal survey, is that it provides very little in the form of detailed answers and personal feelings about the subject in question. It was the search for greater detail and eliciting of personal feelings towards scheduling, that ultimately initiated the personal interview phase of my research. It is the results of these interviews which are discussed in the following chapter, with the hope of providing further insight into the state of scheduling in the South African construction industry.

CHAPTER 5

ANALYSIS OF THE PERSONAL INTERVIEWS CONDUCTED WITH THE MAJOR CONSTRUCTION COMPANIES ON THE WITWATERSRAND

I. Introduction to Chapter

The postal survey, as discussed under Chapter 4, provided an overview of the scheduling undertaken in the South African construction industry, as well as offering some insight into the attitudes of individuals towards scheduling. The second objective of this research report, was to obtain a detailed insight into problem areas highlighted by the postal survey, and to fathom the particular stances taken by the larger construction companies towards scheduling. The method chosen to accomplish these remaining goals, was to conduct personal interviews with the larger construction companies. It is the objective of this chapter to convey the results of these in-depth interviews.

The companies approached during this interviewing phase were chosen from the respondents of the postal survey. The criteria for the inclusion of companies, was that only companies in the Witwatersrand area were chosen, and that these companies had to have an annual turnover in excess of R20 million.

The reason for choosing only companies on the Witwatersrand, was to limit travelling and to ensure that sufficient contractors were approached within a limited time period. It is my opinion, that these criteria for selection did not impart any bias upon the results, as virtually all the companies approached on the Witwatersrand were operative nationwide, and hence their policies and procedures will apply throughout the country.

The reason for only approaching companies with an annual turnover of more than R20 million, was that this category of company was involved with the most sophisticated and advanced scheduling, as shown by the postal survey. This is not to say that the smaller companies are uninteresting from an academic point of view. In fact, there are numerous questions about the scheduling done by the smaller contractors that should be researched. Areas of research within this group could include such items as the applicability of network scheduling, the reasons for the relatively minimal use of network scheduling, the use of computers to aid the scheduling process, and any further questions that would extend the present body of knowledge on how these smaller contractors view and achieve their scheduling. Hence, it is my sincere hope that in the future, research will be conducted within the companies having an annual turnover of less than R20 million.

In the postal survey, a total of 96 contractors indicated an annual turnover in excess of R20 million per annum. It was found that 44 (ie 45.8%) of these operated on the Witwatersrand. Of these 44 contractors, I finally managed to interview 30, or 68.2% of the larger contractors operating on the Witwatersrand. Details of these companies are given at the end of this report, in Appendix "F" on page 183. The reason for not seeing all 44 contractors was that the remaining 14 were either not prepared to see me, or the relevant people at these companies were not available. However, it should be said that the 30 contractors that were interviewed proved to be more than sufficient, as definite trends had already started to appear after approximately 20 interviews, and the remaining 10 interviews were conducted purely to ensure that these early trends were unequivocal.

The interviews were conducted with the aid of guideline questions, as shown in Appendix "C" on page 168. The guideline questions were used purely to elicit responses to structured questions for comparative purposes. However, the interviews were conducted very informally, and the answers given to Question 16 usually brought to light topics that lay very close to the heart of the party being interviewed.

The remainder of this chapter deals with the results obtained from the personal interviews, and concludes with observations and conclusions that can be drawn from the data collected.

II. Analysis of the Collected Data

A) Introductory Note

Of the 30 contractors interviewed, a total of 27 were used for analytical purposes. The remaining 3 companies were not used, as they turned out to be purely holding companies of their construction divisions. Hence, only the data from the actual construction divisions was used. It is then the results of the 27 usable interviews that are presented in this sub-section.

The 27 contractors interviewed stated their type of construction as shown below:

Building	:	10
Civil Engineering	:	8
Both	:	9

In the category "Both", five stated a preference for civil work, two stated a preference for building work, and two stated no preference at all. Hence, the split between building and civil work can be assumed as being almost evenly split.

The majority of building contractors stated a preference for commercial or industrial type work. The exceptions being, three of the building contractors who operated purely as housing contractors. Within the civil contractors, the majority voiced a preference for road construction, with a component of earthworks. Ultimately, both building and civil contractors seemed willing to approach any type of work, as long as it fell within their realm of construction knowledge. Therefore, it stood to reason that the type of scheduling used had to be flexible enough to allow any type of work to be scheduled on the system.

Turning now to the questionnaire; a copy of which is shown in Appendix "C". It must be stressed that these questions only presented a guideline to prompt the interviewed parties into making informal statements about scheduling. The results are presented on a question by question basis, as with the postal survey in Chapter 4. Any additional remarks made to the questions will also be discussed. The actual question has been reproduced at the beginning of each sub-section to eliminate the continual need of having to turn to Appendix "C". No discussion of the actual question will be given as the questions are self explanatory.

The questions about computer usage, contained at the end of the questionnaire, will be presented together with the outcome of Question 6. The summary conclusions, and overview of all the personal interviews will be discussed under sub-section III of this chapter.

Finally, it must be noted that this chapter does not present a statistical discussion of the results, but rather portrays the results as briefly as possible, and then moves on to the feelings expressed by the interviewed parties about scheduling in general.

B) Guideline Question 1

Is there a company policy for scheduling ?

Only two of the companies questioned had a formal structure to be followed when scheduling. One of which was a housing contractor, where the structure for scheduling had to be on bar charts, as it was felt that any other technique was a waste of time when involved in housing. The second company was a general building company, who had invested a large sum of money in computerized scheduling, and insisted that their staff use this system.

All the remaining companies indicated that no policy was required, and that the end results were the most important. Hence, any type of scheduling system could be employed, provided that it performed adequately on the contract being undertaken.

C) Guideline Question 2

Who produces the schedules ?

The most frequent answer given to this question, was that the contract manager, together with the site agent, produced the schedules. Five of the companies interviewed maintained a central planning department to aid the site agent and the contract manager in preparing the schedules. Only two contractors, ie. 7,5%, stated that all planning was done by a central planning department.

From these results, it seemed that companies preferred to let the person using the schedule on site, actually produce the schedule at the outset of the contract. The importance of insisting on input from site agents, during the scheduling phase, was stressed by almost all companies. Of the two companies using central planning departments, one remarked that it was successful, whereas the other stated that they wanted to change to a system where the contract manager would carry the responsibility for the scheduling.

D) Guideline Question 3

What type of scheduling is used ?

The postal survey contained the exact same question. Hence, my first analysis of the data to this question, was to compare the results with those of the postal survey. It was found that the results from the postal survey corresponded perfectly to those of this question. This proved, to a certain extent, the reliability of the postal survey.

Returning to the results, bar chart usage was indicated by all but one contractor. The one exception, was a company who used CPM exclusively. All the contractors using bar charts also used a second scheduling method or computer package, which presented the CPM logic on a bar chart type output. The use of CPM and PDM, was spread fairly evenly amongst the contractors; whereas the use of PERT was only mentioned twice. The LoB technique was mentioned by 25% of the companies approached, all of whom were civil engineering contractors.

One of the opinions expressed on numerous occasions, was that bar chart usage was still necessitated for preliminary studies and for use with the site personnel. It was probably due to this factor, that a preference for computer programs generating outputs in the form of bar charts, (but still retaining CPM logic) was expressed.

E) Guideline Question 4

Does type of scheduling vary from contract to contract?

A total of 30% of the companies felt that their scheduling was always the same, regardless of the type of contract. They stated that they had a set standard, and that this set standard was adhered to, regardless of the nature or size of the undertaking.

The other 70% of the respondents, felt that their scheduling differed with each contract. It was stated that the changes in the schedules were dictated by the size of the project, as well as its complexity. The general opinion seemed to indicate, that smaller tasks required less scheduling input, and that the techniques used could be of a simpler nature than those used on larger projects.

In general, it appeared that the complexity of the schedules was really a function of the company, and hence there was really no golden rule to be followed when deciding on the consistency of scheduling throughout all types of projects. Although, the literature suggests that network scheduling can be applied to both very complex projects, as well as very small and straight forward ones. This also applies to most computer packages. Hence, it is my opinion that a company with a user friendly computer package using network logic, should be able to schedule any type of project.

F) Guideline Question 5

Are scheduling techniques pure ?

The objective of this question was to determine whether or not the scheduling techniques were used in textbook fashion, or whether they constituted a mixture of principles from various techniques.

The response was almost an even breakdown, as 12 of the respondents felt they were applying a pure technique, whereas 15 indicated the use of conglomerate methods. The use of mixed techniques was generally found in computer software, which tended to incorporate numerous advantageous principles from different techniques.

G) Guideline Question 6

How is the schedule produced ?
(Manual, Computer or Both)

The results of this question are shown below:

TABLE 10

METHOD USED TO PREPARE SCHEDULES	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS
Manual-only	10	37,0
Computer-only	1	3,7
Computer & Manual	12	44,5
Computer mainly & some manual	1	3,7
Manual mainly & some computer	3	11,1

Number of respondents using each type of schedule preparation method
(Personal interviews)

The foremost peculiarity of the results, was that 10 respondents indicated manual-only scheduling. In the postal survey, five of these respondents had indicated manual and computer scheduling. It turned out that these five companies did in actual fact have computers, but they were not used in a scheduling capacity; hence only manual schedules were produced. The reasons given by the companies with computers, but not using them, was that the computer programs took too much time to prime, and that not enough skilled labour was available to effect this work.

As far as the rest of the results were concerned, they were fairly straight forward, approximately 50% of the companies used computers in some manner, whereas the other half of the contractors did not make use of computer aided scheduling. The figures for computer usage were 15% to 20% lower than the postal survey indicated. This can once again be traced back to the availability of computer systems, but the reluctance by management to use them.

The additional questions about computer usage, showed a definite trend towards IBM and IBM compatible micro-computers, with minimal use of Olivetti and Hewlett Packard in some companies. Numerous companies mentioned that they used to run on HP systems, but have moved to IBM or IBM compatibles due to the greater amount of software available.

The software usage was not dominated by a single package, and some of the typical packages mentioned were, Marsbar; Promis; Time Line and Hornet. Most companies seemed to gripe about and praise their particular choice of software; hence, no particular software package seemed perfect for the general expectations of the construction industry.

As far as encouragement or discouragement by upper management to use computers for scheduling was concerned, two thirds of the respondents indicated they were encouraging their staff to use computer scheduling, whereas the remaining third felt they neither encouraged nor discouraged computer usage.

In general then, it can be said that computers for scheduling were in some instances used to their maximum capability, and in others they were available, but not used at all.

From this, one can but conclude that computer usage for scheduling is still in its infancy. One point that must be mentioned, is that the companies using computer scheduling with satisfactory results, all felt that it represented the future trend in scheduling, and that their companies would not run as effectively without their computer schedules.

H) Guideline Question 7

Why is it produced this way ?

Of the companies using computers, the general consensus was that computers were faster, easier to do "What if ?" scenarios, and provided easier updating than did the manual systems. The only diverging opinions voiced, were those of companies who had been forced to use computers through client pressure. These companies contended that the computer scheduling was unnecessary and that nobody ever understood the printouts in any case. It is possible that these attitudes prevailed because these companies had been pressurized into the adoption of computer systems, rather than having made the choice themselves.

Within the companies using manual scheduling, the consensus was that manual systems had worked in the past, so there was no need to change, and no reason why they should not work in the future. The other point raised, was that manual systems were understood by all parties concerned, whereas the same could not always be said about computer generated schedules. In my opinion this presented a somewhat shortsighted outlook!

These attitudes conveyed once again, that the acceptance of computer schedules is in its infancy, and acceptance will be a very slow process, as computers are still viewed by many as incomprehensible creations!

J) Guideline Question 8

When is the schedule prepared ?

