Project Planner

Take control of time on any task

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Getting Started

Project Planner has been designed to cater for people with a wide range of backgrounds and skills. Many of you will therefore not need to read through this text from cover to cover in order to use the computer programs. To accelerate your progress, we suggest the following:

A. If you already understand the principles of Scheduling and Critical Path Analysis, simply turn to Chapter 10, where you will be given detailed instructions on how to use the Applications Program.

B. If you understand what Critical Path Analysis is, but don't know how to apply it, then turn to Chapter 1, and follow the instructions on how to use the Teaching Program.

C. If you are starting from scratch, if you don't have your Amstrad CPC464 handy, or if you simply want to take a more leisurely approach, then please read through the Introduction before you go any further.

NOTE

If you are not familiar with the procedures required to load the Teaching or Applications Programs into your computer, refer to Appendix 2, where you will find specific instructions for loading **Project Planner**.

Notes on Style

Please note that the typestyles used in AMSOFT publications are intended to help identify the different operations and sequences used in computer operation:

Keyboard actions that instruct a command sequence but do not necessarily have a corresponding representation on screen are shown in Helvetica 75 typeface. Non-printing keys are shown enclosed in square brackets:

P	Where the letter 'P' appears on the screen display
P **[ESC]**	As a command, with no corresponding displayed character

General narrative and descriptive text will be shown in one of a variety of serif typestyles, eg: Century, Palatino, Times etc.

Contents

Introduction

Welcome

Titles in the **BRAINPOWER** series are uniquely designed to harness the power of your Amstrad CPC464 to enable you to learn new skills in a simpler and more enjoyable way. The sophisticated interactive approach ensures that you can work at your own pace and, once you have mastered the topic, the Applications Program will continue to serve your needs. We have made every effort to create a course which is straightforward to use, but if you think that we could improve upon it, please send us your written comments.

Project Planner is a complete learning and applications course based upon the theory of Critical Path Analysis. Your purchase consists of three elements;

1) The Text Book which you are now reading. Please bear in mind that you will be using it continuously in conjunction with your Amstrad CPC464.

2) The Teaching Program, which will be used to give you a full understanding of the concepts of Critical Path Analysis.

3) The Application Program, which you will be able to use to solve your own scheduling problems.

You will find that the Teaching Program is not a simple tutorial on how to use the Applications Program. Once you gain an understanding of the material, you will be able to use Critical Path Analysis to solve problems with or without your computer.

If you think that you already have a sound grasp of the principles of Critical Path Analysis, then you may wish to try out the Applications Program immediately. If so, simply turn to Chapter 10. There you will discover the detailed instructions for solving your own scheduling problems.

Critical Path Analysis

Project Planner will present to you a simple, yet sophisticated analysis technique which will prove particularly useful in planning the schedule for any project, however complex. You will be able to manipulate the project parameters to determine the most appropriate course of action to suit your needs. When the analysis is complete, you will have a comprehensive master plan against which you can measure the progress of the project. The benefit of all such analysis techniques is that they provide you with a framework upon which you can build your understanding of the elements of a complex problem.

If you want to be able to predict with confidence how long a particular project should take, and when each of the component parts will occur, then you will find **Project Planner** an invaluable aid.

For those who are not familiar with the techniques involved, we should explain the nature of the problems which can be simplified using Critical Path Analysis. You will find that not all problems lend themselves to this method. In particular, situations which involve a high degree of uncertainty or indeterminacy and involve a measurable cost or benefit should be examined using Decision Analysis, Linear Programming, or Discounted Cash Flow techniques. These subjects are already, or soon will be available in companion **BRAINPOWER** titles.

Critical Path Analysis involves dividing a complex, but usually fairly clearly defined project which spans a significant period of time, into a series of component activities. The number of components is such that each is made simple enough to be easily understood, and hence the duration of each and its relationship with the other components can be quickly determined. The project is then 'reassembled' in such a way that its overall timescale is revealed. The technique generates a comprehensive timetable by which the progress of all components can then be measured.

An important feature of the analysis is the ability to dissect and reassemble the project in different ways to maximise the benefits to those concerned; usually to find the quickest or most cost efficient route. Further value is gained by using Critical Path Analysis as a tool to direct your valuable management time towards those elements in a project which control the overall project timescale.

As has been mentioned a number of times, the actual method presented in **Project Planner** is called Critical Path Analysis (CPA), whilst the discipline of using this analysis to manage a project is called Critical Path Management (CPM). You will often find that people use the two phrases interchangeably.

1. The Teaching Program

1.1 Teaching Method

Before we move into the stage of actually learning anything, we will quickly review how the computer is going to be used in conjunction with this book. First of all, you will find that all written explanations of the subject will appear in the book. We don't think that you want to strain your eyes reading computer screens full of text, and anyway computer memory is a relatively expensive medium for storing the written word. Because of this principle, you will be switching back and forth between book and screen all the time, so lay the book out next to the computer where you can refer from one to the other easily. You will find it useful to have a pencil and paper handy as well. The screen will be used to show you examples in operation and to present you with exercises so that you can check you own understanding.

As you work your way through the book, you will be asked to operate the computer by pressing certain keys. This is so that the computer knows which point you have reached. Any key you need to press will be highlighted in the manner explained at the front of the manual, such as **[SPACE]** or **4**. Likewise, when the computer wants you to return to the book, it will direct you to your place by giving you the number of the relevant chapter sub-heading.

1.2. The Six Step Process

Critical Path Analysis can be defined as a six step process, starting with the disassembly of the project and leading through to the production of the final presentation 'timetable'. The basic steps will be presented in the worked example in Chapter 2, and then each of the elements of the process will be explained in more detail in the subsequent teaching chapters. The steps can be defined as follows:

1) PROJECT STRUCTURE - Divide the project into easily handled component parts; determine the relationships between the parts, and draw a diagram of the relationships.

2) OVERALL DURATION - Apply the first stage of the Critical Path Analysis calculation to determine the length of time that the project will take.

3) CRITICAL PATH - Apply the second stage of the Critical Path Analysis calculation to indentify the key elements of the project which are determining the overall duration.

4) SPARE TIME - Review the project to find which components have freedom to be extended or delayed.

5) BALANCE - Rework the links between the project components to take maximum advantage of any spare time available.

6) PRESENTATION - Produce a Bar Chart with which you can communicate the final sequence and schedule of the project to others.

1.3 Getting Started

Instruct your computer to load in the Teaching Program. If you are a newcomer to computers, then you should refer to the loading instructions in Appendix 2. When the program starts, press the **[SPACE]** key, and it will display a list of options from which you can choose. The options relate to the chapter headings in the text book. You make your choice by using the **[SPACE]** and **[ENTER]** keys. Each time you press **[SPACE]**, the black bar will move one step down the list, and if it is at the bottom, it will jump to the top. When the bar is on the item you wish to select, press the **[ENTER]** key, and the computer will act on your choice. This type of selection list will be referred to as a `MENU` from now on.

When you use the program for the first time, you should select the first option '`A Worked Example`', from the menu, but on subsequent occasions, you can choose the option for the particular unit you wish to study.

```
MENU
A Worked Example
Project Structure
Overall Duration
The Critical Path
Spare Time
Balancing The Schedule
Presentation
Summary & Practice
```

Once an option has been selected, the computer will have to load another section of the program. If you are using a cassette tape recorder, this can take quite a long time, particularly for the later topics, so please be patient.

When the correct section is loaded, the computer will give a message confirming the name of the unit and it will point you to the correct chapter in the book. Once any one unit is completed, the program will always give you the option of repeating the unit, stopping, or going on to the next unit. From time to time, instructions will be displayed on the screen which are not mentioned in the book. Always read and follow these instructions carefully.

Before you begin, remember to equip yourself with a pencil and paper, in order that you can make notes and sketches as you go. You should also be prepared to concentrate on a unit for quite a long period of time, for although we have made each step as simple as possible this is not a trivial subject to study. There will be plenty of opportunities to rework sections and ensure complete understanding, and of course plenty of practice to build your confidence.

1.4. Using Networks

The only simple way of performing a manual Critical Path Analysis is to construct a diagrammatic representation of the relationships between the components of the project. This is the technique used and explained in the Teaching Program. However, once you employ your Amstrad CPC464 to perform the analysis for you, the network is no longer required. The computer can jump directly to producing a bar chart presentation document. The process of drawing a bar chart from a network is explained in Chapter 8.

2. A Worked Example

2.1. The Problem

To provide you with an overview of how Critical Path Analysis is applied, this chapter will demonstrate the techniques on a very simple example. Do not be too concerned if you cannot follow the process through every step, because the Teaching Program will explain all the steps in detail in the chapters which follow.

The example concerns a businessman who wishes to prepare a timetable for the steps involved in opening a new bookshop. He has divided the project into eight basic steps, and has estimated how long each will take. To make it simpler to refer to them later, each activity has been given a number. They may not be strictly in the order that they must be performed, but that does not matter for the purpose of this analysis:

1. Arrange a source of finance;	6 weeks
2. Engage the staff;	4 weeks
3. Find some premises;	8 weeks
4. Purchase a stock of books;	5 weeks
5. Install the shopfittings;	4 weeks
6. Prepare an advertising campaign;	8 weeks
7. Stock up the shop;	2 weeks
8. The grand opening;	1 week

The businessman has noted that this adds up to a total time of 39 weeks, but he can see that some of the work can be 'overlapped' with other tasks. This is the type of problem which Critical Path Analysis can easily resolve. Incidentally, the jobs or tasks which make up a project are usually called **activities**, and that is the word we will use in future.

2.2. Putting Things in Order

The list of activities to be completed before the shop can open is roughly the correct sequence, but it is obvious that some activities can be done at the same time as others. In fact, it is easier to think of the list in terms of what **cannot** be done simultaneously. Imagine that we have discussed this issue with the businessman, and he has confirmed the following;

a) Nothing else can be done until the finance is arranged.

b) The shopfitting cannot be done until the premises have been arranged.

c) The advertising cannot be planned until the location of the shop is confirmed, and the nature of the stock to be purchased is finalised.

d) The shop cannot be stocked up until the staff are hired, the stock is available, and the shopfitting is complete.

e) The shop cannot be opened until everything else is finished.