A total of 89% of the respondents stated that they produced a preliminary schedule at the tender stage. These schedules were generally only approximations, although three of the contractors viewed the tender stage schedules as being very close in detail to the final working schedules.

The remaining 11% of the contractors, stated that their schedules were only prepared after the award of the tender. It is interesting to note, that all the contractors within this category were housing contractors, where it was deemed to be unnecessary to produce schedules to aid in the tender period.

The preferred time period for the final working schedule to be produced, was almost unanimously a period of between 2 and 4 weeks after the award of the tender.

K) Guideline Question 9

What is the schedule used for ?
(Planning, Control or Both)

All the companies interviewed, stated that the schedules were used for planning purposes. This was in no way surprising, as scheduling is aimed primarily at planning.

All the companies, except for one, indicated that the schedules were also used for control purposes. It is interesting to note that the one exception was once again a housing contractor. The contractors using the schedules for control as well as planning, all indicated that time control was the primary objective. Labour and cost control were mentioned in equal proportions, by approximately half of the contractors.

L) Guideline Question 10

Who is issued with a schedule ?

The general opinion expressed by all the contractors, was that the schedules were generally issued to the relevant site staff, ie. the site agent and foreman. Moving upwards in the managerial hierarchy, it was held that the schedules were generally viewed by contracts managers and/or contracts directors. It seemed that the schedules would only go higher in the managerial structure, if management meetings were held and the project was discussed in detail. The other possibility of upper management viewing the schedules, was if the project in question was found to be in trouble, for whatever reason.

Generally, the feelings expressed by the companies seemed to be quite logical, as scheduling is primarily concerned with the smooth construction of a project, and hence is of the utmost use to the personnel directly involved with the construction activities. However, if problems do occur, it is self evident that upper management will become involved, in an attempt to rectify the situation.

M) Guideline Question 11

Who updates the schedules ?

The trend followed by all the companies was that the updating of the schedules was done by the person, or persons, who originally produced it. In the cases where the schedules were produced by the contracts manager together with the site agent, the responsibility for updating was then placed on the shoulders of the site agent. Where central planning departments were used, the responsibility for updating remained with these departments.

N) Guideline Question 12

How often are they updated ?

The preferred updating periods were expressed to be either weekly or fortnightly. This somewhat contradicted the results from the postal survey, where monthly updating seemed quite prevalent. Monthly updating was only mentioned by one contractor during the personal interviews. Approximately 25% of the contractors indicated that no specific time period should be attached to the updating of schedules, and that the updating should only occur when delays or variation orders were experienced.

O) Guideline Question 13

How efficient is the present technique at fulfilling company objectives ?

It must be noted that the responses to this question were of a highly personal nature. In other words, the responses given represented the opinions of the persons interviewed, in a subjective manner. However, if one considers that generally upper management personnel were interviewed, one may assume that the answers given were fairly accurate.

The general response to this question, was that the techniques were good or adequate for the purpose of the company concerned. Amongst the companies using computers to produce their schedules, a common grievance was that the personnel lacked experience with the computer system or that the personnel even felt threatened by the computer system.

P) Guideline Question 14

Any areas that the present technique excels at ?

One of the foremost points mentioned by the computer users, was that computer scheduling saved time and improved on efficiency. A complaint by the companies who had computer systems, but who did not use them, was that the systems were too complex. Considering both these points, it became clear that computer usage was a highly controversial area.

The bar chart method was mentioned numerous times for its ease of understanding and universal acceptance. The feeling that bar charts were quite adequate for most contracts was also stated.

Line of Balance was praised by the civil engineering contractors for its excellence in repetitive work, such as road construction.

All network-type methods were mentioned as being good on larger, more complex sites. It seemed that the utilization of network schedules on small project was not encouraged.

Q) Guideline Question 15

Any problems experienced with present technique ?

Most of the problems that were mentioned, related to the shortcomings of the bar chart. Points mentioned under this category included issues such as: lack of detail; difficulty of updating; lack of critical path; lack of detail about activity interdependencies and difficulty of applying cost control criteria.

The other problem areas that were mentioned, were with human resources for producing and updating schedules. It was contended that more sophisticated scheduling required skilled personnel, and that there was a definite lack of skilled personnel in this area. Hence the issue of training for personnel was aired; details of this are provided under the following question.

R) Guideline Question 16

General comments on scheduling undertaken within the construction industry, in South Africa.

The object of this question, was to allow the contractors to talk about scheduling in general, and to discuss any particular areas they saw as being particularly important. As it turned out, most of the contractors took this opportunity to discuss areas of scheduling that interested them personally. Furthermore, an overview of scheduling during the past couple of years, from the viewpoint of the contractors, was also acquired. Finally, comments about the possible future of scheduling in the South African construction industry were given.

The first comments that will be discussed, are those concerning the past history of scheduling. The general consensus indicated, that prior to the 1980's, no great importance was placed on scheduling. It seemed, that prior to this period, time durations for construction contracts were very flexible, and no great importance was therefore placed on scheduling techniques, as they were primarily concerned with time control.

However, with the advent of lower profit margins and increased costs of finance, contract periods were continually shortened, and hence the relative importance of scheduling increased. The move towards more sophisticated scheduling and the increased commitment to scheduling, was seen by some contractors as having been the natural consequence of the higher demands placed on contractors, with respect to contract periods.

It was remarked that contractors commenced using the advanced scheduling techniques available in order to remain competitive. However, some contractors stated that the move to more sophisticated scheduling was forced upon them at the insistence of their clients. As client pressure grew, and the contractors were compelled to produce network-type schedules for the benefit of the client, it became a natural sequence of events for the contractors to start using the improved scheduling techniques for their own benefit as well.

The first moves towards improved scheduling and to a heightened commitment towards these schedules was the increased time demands placed on contractors, in the form of shorter contract periods. The second revolutionizing of schedules was seen by numerous contractors as the advances made in computer technology. It was stated that with the advent of the micro-computer and its associated lower costs, as well as the multitude of software available for these systems, scheduling entered a new phase. Some contractors even subdivided the computer revolution into two separate aspects: firstly, the great advances made in computer hardware at the turn of the decade, and secondly, the rapid development of dedicated scheduling software towards the mid-1980's. Various companies saw the advent of micro-computers as being such a profound revolutionizing tool in scheduling, that it was their hope to eventually be able to provide each site with its own computer, so as to allow the site personnel to administer their own scheduling. The provision of computers for every site was envisioned by numerous contractors, as heralding the third phase of the improvement of scheduling in the construction industry.

The present situation of scheduling was viewed with various optimistic and pessimistic overtones. Several contractors viewed the present situation in scheduling as being nowhere near optimum, and they saw one of the largest problems as being a lack of education. An inclination to sacrifice good scheduling because of the lack of skilled personnel available, seemed profuse within the industry. What was interesting however, was that only a few of the companies interviewed provided training programs on scheduling for their personnel. Hence, it would appear that the lack of skilled manpower was a convenient excuse for many contractors to continue neglecting their scheduling. The companies complaining about the shortage of skilled manpower, indicated that the building and civil engineering controlling bodies, such as BIFSA and SAFCEC, should be responsible for offering training courses on scheduling. This attitude seemed to be a simple manoeuvre to transfer the area of responsibility; as it is surely the individual company's responsibility to provide training for their personnel, in the particular technique or techniques that they are using. If the respective industry controlling bodies were to involve themselves in the training of personnel in the art of scheduling, it is my opinion, that this training should take the form of an overview of the various scheduling techniques, highlighting their more salient points, as well as their advantages and disadvantages. This type of training would be particularly appropriate for the education of site personnel.

An interesting point raised by one of the respondents, was that scheduling in South Africa was of a higher standard than in the United Kingdom or in the United States, and that locally a greater commitment was given to scheduling. The reason given for this statement, was that the responsibility placed on local managers was greater than that placed on overseas managers, due to the fewer managerially skilled personnel available in this country. Hence, it was stated that managers ensured that a higher degree of scheduling was done, so as to protect against future problems which would ultimately demand their attention and consume valuable time. This is a rather interesting statement, albeit almost impossible to substantiate. Although my own personal opinion, after having viewed scheduling in the United Kingdom and West-Germany, is that such a statement may well portray the present situation.

The future of scheduling, was seen by some contractors as a further move towards computers and more sophisticated scheduling techniques. Other contractors, however, saw scheduling as remaining much the same as it had been in the last couple of years. Comments such as: "It worked in the past, so why should it not work in the future?", when applied to bar charts, generally epitomized this attitude. There were however more moderate opinions, such as statements about the gradual process of training being undertaken over the next five to ten years, resulting in a general improvement in the scheduling done. The middle of the road attitudes seemed to be united in the opinion that scheduling would only improve and meet the challenges of the future, if sufficient education was provided for the work force. This may be seen as an obvious solution, yet it appeared to be neglected most of the time.

The following pages will be devoted to further points raised by the contractors, and will be presented in point format.

- "Older" clients and consultants do not, in general, fully understand advanced scheduling techniques, such as computer based network systems. This point was raised on numerous occasions. It was felt, that this category of people were more responsive if bar chart type systems were supplied by the contractor. The contractors contended that they generally produced network schedules for their own use, and supplemented these schedules with bar charts for the benefit of clients and professionals.

- The following point can be viewed as an addendum to the first point. Namely that large corporate clients and "younger" consultants were becoming ever more demanding with respect to scheduling. In other words, this group of people were demanding more sophisticated scheduling from the contractors. This would seem to indicate a split of the clients and consultants between "older" and "younger" generations.

- One contractor felt very strongly, that the education of architects and civil engineers at institutions of higher learning, were centered prominently around scientific areas and not enough around managerial issues. Hence, he felt that the whole area of scheduling was being neglected in the curriculum for architects and civil engineers. These comments were concluded by statements about the lack of understanding sometimes exhibited by these consultants.

- Some contractors indicated that scheduling could not be accomplished successfully, due to the clients invariably not reaching a design freeze. The contractors asserted that due to this point, the schedules were almost never finalized until halfway through the contract. It was stated that this then ruled out many of the usual advantages attributed to scheduling.

- A supplementary point to the one above, was that other contractors felt that because of the lack of design freezes, and the continual influx of variation orders, it became essential to schedule in greater detail at the outset of a contract. The contractors viewed this original schedule as an integral part of the claims procedure for variation orders. Hence, these contractors exhibited a profound commitment to their schedules, by continually updating. Furthermore, they also indicated a great belief in highly detailed and sophisticated schedules.

- The importance of the involvement of the site agent in the preparation of the schedules, was stressed by most contractors. Of interest, was the fact that those contractors who had relied on planning departments in the past, and had changed to on site scheduling, were the most emphatic about this point.

- Linked to the last point; some companies were so committed to the involvement of the site agents during the preparation of the schedule, that they had supplied their site agents with micro-computers and left the scheduling entirely up to them. This would obviously only work, if the site personnel were adequately familiar with the scheduling technique in use.

- Numerous companies, who had tried computers for scheduling, mentioned the difficulties experienced with personnel being initially "afraid" of the computers. Most had overcome this problem through the education of their staff. However, many voiced the opinion that some people could simply not be enticed into using the computer systems.

- A lack of top management support for computer scheduling was also often mentioned. This lack of support was usually attributed to the fact that upper management consisted mainly of "older" generations, themselves unfamiliar with computer technology.

- In the area of personnel education, two contractors mentioned that on numerous occasions they had witnessed how personnel had initially voiced a strong reluctance to schedule with the aid of computers, but had become very interested and committed to scheduling in this way, after formal education in the techniques and benefits of scheduling.

- All of the housing contractors indicated that anything more sophisticated than bar charts would purely be a waste of time and money on their part. The housing contractors felt that the process of building a house was so simple, that only a basic method of time control was needed, and that this requirement was more than adequately fulfilled by the bar chart.