From these points, we can write down a list of what must be completed before each activity can start. Activities which must be completed before a particular activity can begin are known as the **prerequisites** of that activity. The word 'prerequisite' simply means 'required before'. The list appears as follows, with the prerequisites identified by the activity number from the left hand column. The letters in the last column explain which of the points (a to d) listed above provided the source for determining the prerequisites:

Activity Number	Description	Prerequisites	Source
1.	Arrange a source of finance;	No prerequisites.	
2.	Engage the staff;	1	a
3.	Find some premises;	1	a
4.	Purchase a stock of books;	1	a
5.	Install the shopfittings;	1 and 3	a, b
6.	Prepare an advertising campaign;	1, 3 and 4	a, c
7.	Stock up the shop;	1, 2, 3, 4 and 5	a, d
8.	The grand opening;	1,2,3,4,5, 6 and 7	a, e

The list of prerequisites can be simplified, because some prerequisites are inherent in others. For instance; activity number 5 has prerequisites 1 and 3, but activity 3 already has prerequisite 1 and so giving activity 3 as a prerequisite automatically includes activity 1. The simplified list becomes;

Activity Number	Description	Prerequisites
1.	Arrange a source of finance;	No prerequisites.
2.	Engage the staff;	1
3.	Find some premises;	1
4.	Purchase a stock of books	1
5.	Install the shopfittings;	3
6.	Prepare an advertising campaign;	3 and 4
7.	Stock up the shop;	2, 4 and 5
8.	The grand opening;	6 and 7

2.3 Laying Out the Sequence

The key technique used to perform a manual Critical Path Analysis of a project is the construction of a diagram which represents the sequential relationship between the activities. Each activity is drawn as a circle, called a **node**, and lines are drawn between the nodes to demonstrate the prerequisites. We will now use the computer screen as a drawing board, and create on it a diagram to represent our example.

1) Select the activity from the list which has no prerequisites; activity number 1. This is represented by a circle at the left hand side of the screen - press **G O** and the computer will draw this. The node is numbered to remind us which activity it represents.

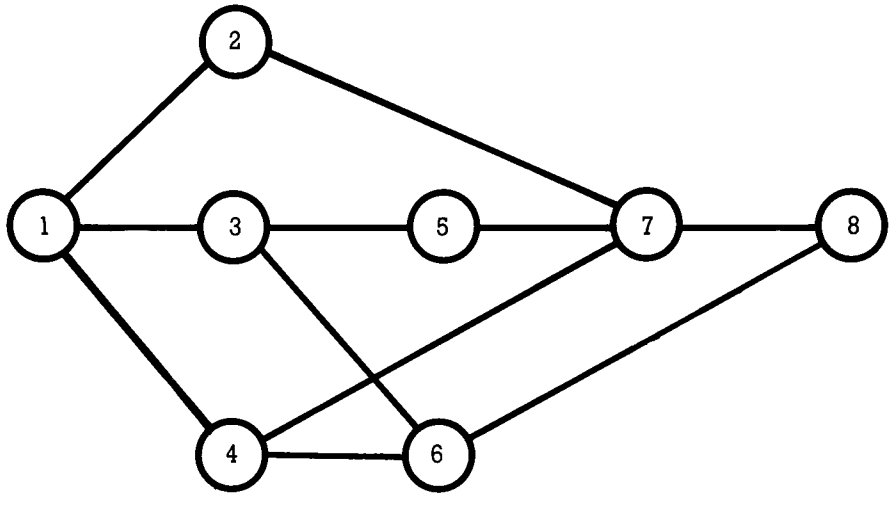
2) Select any activities which have only activity 1 as a prerequisite. In this case, the activities involved are numbers 2, 3 and 4. We need a circle to the right of node 1 to represent each of them, and then we must draw a line from node 1 to each to represent the prerequisite link - press **1**, and the computer will do this for you. We now have activities 1 to 4 represented on the diagram.

3) Choose all activities which have any of the activities already drawn (1 to 4) as prerequisites, but no others. Thus we choose 5 and 6, but not 7, because 7 also has 5 as a prerequisite. 5 and 6 are inserted as circles to the right of the nodes which represent their prerequisites, with lines to indicate their prerequisites - press **2** to display this. Activities 1 to 6 are now represented.

4) Repeat the process used in step 3 until all of the activities are represented on the diagram. In this case, the process is repeated twice; firstly adding activity 7 - press **3**, and secondly adding activity 8 - press **4**.

The diagram is now complete . It includes a circle (or **node**) for each activity and all of the prerequisites are represented by lines linking the nodes together. The diagram is called a **network**, because it is formed from a network of nodes and lines. You will note that activities which must be performed first are to the left of the screen, and those to be performed last are to the right; time 'passes' from left to right through the network.

The computer will offer you the opportunity to repeat the process of constructing the network, or you can choose to continue with the next section.



2.4. How Long does it Take?

Now that we have a network which represents the project, calculating the time from start to finish is a simple matter of addition, but first we will mark on the network how long each activity will take. In critical path language, a period of time is referred to as **duration**. We will write the duration of each activity just above the appropriate node. It is essential for the performance of the analysis, that all of the durations are given in the same units. In this particular case, the unit of time we are using is a week, but on other projects if could be more convenient to use days or months. Press **5** to display all of the durations on the network.