- One of the civil engineering contractors asserted that scheduling complexity and commitment had developed sufficiently to ensure that the schedule should become a contractual document. Then claims could be levied by both client and contractor against discrepancies from due dates listed on the schedule. The contractor in question indicated that this would ensure that he obtained information from the client on time, and that he also delivered his part of the bargain on time. However, the finer details of how to implement such a system seemed to elude the contractor in question.

The above points represent the most salient comments made by the contractors about scheduling in the industry. The remainder of this chapter will be devoted to comments made by the contractors about project managers and their role in scheduling projects. As project managers are generally very heavily involved in the scheduling aspect of projects, the topic of project management seemed to crop up at numerous times during the discussions on scheduling, and as such these comments are presented in point form below.

- Two contradictory statements about the scheduling produced by project managers were made. Firstly, that project managers produced overly complicated schedules, and secondly, that project managers often did not fully understand sophisticated scheduling techniques.

- A statement was made by one contractor, that project managers lacked a true understanding of contracting and as such could not possibly produce viable schedules.

- Possibly the most important statements made, were those concerning a particular company, on the Witwatersrand, which specializes in a project management type function. This project management role revolves around the production of a schedule for the client, to which the contractor is then asked to operate. The comments made about this particular company and the scheduling produced by them, were concentrated very distinctly in opposite corners, ie. the contractors either liked the idea, or had a most definite dislike for the system. Further details about this area of scheduling will be presented in Chapter 6.

Other comments made about project managers, were generally about the concept of project management and not specifically about the project managers role in scheduling for a project. As such, these comments have been omitted.

III. Conclusion

The results obtained from the personal interviews, were primarily of a subjective nature as voiced by the contractors interviewed. Most of these opinions have been reiterated under Question 16 of the previous sub-section. Hence the conclusions given under this section are those that were ascertained from the results of the other guideline questions.

The primary conclusion, was that network-type schedules were used extensively by the larger contractors, although the bar chart was invariably still produced as well. The reasons for the continued use of the bar chart seemed to hinge on the simple nature of the bar chart, and the fact that it was readily understood by most people. This was particularly important, when considering that contractors felt clients and consultants often did not understand more sophisticated techniques.

The importance placed on the input obtained from site agents during the formulation of the schedules, seemed to indicate a general understanding of the importance of obtaining input from the people who will actually be involved on a day-to-day basis with the construction of the project. Comments to this effect were given by most contractors.

The use of computers to generate schedules seemed to be an ideal sought by most companies, but had not yet been achieved. Computer usage was a definite occurrence in a lot of the companies interviewed, but problems were still rampant with this new technology. The hardware and software appeared to have progressed sufficiently to be effective, yet problems experienced at present, hinged mainly around human factors, such as computer illiteracy and mistrust of computers. The solution was seen by all, as being education. Most contractors also felt that this education would lead to widespread computer use, which was seen to represent the future of scheduling as a whole.

Of great interest, was the fact that almost all the contractors interviewed, used their schedules for both planning and control purposes. This indicated an understanding of the advantages of scheduling, as well as signifying a commitment to scheduling, as the use of schedules for control purposes would be impossible without a commitment to the original schedule. This was corroborated by the regular updating intervals specified by the respondents.

A point that was highly subjective, while being interesting none the less, was the satisfaction with the techniques as indicated by the contractors. Generally, the contractors seemed to be satisfied with the performance of their chosen scheduling techniques. This surely indicates a harvest of benefits that can be reaped from the scheduling techniques used, otherwise these contractors would not be satisfied with their chosen methods. This was further substantiated by the fact that numerous points were mentioned about areas where the techniques excelled at, whereas problem areas were only mentioned occasionally.

Ultimately, the contractors biggest concerns seemed to hinge around the successful implementation of a certain technique, rather than the choice of that technique. Although it must be stressed, that network-type schedules seemed to be preferred by the contractors, rather than the simpler bar chart methods. The reason for this, as given by the contractors, was a need to see the interdependencies amongst the activities. Returning to the question of implementation, the main problem in this area pivoted around the dealings with people unskilled in the techniques of scheduling. Hence, the desire for more readily available training schemes was voiced. Closely linked to this, was the desire for the training of manpower in the use of computer equipment and to schedule with the aid of computers.

Finally, the personal interviews indicated that scheduling had progressed a long way since the 1970's, but that it was still in its infancy and as such, was still faced with numerous problems. The main problem being a lack of understanding of the principles of scheduling amongst the contractor's personnel, the clients and consultants alike.

As stated earlier, the one group of consultants that continually seemed to predominate during the discussions with the contractors about scheduling, were the Project Managers. Generally, the mention of Project Managers was accompanied by a substantial amount of criticism. Due to this criticism, I felt it essential to provide the Project Managers with an opportunity to present replies to the critique. Furthermore, the Project Managers line of work revolves integrally around scheduling, and hence I saw Project Managers as possibly being able to provide some insight into scheduling from their point of view.

Hence, it was decided to conduct a number of interviews with some of the larger Project Management companies on the Witwatersrand. The results of which are the topic of discussion in the following chapter.

CHAPTER 6

THE PROJECT MANAGEMENT INTERVIEWS

I. Introduction to Chapter

Once the decision had been made to include interviews with the larger Project Managers on the Witwatersrand, the names and telephone numbers of these companies had to be acquired. It was decided to approach the Project Management Institute for help, and they supplied me with the required names and numbers. Companies were then approached at random, and a total of 8 companies were finally included in the interviews; details of these companies are once again provided at the end of this report, under Appendix "G" on page 188. Six of the companies interviewed were large organizations, one was a small business and the final company turned out to be a supplier of scheduling software.

The interviews were conducted very informally with the aid of guideline questions, in much the same fashion as the contractor interviews. A copy of the questions can be found in Appendix "D" on page 172. From the questionnaire, it can be seen that a number of the questions actually delved into the Project Management profession as such, and side tracked somewhat from the research topic of scheduling. Due to this factor, any data gathered from these questions has been omitted.

II. The Results

I will not detail the outcome of each question individually, as not all questions were answered by all respondents, and the number of respondents was also too small to produce any form of comprehensive statistical analysis. Hence, I will simply outline the most salient points raised by the companies interviewed.

Directing attention firstly to the company selling scheduling software for construction purposes. The first point raised, was that in general the competence amongst clients, consultants and contractors with regard to sophisticated scheduling, was exceptionally low. It was contended that scheduling had been progressing over the years, but that it was a very slow process. This seemed to be particularly true for computer based scheduling. The company in question apparently spent a lot of its time not only selling the software, but was also heavily involved in the education of construction company personnel. This training of personnel occurred in two distinct areas, firstly in the simple use of computers, and secondly in the use of the scheduling software. Ostensibly, there was an increasing demand for software, as contractors learned to appreciate the advantages of these packages. However, there appeared to be a reluctance to purchase software, as the availability of manpower skilled in the use of computer scheduling, tended to be minimal.

The points raised by this company, substantiated the findings of my personal interviews with the construction companies. Namely, that the single largest stumbling block for computer scheduling at present, is the shortage of skilled manpower.

Turning now to the other companies interviewed. When confronted with the criticism that Project Managers produced overly sophisticated schedules, the normal reply was that Project Managers required state of the art schedules in order to be able to fully explore "What if?" simulations, and ultimately to provide an optimum sequence of events for a particular project. Furthermore, the Project Managers could not grasp the reason why this factor was seen in a negative light, as supplementary bar chart type schedules could also be produced if required. As such, it was indicated that the detail and complexity of the schedules, was at all times adjusted to suit any particular client or contractors needs.

On conveying the idea that Project Managers did not fully understand sophisticated scheduling techniques, the standard response was one of disbelief that the contractors could harbour such ideas.

The remainder of the comments, bearing relevance to my report, were all aimed at the general state of scheduling in the construction industry. All respondents maintained that the art of scheduling in the construction industry was improving. However, at the same time it was stated that it was an exceptionally slow process. Leading on from this, the solution to obtaining improved scheduling was seen by most as being improved and further training of site personnel, as well as other professionals. This continuing education was viewed as being essential in the field of computer scheduling, as the illiteracy rate in this area seemed to be very high. Following on from the previous point, computer literacy was stated as being a critical pivot point for the future, as computer scheduling was viewed as holding the key to construction scheduling in the next decade in South Africa.

One particular company that was interviewed, turned out to be of particular interest with regard to my research, and has been briefly mentioned in the end of the previous chapter. This company specializes primarily in producing schedules for contracts, at the request of either the client or the contractor. The system works on the basis that the organization in question is provided with the contractors resource availability, resource limitations and all other relevant information. From this information the schedules are produced by means of a sophisticated computer program. The schedules so derived, are then discussed with the parties concerned to ascertain their applicability. The schedules thus finalized, are then regularly updated, by the company, for the duration of the contract. The company sees its primary function as preventative management based on the schedules. In other words, they ensure that time and cost discrepancies are dealt with at the earliest possible opportunity.

During the contractor interviews, this company was mentioned on numerous occasions. The comments made about this company were either very complimentary or of an utterly deplorable nature. Complimentary comments generally came from contractors who had admitted that their scheduling ability was inadequate, and as such, they welcomed a "buy a schedule" type organization. Unfavourable comments were made by the contractors who felt that the company in question meddled in their affairs, and was generally of no help to them. It should be noted that these disgruntled contractors did not approach the company of their own free will, but were requested to do so by the client. This then may explain their attitudes.

The companies reply to the criticism mentioned, was simply that no organization of this nature could always be viewed by all people as being required and helpful. A comment of this nature was to be expected, and the evident success of the enterprise seems to indicate that the majority of people view the company's services as beneficial. From this one might conclude, that scheduling by contractors is rather unsatisfactory and that clients would prefer outside specialist assistance. Is this then an indication, that the future of scheduling in the construction industry will hinge around a process, whereby outside consultants will provide the schedules by which the contractors will work?

CHAPTER 7

COMPARATIVE DISCUSSION OF LOCAL SCHEDULING WITH THAT OF OVERSEAS COUNTRIES

I. Introduction to Chapter

This chapter is divided into three sections. The first being this introduction to the chapter. The second section will discuss the results of my postal survey and my personal interviews, in relation to the surveys carried out in the United States and Europe, (in other words, this section will take the form of a comparative discussion between foreign trends and the present local situation). The final section presents a brief conclusion to the comparative discussions of this chapter.

II. Comparison of foreign trends with the present South African situation

A) The United States Survey by E.W. Davis

As stated in Chapter 3, the most celebrated survey conducted in United States of America, was by Mr Davis. In order to facilitate the reader in following the discussion presented, the main results of Mr Davis' survey have been reproduced below:
(Davis, E.W.; 1976)

1) About 80% of companies sampled were using CPM-type systems.

2) The schedules were used significantly more for planning than for control.

3) 88,7% used the schedules at project or site manager level, with 40% using them as high up as upper management.

4) Management concerns about CPM-type scheduling were as follows:

   i) The efficient use of the produced schedules, was questionable;
   ii) The time required for effective use was very high;
   iii) The input/output was too complex and often too much paper was generated.

5) Evaluating success of the system was almost impossible to ascertain, due to its' subjective nature.

6) The reasons given for the success of the system were attributed to the following five factors in order of importance:

   i) Good computer programs
   ii) Good training of personnel
   iii) Good top management support
   iv) Interest shown by people using the system
   v) Other diversified reasons

One important point that must be stressed about the survey by Mr Davis, is that his research was only conducted into the very large construction companies in the United States. As such, my comparative discussion will focus only on the results acquired from the larger local construction companies, that is to say, all companies with an annual turnover in excess of R20 million.

The first point raised by Mr Davis, was that approximately 80% of the companies sampled, used CPM-type scheduling. My own results showed that not more than 20 to 25% of the South African contractors used CPM-type scheduling. However, if one combines CPM, PERT and PDM into one category of network-type scheduling, the figure becomes approximately 60%. From this result, we can conclude that network-type scheduling, in the South African construction industry, has not achieved quite the success that is seems to enjoy in the United States.

Viewing this objectively, this result was not really surprising when one considers that the American construction industry has been using network-type scheduling for approximately 25 years, whereas the local industry has shown dedicated involvement with network-type schedules for no more than 10 years. This fact was corroborated by the comments made within various local construction companies, that dedication and proper use of advanced scheduling had only been seen in the last 7 to 10 years. Therefore, it is self-evident that the American contractors have progressed to a far higher point along the learning curve.

The second point raised by the United States survey, was that the scheduling was used significantly more for planning, than for control. The same cannot be said of the South African industry, as all the respondents interviewed indicated that their schedules were also required for control purposes. When viewing the entire industry, it would be incorrect to state that universal use was made of the schedules for control purposes. Even so, a total of 85% of the industry indicated that the control function was attributed to their schedules. A possible reason for this difference in the results, is that computer technology has made large advances since Mr Davis' survey was published. As such, the updating of schedules has been simplified, thus making the control function more readily achievable. Furthermore, present day computer software usually provides the ability to link the numerous control functions to the schedule, without very much extra effort.

The third point raised by Mr Davis, correlates very closely with my own results. A possible reason for this similarity in the results, could be the similar structure of construction companies in both South Africa and the United States, as well as the analogous nature of the construction process worldwide. Furthermore, the obvious importance of the schedules to the personnel involved at the coal face, would also ensure that the results to this type of question were the same.

The fourth point introduced, namely that of the concerns voiced by management in connection with areas of scheduling that were seen to be the most problematic, were in general much the same as those of the local construction industry, and are discussed below.

The efficient use of the schedules was queried by some local companies, particularly with regard to the efficient use of the schedules by the contractors site personnel. However, the general consensus expressed by the local construction companies, was that schedules were used fairly efficiently in the industry.

The time required to effectively produce schedules, was mentioned on isolated occasions by companies in the local industry. Companies who used to have a problem in this regard, tended to solve the problem by the introduction of computers, which in some instances alleviated the problem. Furthermore, the approach of allocating the updating responsibility to the site personnel working on computers, allowed for regular updates with minimal time expenditure. Ultimately, this concern is to a large extent no longer valid in the present day, as computer software has drastically reduced the time required to produce advanced schedules.

The third area concerned the excessive complexity of the input/output required by computers and the large amounts of paper occasionally generated. This aspect was not mentioned by local respondents, and the probable reason being that computer technology has made great advances. Due to these advances, it is no longer necessary to continually print out the schedules, as one is now able view the schedules on the computer monitor. The introduction of colour monitors has further improved the situation, and it is not uncommon for schedules to be clearer on the monitor, than they would be if printed in black on white. The aspect of the complexity of the input, is also no longer a relevant factor, as computers accept direct input, rather than having to make use of punch cards. Similarly, the output of the data can be manipulated, to produce output ranging from simple to highly complex.

It is then fair to say, that although these concerns were mentioned by the South African contractors, the majority of the companies had overcome the concerns voiced by their American counterparts, by adopting advanced computer generated scheduling.

The fifth area mentioned by the Davis survey, was that of not being able to evaluate the success of a particular system, due to the very subjective nature of evaluating success. From my own experience, I can concur with this sentiment, although my questions in this regard seemed to indicate general success with the chosen systems.

The final comments made in the Davis survey, revolved around the perceived reasons for the success of a particular system. The data that I uncovered in this particular area, closely paralleled the areas mentioned. The area that was viewed, by local industry, as being the foremost necessity for the success of a system, was the training of personnel. This area was also mentioned at numerous times by management, as being one of their biggest concerns at present. The remaining areas quoted by Mr Davis survey, very closely mimicked those of the local industry.

From the above, it was then apparent that the uses and feelings towards scheduling in this country, follow those of the United States fairly closely. However, the main area of dissention was the extent to which network-type schedules were employed. As stated previously, this was probably due to the differing time periods that the techniques had been used in the two countries.

B) Turkish Survey by Mr Arditi and Mr Koseoglu, and the British Survey by Dr Arditi

Once again, the salient points raised by the surveys are reproduced below, so as to aid the following discussion.
(Arditi, D. & Koseoglu, H.; 1982)
(Arditi, D.; 1981)

1) 35% of Turkish companies used network-type scheduling, and 70% of British contractors used network-type scheduling.

2) In Turkey, no companies made use of precedence diagramming systems, whereas in Britain 37% of the companies used PDM.

3) 63% of companies in Turkey used a bar chart method, and in the U.K., 67% used bar charts's.

4) 57% of Turkish contractors used computers to schedule, whereas only 38% of British contractors used computer aided scheduling.

5) In both countries, head office planners felt it very difficult to make computer printouts legible to site staff. This attitude was backed by the site staff respondents, who indicated that computer printouts were difficult to read, took too much time and that they were ultimately unnecessary.

6) In Turkey, all companies surveyed stated that a central planning department was used for planning. 57% of the site staff voiced irritation at this setup. A similar situation seemed to prevail in the U.K., although no figures were provided.

7) In both Turkey and the U.K., no provisions were made within the companies for the education of the personnel in networking techniques.

As with the American survey, the Turkish and British surveys were only conducted into large construction companies. As such, my discussion will once again only take into account any results obtained from the larger South African contractors.

The first point uncovered by the surveys, indicated that only 35% of the contractors interviewed in Turkey, used network-type scheduling. This result is approximately 25% less than the result obtained from local industry. Hence, this would seem to indicate that the local industry is technologically more advanced, and that the benefits of network scheduling have been more readily appreciated. However, 70% of the British contractors used network-type scheduling. The reason for this can probably be linked to the time period that network schedules have been used in that country. It was, however, interesting to note that the U.K. use was only 10% higher than the local use, whereas the use in the U.S.A. was 20% higher than the local figure.

The second point raised, indicated that no use was made of PDM in Turkey, while 37% of the companies in the U.K. did use PDM. Approximately 22% of the companies in local industry used PDM. The reasons for the different usage patterns to Europe, can probably be attributed to the same reasons as mentioned under the first point.

The third result, indicated that approximately two thirds of the contractors, in both Turkey and the U.K., used bar charts. My own results also indicated fairly widespread use of bar charts by the local industry, (42% of the contractors stated the use of bar charts). However, the local contractors made use of the bar charts together with network-type schedules. The same could not be established from the published results of European surveys.

The fourth point detailed computer usage in the surveyed countries. It was very interesting to note, that Turkish contractors made greater use of computers in scheduling than their British counterparts. The reason for this, could be that Turkish contractors had only recently commenced changing to network-type schedules; during a time when computers for scheduling had become far more established, and hence it became more logical for the Turkish contractors to immediately make two changes, one to network scheduling and secondly to computer aided scheduling. A similar explanation is probably true for the local industry, where approximately two thirds of the companies indicated computer aided scheduling.

The fifth point, on the comments made by head office planners in connection with their attempts at explaining computer printout schedules to site staff, and the sixth point, on the widespread use of central planning departments, are both no longer comparable to the local industry. The reason for this being that local companies have almost exclusively moved away from central planning departments. The reasons for moving away from central planning, as given by local companies, was very much the same as those reasons quoted in the Turkish and British surveys. As such, it is quite conceivable that the Turkish and U.K. industry's will follow in the footsteps of the local industry.

The final point raised by the surveys, revolved around the lack of training opportunities provided by construction companies. From my own survey, this very point manifested itself as being a major problem in the local industry. The local contractors felt that this training was not their duty, but should rather be provided by the co-ordinating bodies of the industry, as well as institutions of higher learning. Whether or not this attitude is legitimate, remains an area of dispute.

III. Conclusions

Having now viewed, on a comparative basis, the results of the overseas surveys with my own results, it seemed clear that the local construction industry was lagging behind that of the American industry, as far as the extensive use of network-type scheduling was concerned. However, the local industry did seem to have advanced further in the uses attributed to the schedules, such as control by means of these schedules.

In relation to other industrialized countries, such as the United Kingdom, it seemed that the South African construction industry was closer linked to the trends experienced there. In comparison to the Turkish industry, it was apparent that the local industry is further advanced in its use of scheduling.

As for the future of the local industry, it appeared that the trends of the British and American industry would possibly be followed. Indicating that greater use would be made of network-type scheduling in the future.

CHAPTER 8

DIRECT ANSWERS TO THE PROBLEM STATEMENT OF THIS RESEARCH REPORT

I. Introduction to Chapter

Presented in the previous chapters are the results of my surveys, the analysis of the data, the conclusions derived from the analysis, and the discussion of local trends with those of overseas countries. This chapter therefore presents solutions to the questions posed in the detailed problem statement as defined in Chapter 2, based on the results of all the previous chapters. In order to aid the reader, the actual questions posed in the third chapter are reproduced at the beginning of each discussion.

Before commencing with the answers, it must be stated, that one of the fundamental objectives of my research, was to provide an insight into the scheduling undertaken by the industry. This insight has been extensively covered during the discussion of the survey results, and as such will not be reiterated under this section.

II. Discussion of the Solutions to the Problem Statement of this Research report

A) Answer to Question 1

" Types of scheduling techniques used? "

The answer to this question has been discussed in detail during the presentation of the survey results. As such, the reader is advised to refresh his memory by viewing Graphs 2 to 6, on pages 59, 61, 62, 63 and 66 respectively, as I will only reiterate the most salient points below.

The type of scheduling undertaken by the smaller companies, revolved mainly around the use of the bar chart, with only occasional use being made of more sophisticated network-type schedules. The larger the company, the more a move toward network scheduling was noticed, often in combination with bar charts. The use of CPM and PDM were favoured within the network scheduling category, with only minimal use being made of PERT. It is important to remember that bar chart usage was favoured widely, even if network schedules were produced. These bar charts were usually used as a secondary means of communicating the sequence of activities to site personnel, as well as to other persons not fully familiar with network schedules. The final point I would like to raise under this question, is that the use of the LoB technique was generally only applied to repetitive type work.

B) Answer to Question 2

" Do larger companies use more sophisticated techniques? "

The results of the postal survey, in combination with the results of the personal interviews, indicated very clearly that larger companies did indeed use more sophisticated scheduling techniques. This was seen in both the type of schedules preferred by the larger companies, as well as the advanced computer hardware and software utilized. What is once again interesting to note, is that although very sophisticated schedules were often produced by the larger companies, they still, in numerous cases, produced bar charts to supplement the network schedules. This situation was seen by companies as being required due to the lack of skilled manpower and the lack of appropriate education.

C) Answer to Question 3

" How successfully are the techniques implemented? "

The answers to this question, generally indicated that the techniques chosen were usually well implemented by the companies. This statement is based upon the comments made by the respondents during the personal interviews, as well as from the answers given to Question 11 of the postal survey. However, ultimately an accurate answer to this question is virtually impossible to ascertain, as the question attempts to uncover a highly subjective topic.

D) Answer to Question 4

" Does the size of a company influence the type of scheduling used? "

This question has, to a certain degree, already been answered under Question 2. A very brief answer would be, that the size of the company does influence the type of scheduling undertaken, and definite proof of this point is given in Appendix "E" on page 177 to 181, where the scheduling done by each of the five turnover categories used in the postal survey are presented.