We will now run through the network and write the starting time of each activity above, and to the left of, the duration, and the finishing time next to it, separated by a dash (-):

1) The first activity, the one with no prerequisites, is activity 1. This can start at any time we wish, but by convention, we will set it to start at time zero. It will finish 6 weeks later, at time 6. Press **6** to display this on the network.

2) Next, we can add the start time of activity 2. This can start when activity 1 is finished, on week number 6, and it will finish 4 weeks later, on week 10. Press **7**.

3) Similarly, the start and finish of activities 3 and 4 can be added, they both start on week 6, when activity 1 is completed, and their finish times are found by adding their respective durations to the starting time. Work out what you think they should be, and then press **8** to see if you are correct.

4) The next activity to study is number 5. It starts when activity 3 ends, and finishes 4 weeks later - press **9**.

5) Now activity 6 is more complex because it has not one, but two prerequisites. It cannot start until activities 3 and 4 are finished. Therefore we look to see which one finishes later. Activity 3 finishes in week 14, and activity 4 in week 11. Hence, activity 6 cannot start until week 14, and must thus finish in week 22. Press **0** (Zero) to display this.

6) Activity 7 is similarly treated, because it has three prerequisites, the latest of which to finish is activity 5, in week 18. Calculate activity 7's finish date, and then press **1** to find the correct answer.

7) Finally, activity 9 has two prerequisites. See if you can find the start and finish date, and then press **2**.

We now know how long the whole project will take; we have the start and finish week of every activity, and the last to finish is activity 8, in week 23. Once again, the computer will offer you the facility to repeat that part of the presentation if you wish, or you can go on to the next section.

2.5. Critical Activities

What we in fact calculated in the last section was the **earliest** week that each activity could start and finish. We can now work backwards through the network to determine the **latest** week that each could start and finish without affecting the end date. We simply reverse the process which we have just applied, and use the most complex maths which you need for this program - subtraction!

1) We already know that the finish is week 23, and if this is to remain fixed, activity 8 must start in week 22. Therefore, for activity 8, the earliest and latest start and finish times are the same. Press **3** to see the latest start and finish times appear below the earliest start and finish times.

2) Going back to activity 7, we know it must finish in time for activity 8 to start on week 22. Therefore the latest finish week for activity 7 is 22. Subtract the duration of 2 weeks from 22 to find the latest start week, 20. Press **4** to display the figures. Notice that for this activity, the latest start and finish weeks are 2 weeks later than the earliest start and finish.

3) Activities 6 and 5 can be treated in the same way. Press **5** to display the results.

4) Activity 4 is a little different, because it is followed by both activities 6 and 7. The latest finish of activity 4 cannot be delayed any more than the latest start of both of these activities. Activity 7 must start no later than week 20, but activity 6 must start by week 14. Therefore, activity 4 must finish no later than week 14. It must start 5 weeks before, so the latest start and finish are weeks 9 and 15 respectively. Press **6** to display this.

5) Now activities 3, 2 and 1 can be treated in turn in this way, making sure that the latest finish of each is no later than the latest starts of the activities which follow. If you press **7**, the remaning latest times will be displayed.

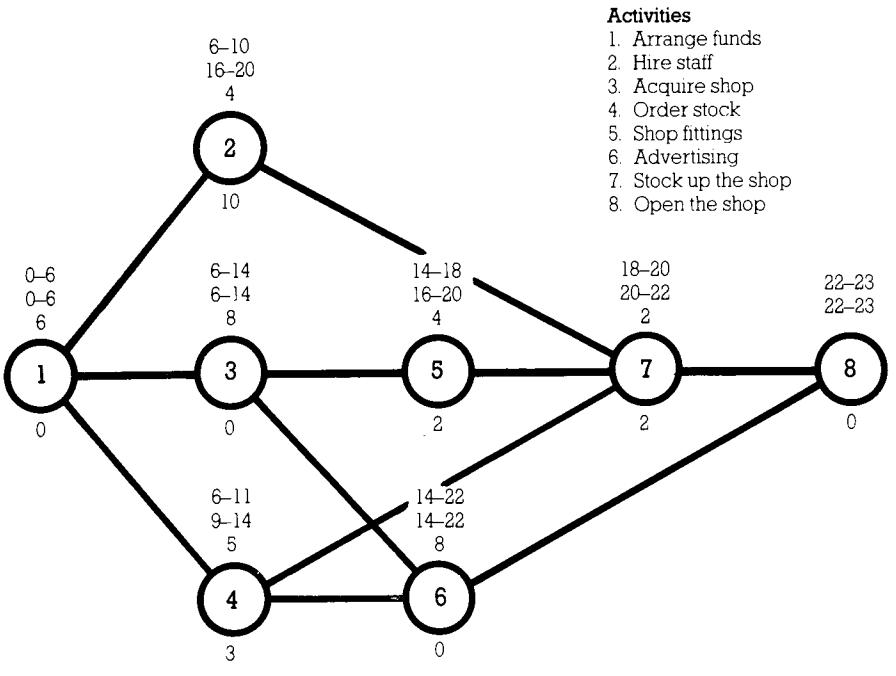
There now remains one important task to perform before the analysis is complete; for each activity, we subtract the earliest start week from the latest start week. The result is called the **float** of the activity. This represents the amount of spare time available to perform that particular job. Press **8** to display all of the floats beneath their respective nodes. You will notice that activities 1,3, 6 and 8 have zero floats. These activities must be performed on time, or the project will be delayed. They are the **critical** activities, and the line connecting these activities is called the **critical path**. Press **9**, and the critical path will be highlighted.