E) Answer to Question 5

" Is scheduling used at all? "

The easiest way to answer to this question, is by viewing Graph 7 on page 68. From this graph, it is apparent that in certain cases no scheduling was done, however this occurred mainly in very small companies. The only occurrence that I was able to uncover, of no scheduling taking place in a larger company, was by a housing contractor with a Category 4 turnover. This result was not totally unexpected, as housing contractors generally only performed elementary scheduling for their projects.

F) Answer to Question 6

" Is scheduling purely an advanced planning tool, or is it used in aiding control? "

From the surveys, it became apparent that the answer to this question is that the schedules were generally used for more than just planning. 85% of the companies indicated that the schedules were also used for control purposes. The main control area allocated to the schedules, was time control, with numerous companies using their schedules for cost and labour control as well. Hence, it is fair to state that at least eight tenths of the contractors used their schedules for both planning and control.

G) Answer to Question 7

" Who does the scheduling? "

The norm indicated, that the contract managers with the input of site agents produced the schedules. Most of the companies who in the past used central planning departments had moved away from this method of preparing the schedules. The main reasons given for this distancing from central planning, was that the site personnel exhibited no commitment to the schedules produced in that fashion, which then ultimately lead to no schedules being used on contracts, and this tended to result in delays and other problems. Furthermore, the lack of input from site personnel often caused situations whereby the central planning departments would indicate activity interdependencies on the schedules, which were completely incompatible with site conditions. This type of problem had since been remedied by involving the site personnel in the scheduling phase of the project. Finally, within the larger companies there was a definite move towards letting site personnel complete their own scheduling; this was normally accomplished with the aid of computers situated directly on the sites.

H) Answer to Question 8

" Have the advances in computer hardware affected scheduling ? "

Computer hardware technology had definitely impacted on scheduling, and the general consensus indicated that these advances in computer hardware had advanced scheduling in the industry, and particularly so in the larger companies. The larger companies that were interviewed, and who had made inroads into the use of computer aided scheduling, stated that since the advent of micro-computers, their scheduling tasks had been greatly simplified. Problems with the unavailability of dedicated software during the early 1980's were mentioned, but it was stated that this situation had been by and large alleviated.

J) Answer to Question 9

" Has commercially available software affected scheduling? "

Computer usage in general, had increased since the turn of the decade, but this usage in industry was initially restricted due to the small number of dedicated scheduling packages available at the beginning of the 1980's. However, this situation seemed to have been relieved, as presently we see the emergence of new packages almost continuously, as well as the release of updated and improved versions of existing packages.

Probably the best way to summarize the answers to both questions eight and nine, is to reiterate a comment made by one of the respondents during the personal interviews. The person in question stated that scheduling by the South African contractors had undergone two revolutionary trends during the past ten years. The first of these was the introduction of the micro-computer at the turn of the decade, and the second was the development of large quantities of dedicated scheduling software for these new machines. Hence, the answer to both questions posed is "yes". However, the comments made to these questions apply exclusively to the larger contractors. The response by smaller contractors about computer scheduling, indicated that they had, in isolated cases, commenced with the use of computer scheduling, but that the main method still employed at present, was still manual scheduling.

K) Answer to Question 10

" What are the general feelings and opinions of the industry, about scheduling in South Africa? "

Answers provided to this question by the industry, came purely from the larger construction companies, and were obtained during the personal interviews. Very few of the viewpoints of the smaller contractors could be ascertained from the postal survey. The general consensus among the larger contractors, was that scheduling in the industry had in fact progressed very far in the past eight years. It was indicated that prior to the turn of the decade, very little in the way of scheduling technology was applied to contracts. However, during the past ten years, the increased pressures placed on the contractors had changed the situation. The main pressures on the contractor were seen as, shortened contract periods, lower contract profit margins, and more frequent and longer recessionary periods. The solutions to improved planning were seen by contractors as being, the advent of the micro- computer, better software, greater commitment to scheduling, and the improved education of personnel in the field of scheduling.

A number of the contractors interviewed, indicated that they saw themselves as being on the "right track", yet felt that the industry as a whole had yet a lot to learn. The larger contractors also stated that in their opinion, the smaller contractors generally lacked a commitment to scheduling. This conclusion was corroborated to a large extent, by my postal survey results, yet it cannot be said that the situation was unequivocal throughout the smaller contractors, as there were obviously a number of the smaller construction companies who were using sophisticated scheduling techniques, and did exhibit a commitment to their schedules.

The above commentary represents the views of industry about the past and present situations of scheduling. A great number of comments were made about the future path of scheduling, and these will be presented in the discussion of the final question.

L) Answer to Question 11

" How does the construction industry view the future of scheduling, and what are industry's expectations of scheduling in that future? "

Forecasts about the future usually represent sought after information, yet accurate forecasts are invariably hard to come by. Hence, a series of predictions about the future are presented below. All of the predictions are based on comments made by the respondents during the personal interviews.

The foremost prediction for the future, was a unanimous statement that the relative importance of scheduling in the years to come, would gradually increase. That is to say, contractors saw future trends placing an ever increasing burden on their shoulders, and as such, their great reliance on accurate scheduling was seen as an irrefutable point. Furthermore, the larger contractors envisaged that the smaller contractors would follow their lead. Although, it seems unlikely that the very small construction companies will ever become fully reliant on sophisticated scheduling, as the type of construction undertaken by these companies would probably not warrant the use of sophisticated scheduling techniques.

In order to expedite the greater use of scheduling in the future, the consensus indicated that the demand for people skilled in the use of scheduling, would increase. To keep trend with this increased demand, education would become the key word. In other words, the demand for educational courses would increase and these programmes would either have to be offered on an in-house basis, or by the industry co-ordinating bodies.

Closely linked to the last point, the relative importance of the computer in the future was envisioned by contractors as being of paramount importance. However, as long as large numbers of personnel are still computer illiterate, the computer can obviously not play as large a role as one might hope. Hence, the need for educational programmes is once again stressed. Companies such as the computer supplier interviewed, who provided both computer training and computerized schedule training, would probably see a rise in the demand for their services in the future.

Numerous contractors saw the future of scheduling as represented by a situation whereby each contract site would be equipped with it's own computer, so that the site personnel would do all their own scheduling, without any aid from head office staff. If this situation could be realized, it was felt that the time currently spent by management on assisting the site personnel in their scheduling tasks, could be spent on more important matters. At present, there were some companies who had already achieved this sought after state, and were very pleased with the results. Hence, currently the only major stumbling block to other companies also achieving this ideal situation, was the lack of skilled manpower available.

Some companies voiced the opinion that the real stumbling block to this proposed future, was the harbouring of archaic notions about computers by upper management. This point seemed to be very valid in some companies, yet I felt that it could be overcome, and indeed will be overcome in the future when a company's present scheduling can no longer cope with the increased demands placed on it. Then the only possible alternative route open to such companies, would be the purchasing of schedules from companies such as the one mentioned under the Chapter 6, the project management interviews.

Finally, the future of scheduling within the construction industry in South Africa, appeared to lie with the increased use of more sophisticated network-type scheduling techniques. The preferred method of producing these schedules in the future was seen as being with the aid of computers, and produced directly on site. The alternative to the above, being the purchasing of schedules from companies specializing in the scheduling field.

CHAPTER 9

CONCLUSION

I. Conclusion

From the postal survey, it was conclusively established that scheduling was undertaken by the majority of contractors in the industry. The only exceptions being very small contractors and some of the larger housing contractors. Of the scheduling techniques used, the bar chart still ranked as the favourite. This however, was very much less the case in the large construction companies, where the use of network-type scheduling was fairly common. The preparation of the schedules was still greatly by manual means, although once again the larger contractors had moved extensively to the use of computer aided scheduling. The schedules were used primarily for planning, together with a large contingent of companies using them for control as well. Updating was generally seen to take place between fortnightly and monthly. Furthermore, the survey seemed to indicate that the contractors were in general satisfied with the schedules they produced.

Also evidenced from the postal survey, was that the R20 million per annum turnover figure indicated a definite watershed between results. Companies below this turnover generally used less sophisticated schedules, invariably manually produced and used almost exclusively for planning. The companies having a turnover above this mark generally used network scheduling together with bar charts, produced them on a computer and employed the schedules for control purposes as well. Following the postal survey, my further research impacted purely on companies with an annual turnover exceeding R20 million. Possibly a very interesting research topic for the future, would be the investigation of the smaller companies and the determination of the reasons why the trends that persisted in that group of companies, were seemingly inherent to the group.

During the personal interviews, a better understanding of the larger companies was established. An insight was also gained into the attitudes of the construction industry towards scheduling.

The primary feature observed with regard to the larger contractors, was their high commitment to scheduling. Generally advanced features and techniques were made use of, so as to obtain the best possible scheduling. This commitment to scheduling, seemed only too have evolved in the past eight to ten years. Coupled to this commitment, was the progress made by computer technology and the vast amount of commercially available software, which assisted in accelerating the use of more sophisticated scheduling. The further developments in computer technology were seen as the primary function in the future of scheduling, with ideals being set at a level whereby each site would be equipped with its own computer. The current main stumbling block to this ideal being the lack of trained personnel.

The advent of companies providing a scheduling service to the contractors was met with wide acclaim and equally wide disapproval. However, the future of this type of company seemed to be assured.

The present scheduling situation in the industry, would appear to be lagging behind that of the United States. The main reason for this being, that comparatively little use has been made of network-type scheduling in South Africa prior to the 1980's. However, it must be stated that the larger local contractors seemed to be rapidly narrowing the gap, although the smaller contractors did not seem to be progressing at the same rate.

The South African situation was, however, equal to, or ahead of other countries where surveys of this nature have been conducted, such as in Turkey and Britain. Hence, it is my opinion that the local industry would eventually reach the same level of sophistication as that of the United States for example. The time required for this to transpire, is unfortunately not calculable, although the process will be speeded up by any further economic recessions is this country. The reason for this being, that during recessionary cycles, contractors are forced to work as closely to their breakeven points as possible. Hence, less margins for error are included in their contracts, and therefore the accuracy of their scheduling must be appropriately adjusted.

I see the future of scheduling in this country as hinging on two main areas. Firstly, the use of computers will have to increase to assist with the preparation of the schedules. Computer usage will invariably spread to the smaller companies, and ultimately widespread computer usage on sites will be realized. Secondly, scheduling in South Africa will not advance unless greater emphasis is placed on the education of site personnel, clients, consultants and contractors in the advantages of scheduling, as well as the techniques of scheduling. Furthermore, the advancement of scheduling would also be greatly aided, by the education of the same group of people as stated above, in the use of computers and specifically computers for scheduling.

Within the two areas mentioned above, there will invariably be a niche for companies selling scheduling expertise, as it would be a pipe-dream to assume that all contractors will become fully proficient in scheduling in the future.

Finally, my prediction is that the bar chart will continue to predominate in the market, although I see the bar charts of the future being produced on computers rather than manually. Furthermore, future computer based bar chart methods will incorporate some of the network principles, and this will further extend the use of the bar chart. This increased sophistication of the bar chart will hopefully go hand in hand with a greater commitment to scheduling, and will then possibly lead to a future of projects more frequently being completed on time and within budget.

APPENDIX "A"

COPY OF COVERING LETTER AND QUESTIONNAIRE USED FOR THE PERSONAL SURVEY

Department of Civil Engineering

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

1 Jan Smuts Avenue, Johannesburg

P O WITS
2050, SOUTH AFRICA

'Uniwits'
4-27125 SA
(011) 716-1111

X Y Z Company (Pty) Ltd
Box 1000
Blikkiesdorp
1234

Reference:

Enquiries:

(011) 716-

Date: April 1988

NATIONAL SURVEY ON CONSTRUCTION PLANNING

Dear Sir/Madam

Enclosed is a questionnaire, forming part of a nation-wide survey being conducted by the Project and Construction Management division, of the Civil Engineering faculty at the University of the Witwatersrand.