2.6. Summary

From the analysis, we know how long the whole project will take, when each activity can start, and which activities are critical to finishing on time. The value of this as a management tool is that it lets you know which elements of the project are deserving of the most attention, and where you have time to spare.

If you are unsure how we reached these conclusions, then do not be concerned. This program goes on to explain each of the elements of Critical Path Analysis in more detail, and provides practice routines so that you can become completely familiar with the process. If you are ready to continue, select the option on the screen to move on to the next module, or you may prefer to run through this chapter again.

If you did understand how we worked through it, then you may feel that you can attempt to analyse a project for yourself, either on paper, or using the Applications Program. If you do decide to use the Applications Program, you will find that it produces additional information which we have not yet explained, and it presents the results in the form of a **bar chart**, rather than a network.



3. Project Structure

3.1. Three Step Process

In the worked example, we performed three steps to create the network on the computer screen. The steps were as follows:

1 - Identify the Activities
2 - Define the Prerequisites
3 - Lay out the Network

3.2. Activities

Your first task is to divide the project you wish to analyse into individual activities. The way you make this division depends to a large extent on the nature of the project and the people involved, but the key is to divide it into as few parts as necessary to perform the analysis. The activities must be small enough so that:

1) The duration of each activity can be calculated or determined without to much difficulty.

2) The activity is within the direct control or responsibility of a single person.

An example may help to clarify this concept. If you engage Jack Brown, the builder, to construct an extension to your house, you can consider the construction of the extension as a single activity. As far as you are concerned, you can ask Jack how long it will take, and you know that he is responsible for the whole thing. Therefore, from the rules noted above, there is no point in dividing the project into parts.

Jack, on the other hand, will see it rather differently. He will employ suppliers and subcontractors to handle various parts of the work, and he will divide it into a number of activities. For instance, the extension has three large aluminium window frames to install. Jack therefore rings Acme Aluminium for a price quotation and a delivery time. Jack treats the aluminium window delivery as a single activity, because it is a small enough task for him to determine a duration, and to define responsibility.

Now consider Acme's view of the window order. Jim Bacon, the foreman has to calculate exactly how long the order will take to complete. There are three processes involved; cutting the aluminium parts, assembling the frame and finally glazing and packing for transport. Each process is handled in a different department, and each window must be constructed in turn. Jim therefore divides the work into nine activities; cutting, assembling and packing for each of the windows.

So you can see how the rules are applied to divide a project into activities. There is little point in the builder concerning himself about the way the windows are constructed, even though he needs to draw a network of the extension project. There is even less value in you, as the owner, analysing how long the extension will take in terms of how much time Jim Bacon's packing department will spend on each of your windows; but to Jim, it is essential. So, when you define activities for your projects, be sure that each activity is within the control of one person, and that you can readily define the duration.

3.3. Prerequisites

Once you have established a list of activities, the actual prerequisites for each activity are fairly straightforward to determine. Simply look through the list and for each activity, ask yourself 'what must be completed before this can start?' We will consider Jim Bacon's project at Acme Aluminium. He has divided the work into the following activities:

1) Cut parts for window no. 1
2) Assemble window no. 1
3) Glaze & pack window no. 1
4) Cut parts for window no. 2
5) Assemble window no. 2
6) Glaze & pack window no. 2
7) Cut parts for window no. 3
8) Assemble window no. 3
9) Glaze & pack window no. 3

He knows that windows cannot be assembled until the parts are cut, and they cannot be glazed and packed until they have been assembled. He also knows that each department can only work on one window at a time. What do the prerequisites look like for each activity? List them out on paper, and then try a simple test on the computer by pressing **P** and then **S**.

3.4. Network Layout

The network is absolutely essential for performing a Critical Path Analysis by hand. However, laying out a network is more of an art than a science, and on complex projects, you could expect to redraw it a number of times. Fortunately, if you use a computer based Critical Path Analysis method, such as the Applications Program included in **Project Planner**, you will not need to draw a network. All of the calculations are performed instantly and accurately, and you can make alterations as often as you wish.

With the powerful Applications Program at your disposal, it is unnecessary to teach you how to draw a network. However, you may enjoy trying your hand at producing some networks, and it will reinforce your understanding of how and why the system works. We can offer the following practical advice which may be of assistance to you:

1) Write down a list of all of the activities before you begin, and number each activity. Note the prerequisites and the duration for each, together with notes on how you worked them out, and any special comments.

2) Use graph paper, or some other form of paper with horizontal and vertical lines marked on it. This will help you to lay out the nodes neatly.

3) Always work in pencil, and be prepared to erase parts of your work and to redraw them.

4) Always number the nodes as soon as you draw them, so that you do not forget which activities they represent.

5) Be consistent with the direction in which you lay out the nodes. Start with the earliest activities at the left hand side of the page, and move to the right with subsequent activities.

6) Establish a standard format for writing all of the information around each node. For instance, you could choose to write the duration immediately above the node and the description beneath it.

7) If the project is very large, see if you can divide it into a number of smaller projects, and then develop a network for each before finally joining them all together.

8) Do not be too concerned about the neatness of the network's appearance, as long as it is clear to you. We will explain later that the network is for your own use as a tool of analysis. If you wish to present your results and conclusions to others, then they should be redrawn onto a **bar chart**, which can be as simple or as ornamental as you wish.

The Acme Aluminium problem is a very simple example. If you press **1**, the computer screen will display one way of laying it out as a network. In fact, some further thought about presentation suggests a slightly better format. Press **2**, and the first and last nodes will move. The network is now presented in a way in which all the operations by one department are on one horizontal line. This is a useful layout, because when all of the calculations on the network are completed, it will be simple to scan along the lines and examine the workload of each department. It also shows more clearly the regularity of the flow of work. Any 'special' job going through the factory in a different sequence would stand out very clearly.

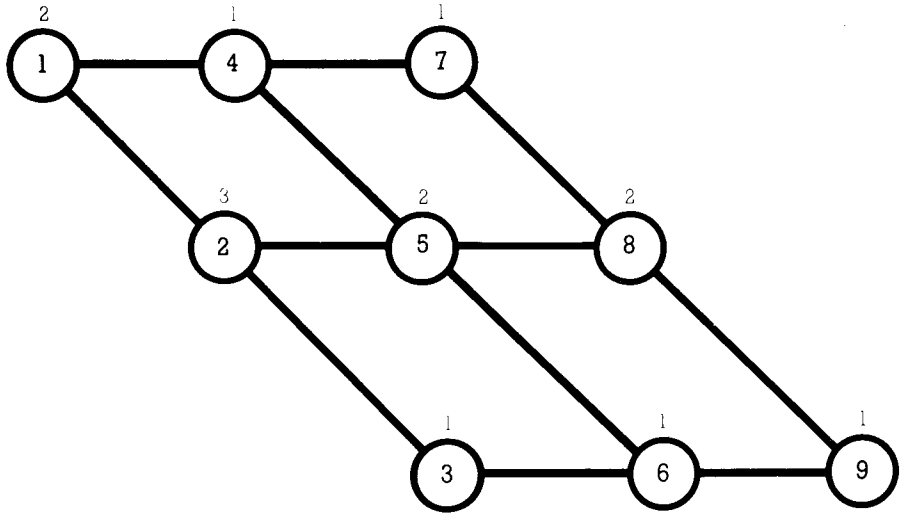
3.5. Activity Times

Now that the network has been created on paper, or in this case on the screen, the only other information required before an analysis can be performed is the duration of each activity. Once again, it is impossible to help you with the assessment of these individual durations for your own projects, but you should find that it is possible for you to make a reasonable estimate. You should always attempt to identify the 'most likely' durations, rather than the best of worst times. In this way, the average errors will tend to balance out, and the overall duration estimate for a project will be relatively accurate.

Now back to the Acme Aluminium Company. Jim Bacon has spoken to the leading hand in each department, and has agreed the durations for the work with each. They have made allowance for the fact that they will have to allow time to set up for the first window, but the second and third will be a little quicker to handle. The durations they anticipate are as follows:

Activity	Window 1	Window 2	Window 3
Cutting	2 days	1 day	1 day
Assembly	3 days	2 days	2 days
Glazing & Packing	1 day	1 day	1 day

If you now press **3**, these durations will be added to the network on the screen, and once that is done, it is ready for analysis.



4. Overall Duration

4.1. Demonstration

The simplest way of explaining the technique involved in calculating overall duration is by demonstrating its application on the shop establishment network. Press **0** **D** to display the network. What we have to do is to calculate the earliest time that each activity can begin and hence the earliest time that it can end. The steps involved are as follows:

1) Determine which activities are the prerequisites of the activity being examined. These are easy to find, because they must be to the left of the activity in question, and must be linked directly to it by connecting lines.

2) Identify the earliest finishing time of all of the prerequisites.

3) The latest of these finishing times represents the earliest time at which the activity under consideration can start, and is recorded on the network as such.

4) The earliest finish time for the activity is found by adding the duration to the earliest start time.

This process is repeated for each activity on the network. Notice that the way the prerequisites are linked will determine to some extent the order in which the activities are handled. An activity's earliest start and finish cannot be calculated until all of its prerequisite activities have been resolved.

The first activity on a network has no prerequisites to determine its earliest start. The earliest start in this case is taken as time zero. Now press **1**, and watch the computer perform this operation on the shop establishment network. Please follow any instructions which appear on the screen.

4.2 Results

What this first forward pass through the network reveals to us is the overall duration of the project. In this case, the duration has been determined to be 23 weeks. The first pass also provides information on the earliest start and earliest finish of each activity. This information has been listed in the table at the top of the next page.

Activity Number	Description	Earliest Start	Earliest Finish
1.	Arrange a source of finance;	week 0	week 6
2.	Engage the staff;	week 6	week 10
3.	Find some premises;	week 6	week 14
4.	Purchase a stock of books;	week 6	week 11
5.	Install the shopfittings;	week 14	week 18
6.	Prepare an advertising campaign;	week 14	week 22
7.	Stock up the shop;	week 18	week 20
8.	The grand opening;	week 22	week 23

4.3. Review Problem

Now that you have seen how this operation is performed, it is time to let you try a problem of your own. Press **2**, and the Acme Aluminium network will appear on the screen. Simply follow the instructions to select each activity in turn and supply the appropriate start and finish times. As you can see, the hardest part of the process is some adding up, and even then the numbers have been kept very simple!