The questionnaire will help our department, to develop improved lecturing syllabuses for both undergraduate and post graduate courses of the future. Hence, it would be greatly appreciated if you would kindly complete the questionnaire and return it in the enclosed envelope.

All replies will be treated with the utmost confidentiality, and collected data will be used for research purposes only.

Any further remarks you might like to make on the subject matter, would also be greatly valued. Such further remarks need not reflect company policy and can be made in a personal capacity.

Thanking you in advance for your help.

Yours Sincerely

R MCCUTCHEON
Professor of Civil Engineering
(Project & Construction Management)

P E RUDZINSKE
BSc. Bldg

Encls 1: Questionnaire

2: Self addressed envelope

The University of the Witwatersrand rejects racism and racial segregation. It is committed to non-discrimination particularly in the constitution of its

CONFIDENTIAL

NAME : _____

POSITION : _____

COMPANY NAME : _____

1) Type of company:

- Building ..... ☐
- Civil Engineering ..... ☐
- Both ..... ☐

If your answer to Question 1 is "Both", please specify preferred category of work:

- Building ..... ☐
- Civil Engineering ..... ☐

2) The company's preferred category of work, as well as other groups of work also accepted.
(eg. Roads, Industrial Building, Housing, Earthworks, Concreting, Platelaying, Pipelines, etc)

Preferred Work: _____

_____

Other Work Accepted: _____

_____

3) Approximate annual turnover:

- Less than R 1 Million ..... ☐
- R 1 Million - R 5 Million ..... ☐
- R 5 Million - R 20 Million ..... ☐
- R 20 Million - R100 Million ..... ☐
- Greater than R100 Million ..... ☐

4) The company's usual role in projects:

- As Main Contractor ..... ☐
- As Sub-Contractor ..... ☐
- Joint Ventures ..... ☐
- As Project Managers ..... ☐
- Other (please specify) ..... ☐

_____

_____

5) Scheduling technique used:

- Bar Chart (Gantt Chart) ..... ☐
- Critical Path Management (CPM) ..... ☐
- Precedence Network ..... ☐
- Program Evaluation & Revue Technique (PERT).. ☐
- Line of Balance ..... ☐
- None ..... ☐
- Other (please specify) ..... ☐

_____

_____

6) For approximately how long has the present technique been used?

_____

If a previous technique was in use, please stipulate the technique, as well as the approximate time span it was used for.

_____

_____

_____

7) Current method employed for preparing the schedule:

- Manual ..... ☐
- Computer ..... ☐
- Both ..... ☐

If network is compiled by computer, please specify type of computer system and the software package used.

_____

_____

_____

8) Uses of the schedule:

- Planning ..... ☐
- Controlling ..... ☐
- Both ..... ☐
- Other (please specify) ..... ☐

_____

_____

If the schedule is used for control, please designate the main uses (eg. cost control, labour efficiency, time control, etc).

_____

_____

9) When is the schedule updated:

- Daily ..... ☐
- Weekly ..... ☐
- Monthly ..... ☐
- Other (please specify) ..... ☐

_____

10) Why is the schedule prepared:

- Required for Company use ..... ☐
- Required by Architect ..... ☐
- Required by Engineer ..... ☐
- Required by Client ..... ☐
- Other (please specify) ..... ☐

_____

_____

11) In a personal capacity, please rate the presently used scheduling system:

- Excellent ..... ☐
- Good ..... ☐
- Average ..... ☐
- Unsatisfactory ..... ☐
- Terrible ..... ☐

12) Approximate number of employees:

- Permanent Direct Site Labour ....._____
(Labourers, operators, artisans, etc)

- Temporary Direct Site Labour ....._____
(Labourers, operators, artisans, etc)

- Permanent Managerial Staff ....._____
(Contract Managers, HQ Managers, etc)

Thank you for your time in filling out the questionnaire, and your valuable contribution to our survey.

APPENDIX "B"

COPY OF FOLLOW-UP LETTER

Department of Civil Engineering

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

1 Jan Smuts Avenue, Johannesburg

P O WITS
2050, SOUTH AFRICA

'Uniwits'
4-27125 SA
(011) 716-1111

X Y Z Company (Pty) Ltd
Box 1000
Blikkiesdorp
1234

Reference:

Enquiries:

(011) 716-

Date: April 1988

REMINDER ON NATIONAL SURVEY FOR CONSTRUCTION PLANNING

Dear Sir/Madam

The response to our survey, mailed approximately eight weeks ago, has been very good. Hence, we feel that it is possible to aim for a 100% return level for the survey.

When this letter was posted, we had not yet received a return from your company. As such it has been assumed that you have either forgotten to complete the questionnaire, or you have misplaced it. Either way, we have included a copy of the original questionnaire and a further return envelope, for your convenience.

In order to obtain our desired goal of blanket coverage, it would be greatly appreciated, if you would kindly complete the questionnaire and return it in the enclosed envelope.

In the eventuality that you have already completed and mailed the first questionnaire, kindly disregard this reminder.

Thanking you for your support and help in this regard.

Yours Sincerely

R McCUTCHEON
Professor of Civil Engineering
(Project & Construction Management)

P E RUDZINSKE
BSc. Bldg

Encls 1: Questionnaire

2: Self addressed envelope

The University of the Witwatersrand rejects racism and racial segregation. It is committed to non-discrimination particularly in the constitution of its

APPENDIX "C"

COPY OF GUIDELINE QUESTIONS USED FOR PERSONAL INTERVIEWS CONDUCTED WITH THE LARGER CONTRACTORS

COMPANY NAME : _____

PERSON NAME : _____

POSITION : _____

Address : _____

_____

Telephone No. : _____

1) Is there a company policy for scheduling ?

2) Who produces the schedules ?

3) What type of scheduling is used ?

4) Does type of scheduling vary from contract to contract ?

5) Are scheduling techniques pure ?

6) How is the schedule produced ?
(Manual, Computer or Both)

7) Why is it produced this way ?

8) When is the schedule prepared ?

9) What is the schedule used for ?
(Planning, Control or Both)

10) Who is issued with a schedule ?

11) Who updates the schedules ?

12) How often are they updated ?

13) How efficient is the present technique at fulfilling co. objectives ?

14) Any areas that the present technique excels at ?

15) Any problems experienced with present technique ?

16) General comments on scheduling undertaken within the construction industry, in South Africa.

COMPUTER USAGE:

a) Type of system used ?

b) Type of software used ?

c) Is computer usage encouraged or discouraged ?

d) General comments on system and software.

APPENDIX "D"

COPY OF GUIDELINE QUESTIONS USED FOR PERSONAL INTERVIEWS CONDUCTED WITH THE PROJECT MANAGERS

Date : _____ Code : PM_____

COMPANY NAME : _____

PERSON NAME : _____

POSITION : _____

Address : _____

_____

Telephone No. : _____

1) Where is the majority of work done.
   ie. Private sector or Public sector work.

2) What services does the company offer the client ?

3) Does the company produce and monitor their own schedules?

4) What type of scheduling techniques are used ?

5) Does type of scheduling vary from contract to contract ?

6) How are the schedules produced ?
(Manual, Computer or Both)

7) Why are they produced this way ?

8) When are the schedules prepared ?

9) Who would receive a schedule ?

10) Who updates schedules ?

11) How often are they updated ?

Perceptions of the Construction Industry about Project Management !

12) PM's are unable to co-ordinate and control projects due to :

- The large variety of standard conditions of contract between various disciplines and their incompatibility.

- PM's not fully familiar with various sophisticated scheduling techniques.

- PM's often use oversophisticated scheduling techniques that no one understands.

- PM's do not delegate and define responsibility adequately.

- PM's act simply as intermediaries, and have hence become paper pushers and ineffectual managers.

- PM's are unpractical people because their background is usually in QS or Architecture, and not in contracting where it should be.

13) PM's are biased toward the client, resulting in an US and THEM situation. (PM should be appointed and paid by both client and contractor.)

14) PM's are not governed by any standard PM contract and hence, they generally carry little or no responsibility.

15) General comments on scheduling undertaken within the construction industry, in South Africa.

COMPUTER USAGE:

a) Type of system used ?

b) Type of software used ?

Can a copy of an actual schedule be obtained from the company ?

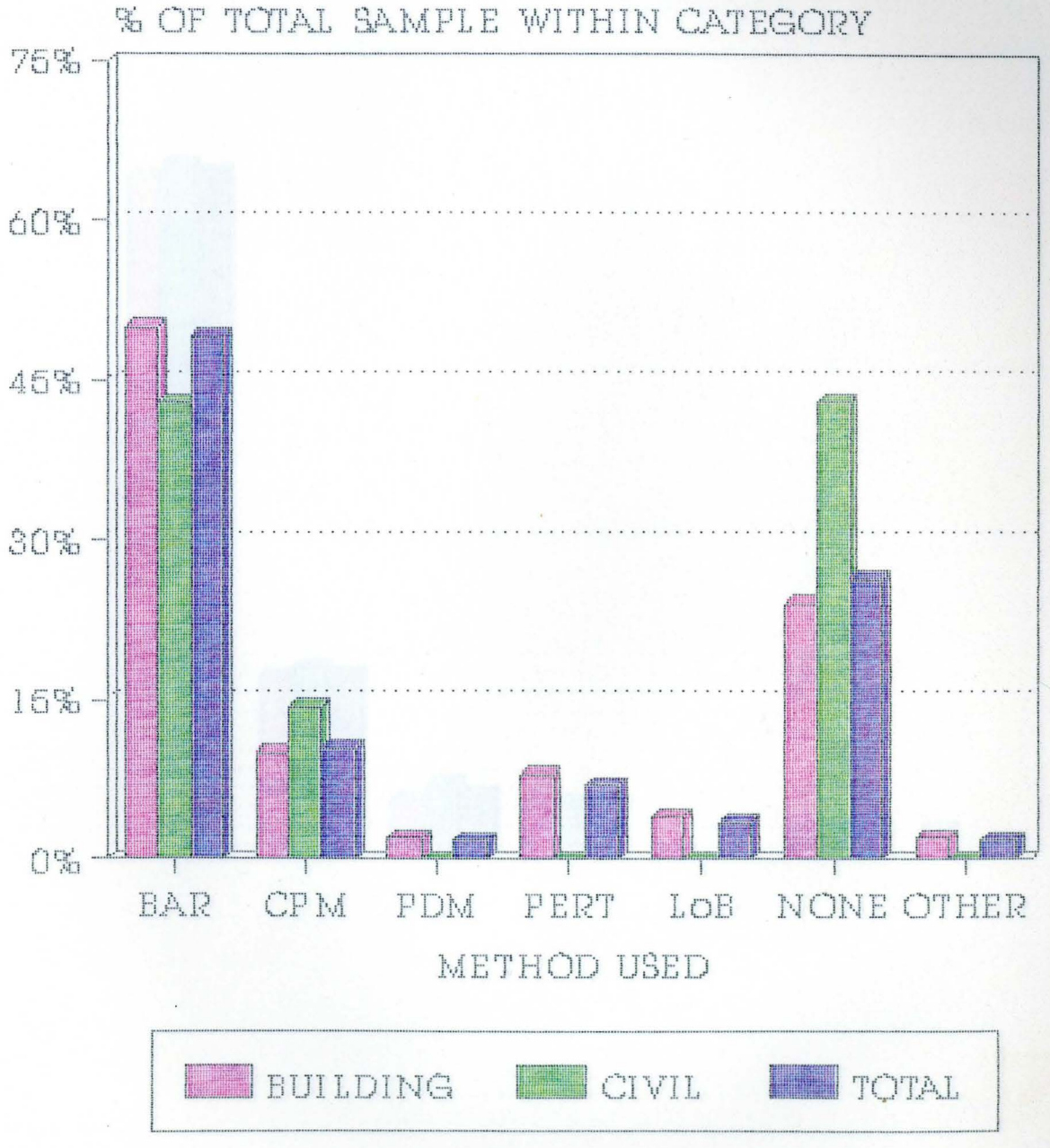
APPENDIX "E"