5. The Critical Path

5.1 Another Demonstration

As in the last chapter, we are going to use an example on the computer screen to demonstrate this part of Critical Path Analysis. Press **C P** to display the network. This time, we are going to work out how long we can delay each activity without causing a delay to the whole project. That is, we want to know the latest time that each activity can start and finish. To do this, we work through the network backwards, doing exactly the opposite of what we did on the first pass. The steps involved for each activity are as follows:

1) Determine which activities follow the one being examined. These are easy to find, because they must be to the right of the activity in question, and must be linked directly to it by connecting lines.

2) Identify the latest start time of all the following activities.

3) The earliest of these latest start times represents the latest time at which the activity under consideration can finish, and is recorded on the network as such.

4) The latest starting time for the activity is found by subtracting the duration from the latest finish time.

These steps must be applied to each activity in turn, starting from the very last activity this time. Because we do not wish the project to be delayed, the latest finish time of the last activity is taken as the earliest finish time already calculated; in this case, week 23. Now press **1**, and watch the computer perform this operation on the shop establishment network. Please follow any instructions which appear on the screen.

5.2. Further Results

As a spot check, the latest start of the first activity must be the same as the earliest start, zero. If it is not, then there is an arithmetic error in the calculations.

The most important point to notice is that, for some activities, the earliest and latest start times are the same. What this means is that these activities cannot be delayed in any way without delaying the overall finishing date. These are the **critical activities**, and the links joining them together form the **critical path**. Press **2** to highlight the critical path on the screen.

In this case, the critical activities are:

1. Arrange a source of finance;	week 0	to	week 6
3. Find some premises;	week 6	to	week 14
6. Prepare an advertising campaign;	week 14	to	week 22
8. The grand opening;	week 22	to	week 23

These are the particular activities upon which the businessman should concentrate his efforts to ensure that the shop opens on the expected date. From this, you will recognise the management implications of a Critical Path Analysis. You can discover where your valuable time and effort will have the most cost-effective results.

5.3. Review Problem

Once again, you have seen how the operation is performed, and now you must try the problem on your own. Press **3**, to display the Acme Aluminium network. Follow the instructions in the same way as before to select each activity. Remember to begin at the end and work backwards, and supply the latest start and finish times. This time, it is slightly harder because the calculations involve subtraction, rather than addition. When you have completed the times, the computer will ask you to define the critical path. Just insert the numbers of the critical activities in accordance with the instructions on the screen.

6. Spare Time

6.1 Float

Key in **S T** on the computer to display the shop establishment network as it currently stands. You can see the critical activities; those with earliest and latest times that are the same, such as activity 6, for instance. But what about the other activities? What does the difference between the earliest start and latest start represent? This is the amount of time by which the activity can be delayed without delaying the finishing time of the last activity. This spare time on each activity is called **float**. By definition, critical activities are those which have a float of zero. Press **1**, and watch the computer calculate the float for each activity.

Now that you have seen the computer do this, press [2] to display the Acme Aluminium network. Follow the instructions on the screen, and insert the float for each activity.

6.2. Free & Interfering Float

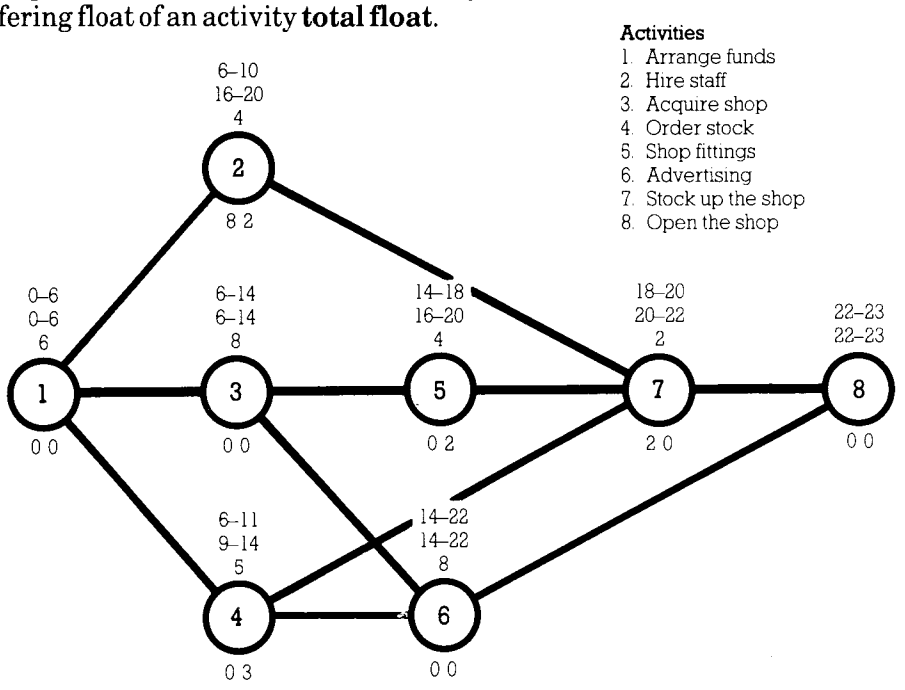
This business of float is not quite as simple as it appears at first. We will demonstrate this by considering some of the activities in our example. Redisplay the shop network by pressing **3**.