GRAPHS SHOWING THE TYPE OF SCHEDULING UNDERTAKEN BY EACH TURNOVER CATEGORY

GRAPH 1A

BAR PRESENTATION

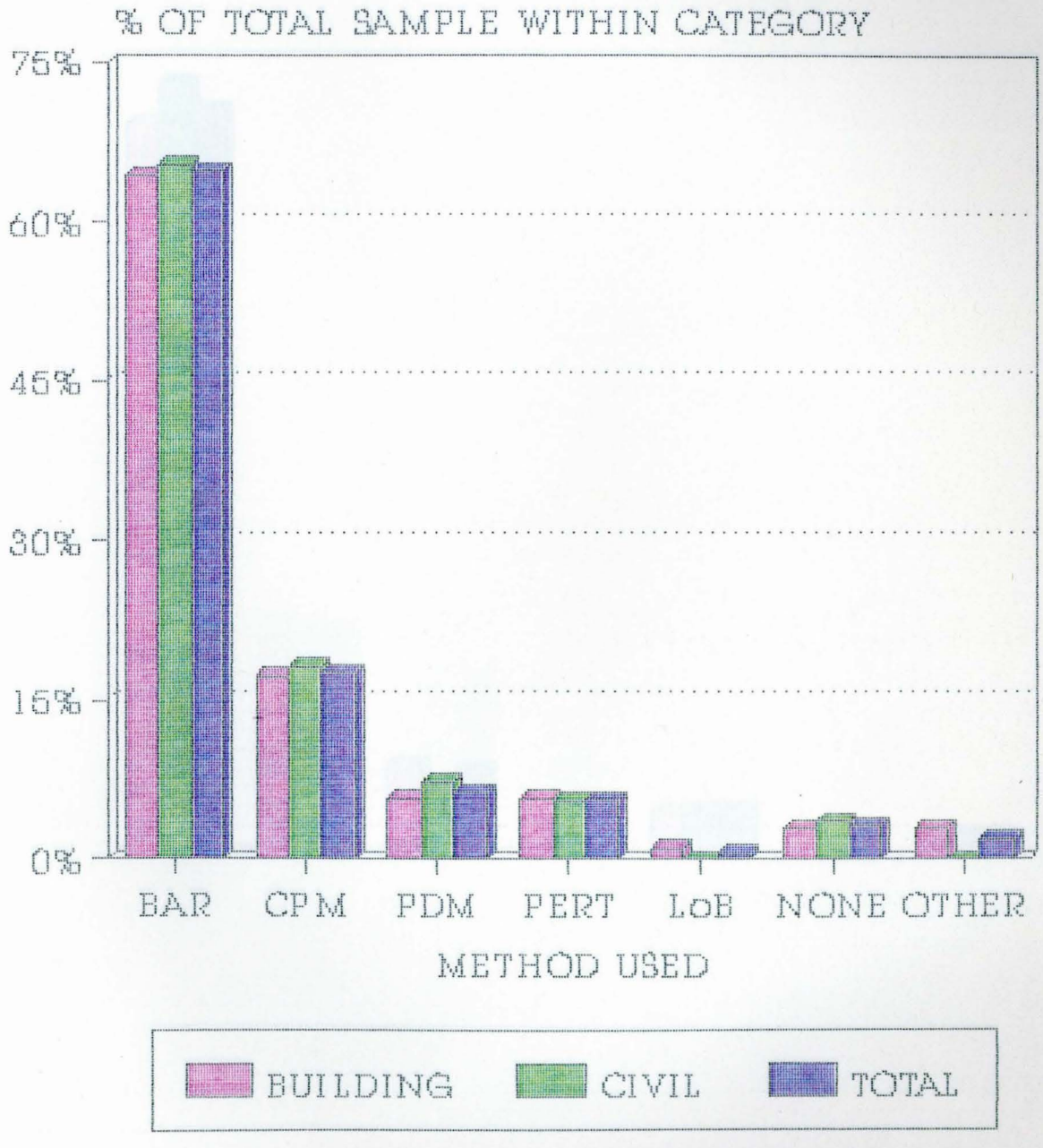
SCHEDULING DONE BY CATEGORY 1 CO.'S



GRAPH 2A

BAR PRESENTATION

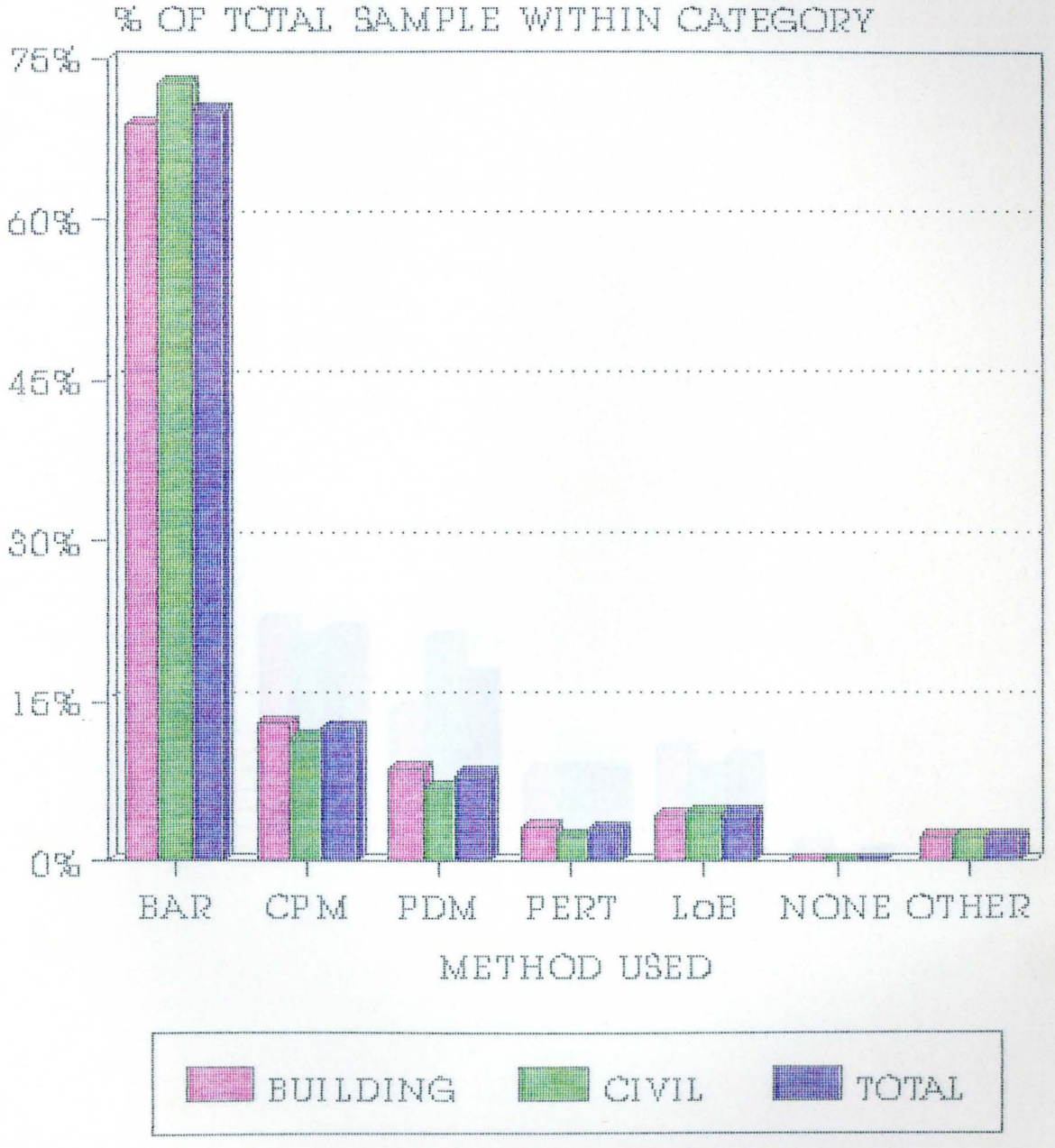
SCHEDULING DONE BY CATEGORY 2 CO.'S



GRAPH 3A

BAR PRESENTATION

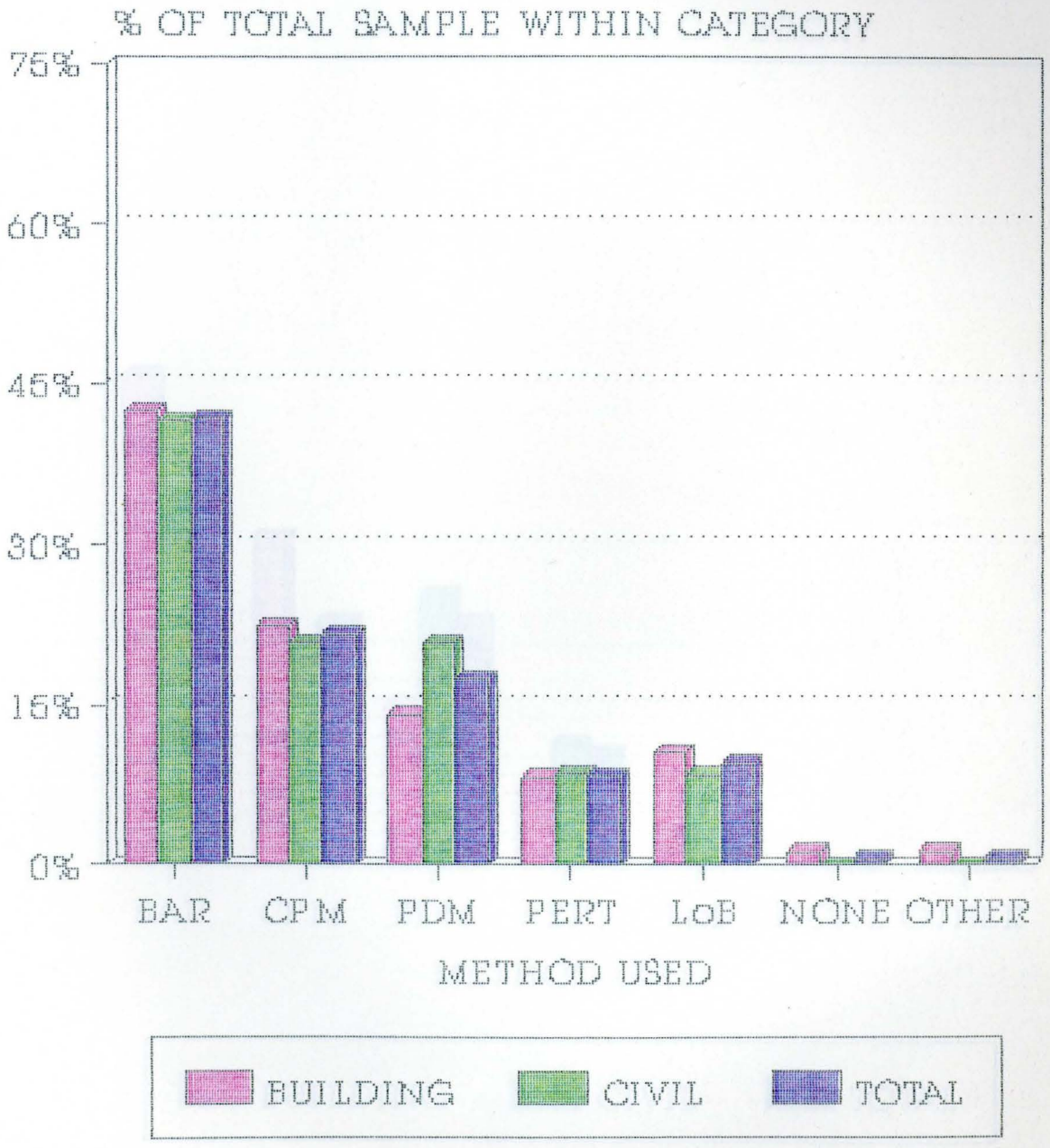
SCHEDULING DONE BY CATEGORY 3 CO.'S



GRAPH 4A

BAR PRESENTATION

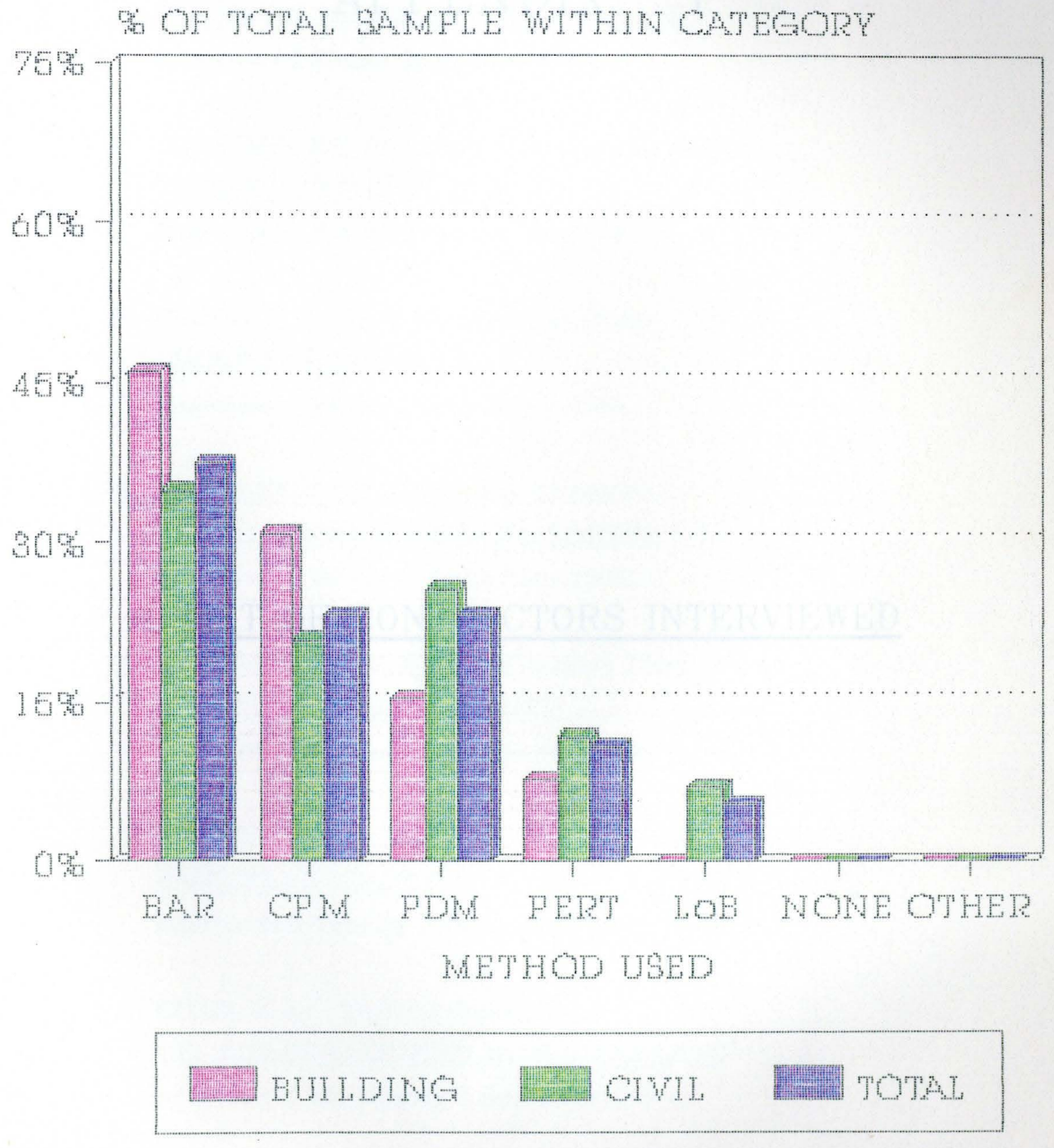
SCHEDULING DONE BY CATEGORY 4 CO.'S



GRAPH 5A

BAR PRESENTATION

SCHEDULING DONE BY CATEGORY 5 CO.'S



APPENDIX "F"

LIST OF CONTRACTORS INTERVIEWED

1. ARMSTRONG, T.; (Contracts Manager)
   WILSON BAYLY HOLMES (PTY) LTD
   Interviewed Tuesday 23 August 1988.

2. BALL, A.G.; (Executive Chairman)
   MOOLMAN BROTHERS CONSTRUCTION COMPANY
   Interviewed Monday 5 September 1988.

3. BRUCE, B.C.; (Managing Director)
   MURRAY & ROBERTS CIVILS (PTY) LTD
   Interviewed Friday 26 August 1988.

4. CARDOSO, F.; (Director of Building Division)
   TIBER BONVEC (PTY) LTD
   Interviewed Friday 2 September 1988.

5. CLOGG, P.; (Chief Executive Officer)
   GROUP FIVE LIMITED
   Interviewed Friday 9 September 1988.

6. CROWLEY, P.F.; (Managing Director)
   LTA EARTHWORKS (NORTH) LIMITED
   Interviewed Friday 2 September 1988.

7. CUNNINGHAM, R.W.W.; (Managing Director)
   GROUP FIVE ROADS LIMITED
   Interviewed Wednesday 31 August 1988.

8. DAMANT, K.E.; (Managing Director Building Division)
   BASIL READ LIMITED
   Interviewed Tuesday 6 September 1988.

9. ELGIE, K.J.; (General Manager)
   LTA BUILDING LIMITED WITWATERSRAND
   Interviewed Wednesday 7 September 1988.

10. ENSLIN, T.L.; (Sales and Marketing Manager)
    RACEC TRADE
    Interviewed Monday 22 August 1988.

11. FODEN, A.J.; (Director)
    GOLDSTEIN DESIGN
    Interviewed Wednesday 24 August 1988.

12. GIURICICH, R.M.; (Managing Director)
    GIURICICH BROTHERS (PTY) LTD
    Interviewed Thursday 24 August 1988.

13. HACKNEY, B.E.; (Chairman)
    LTA CONSTRUCTION LIMITED
    Interviewed Friday 23 September 1988.

14. HARTSLIEF, A.K.; (Contracts Manager)
    GOUGH COOPER HOMES (PTY) LTD
    Interviewed Wednesday 7 September 1988.

15. HAYWOOD, N.V.M.; (Technical Manager)
    LTA CIVIL ENGINEERING LIMITED
    Interviewed Tuesday 30 September 1988.

16. HOLMES, B.G.; (Deputy Chairman)
    WILSON BAYLY HOLMES (PTY) LTD
    Interviewed Tuesday 23 August 1988.

17. HOPCRAFT, R.; (Technical Manager)
    SCHACHAT CULLUM (PTY) LTD
    Interviewed Monday 29 August 1988.

18. HORWOOD, G.C.; (Managing Director)
    R McCARTHY & COMPANY
    Interviewed Monday 12 September 1988.

19. JACKSON, T.N.; (Managing Director)
S.M GOLDSTEIN & CO (PTY) LTD
Interviewed Wednesday 31 August 1988.

20. KENNEDY, A.C.; (Chief Planner)
MURRAY AND ROBERTS BUILDINGS (TVL) (PTY) LTD
Interviewed Tuesday 30 August 1988.

21. LOMAS, M.H.; (Managing Director)
SAVAGE & LOVEMORE (TRANSVAAL) (PTY) LTD
Interviewed Monday 29 August 1988.

22. MARAIS, D.F.M.; (Director of Business Development)
GRINAKER HOLDINGS LIMITED
Interviewed Tuesday 6 September 1988.

23. MOWLAM, W.K.; (Director of Contract Services)
CONCOR CONSTRUCTION (PTY) LTD
Interviewed Tuesday 30 August 1988.

24. NEUBURGOR, L.J.; (Managing Director)
RAPP & MAISTER CONSTRUCTION (PTY) LTD
Interviewed Monday 29 August 1988.

25. OTTO, H.J.D.; (Managing Director)
GOLDSTEIN CIVILS (TVL) (PTY) LTD
Interviewed Tuesday 23 August 1988.

26. RAIT, J.I.M.; (Managing Director)
WIMPEY HOMES (PTY) LTD
Interviewed Monday 5 September 1988.

27. ROUX, C.D.; (Managing Director)
CON ROUX (PTY) LTD
Interviewed Friday 26 August 1988.

28. SCHWARTZ, I.; (Manager Technical Services)
GROUP FIVE CIVILS LIMITED
Interviewed Tuesday 23 August 1988.

29. SEARS, B.; (Contracts Manager)
MURRAY & ROBERTS STRUCTURES (PTY) LTD
Interviewed Monday 22 August 1988.

30. WIEDERHOLD, J.; (Data Processing Manager)
S.M GOLDSTEIN & COMPANY (PTY) LTD
Interviewed Tuesday 23 August 1988.

APPENDIX "G"

LIST OF PROJECT MANAGERS INTERVIEWED

1. LOXLEY-FORD, C.; (Director)
   PROJECT MANAGEMENT INTERNATIONAL
   Interviewed Monday 3 October 1988.

2. STAPLEBERG, L.; (Managing Director)
   PRO-CRIT
   Interviewed Tuesday 4 October 1988.

3. OLIVIER, C.; (Planning Manager)
   GENREC
   Interviewed Tuesday 4 October 1988.

4. DAVIES, P.J.; (Group Marketing Director)
   TITACO PROJECTS (PTY) LTD
   Interviewed Wednesday 5 October 1988.

5. ISRAELITE, C.; (Partner)
   SCHNEID ISRAELITE & ASSOCIATES
   Interviewed Tuesday 11 October 1988.

6. HADJIHAMBI, M.; (Managing Director)
   NEOCON PROJECTS
   Interviewed Friday 14 October 1988.

7. KOCH, J.D.; (Senior Project Manager)
   ENGINEERING MANAGEMENT SERVICES
   Interviewed Thursday 6 October 1988.

8. HENDERSON, R.B.; (Managing Director)
   TIME PROJECTS (PTY) LTD
   Interviewed Friday 28 October 1988.

APPENDIX "H"

LIST OF FOREIGN INTERVIEWS

1. BARNES, M.; (Managing Director)
   MARTIN BARNES PROJECT MANAGEMENT, UNITED KINGDOM
   Interviewed Saturday 20 May 1989.

2. SMITH, N.; (Senior Lecturer in Project Management)
   UMIST IN MANCHESTER, UNITED KINGDOM
   Interviewed Thursday 25 May 1989.

3. THOMPSON, P.; (Head of Project Management Department)
   UMIST IN MANCHESTER, UNITED KINGDOM
   Interviewed Wednesday 06 September 1989.

4. WILLMER, G.; (Lecturer in Project Management)
   UMIST IN MANCHESTER, UNITED KINGDOM
   Interviewed Thursday 25 May 1989.

5. ZELENKA, D.; (Lecturer in Project Management)
   DARMSTADT UNIVERSITY, WEST GERMANY
   Interviewed Monday 8 May 1989.

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