If you look at activity 5, you will find that it has a float of 2. Its earliest finish is week 18, and its latest is week 20. Notice what would happen to activity 7 if activity 5 took advantage of its float. Activity 7 could start on week 18, but if the finish of activity 5 was delayed until week 20, activity 7 would be delayed as well. This would still not delay the project because activity 7 has 2 weeks float, which the delay would use up. Thus, a delay in activity 5 would use up the float of activity 7 as well. We say that activity 5 would **interfere** with activity 7, and thus activity 5's float is called **interfering float**. It does have a float, but it must be used with care, because it will delay another activity even though it does not delay the whole project.

Activity 4, on the other hand, is rather different. It has a float of 3 weeks. Its latest finish can slip back from week 11 to week 14 without delaying the project. In fact, it can slip back from week 11 to week 14 without delaying any other activity. The activities which follow, 6 and 7, have earliest starts of week 14 and week 18 respectively. Thus the float of activity 4 can be used up quite freely without regard to the rest of the project. Therefore, this is called **free float**. If you study the network, you will find that the 2 week float of activity 7 is also free float.

The float of an activity does not have to be just free or interfering float. Some activities have both. Activity 2 is an example of this. It has a float of 10 weeks. The only activity which follows is number 7, which has an earliest start of week 18.

Thus activity 2 can be delayed in finishing from week 10 to week 18 without delaying activity 7. The remaining 2 weeks of float would delay activity 7 if used. Hence the float of activity 2 can be divided into 8 weeks of free float plus 2 weeks of interfering float. 8 plus 2 add up to 10, the float already calculated. We call the sum of free and interfering float of an activity **total float**.



6.3 Calculating Floats

The process to be applied to each activity in the network to determine free and interfering float is as follows:

1) Calculate the total float by subtracting the earliest start from the latest start (subtracting earliest finish from latest finish will give the same result). If the total float is zero, then the activity is critical, and none of the following steps need be applied.

2) Find the earliest starts of all of the immediately following activities, and select the earliest of these times.

3) Subtract the earliest finish of the activity in question from the earliest start found from step (2). This result is the free float of the activity.

4) Subtract the free float found in step (3) from the total float found in step (1). This result is the interfering float.

Press **4** and watch the computer perform this operation on each node in turn. Note that the computer will replace the total float figure with the interfering float. There is no need to display free as well as interfering and total floats, because they clutter the diagram. If you want to know a total float value, simply add the free and interfering floats together.

6.4 Review Problem

Press **5** to redisplay Acme Aluminium. The computer will ask you for the free and interfering float for each activity in turn. When you give the correct interfering float, it will overwrite the total float figure previously displayed. Remember that for critical activities, the free and interfering floats are both zero.

7. Balancing The Schedule

7.1 Saving Time

If you wish, you can accept the start and finish times generated by the forward and backward passes through the network. You can then plan to have the project undertaken accordingly. But what if the finishing date calculated from the network is too late to suit your requirements? What would happen in our example, for instance, if the businessman was advised by the bank that finance would only be made available if he had the shop trading within 22 weeks, 1 week sooner than the network shows? Where should he try to save the time? Press **B S** to redisplay this network.

7.2 Critical Activities

Well the answer is available from the network. There is no point in trying to save time on the activities which have float in them. There is already time to spare for them. You must concentrate on the critical path. If 1 week can be saved on activity 6, for instance, then the whole project will also be shortened by 1 week. Press **1** to see how this happens. A saving of 1 week on activity 4, on the other hand, will only increase the free float of that activity by 1 week, without changing the overall project. Pressing **2** will demonstrate this.

Notice, however, that a time saving on a critical activity may not always be fully reflected in time saved on the project. Press **3** to see what happens if a saving of 4 weeks can be achieved on activity 6. You will find that the project duration is only reduced by 2 weeks to 21 weeks. This is because the time saving on the activity is so great that it is no longer critical. The critical path now passes through activities 1, 3, 5, 7 and 8. The possibility that time saving on a single activity may change the critical path means that it is essential to recalculate the entire network each time you make a change. This can be a painful process if you are analysing the program manually, but it is handled automatically by the Applications Program.

7.3 Prerequisites

There is a second way of changing the overall duration of a project which may not require time saving on individual activities. This involves reconsidering the prerequisites of the activities. For instance, if the businessman can modify his plans slightly so that activity 3 (find some premises) is no longer a prerequisite of activity 6 (prepare an advertising campaign), the critical path will change, and 2 weeks will be saved from the project. Press **4** to see how this happens.

7.4 Sensitivity Analysis

The essential point in this chapter is that a single analysis of a project is not sufficient. The opportunity must be taken to see how changes to times and prerequisites can alter the overall project duration. It is also important to identify those activities about whose durations you are uncertain. If you think that there is a risk of an activity being delayed, you can change its duration on the network and see what the overall result would be.

Fortunately, making use of the Applications Program which is included in this pack will enable you to test all of these issues quickly and efficiently. Be sure to take advantage of this amenity.

8. Presentation

8.1. Communication

No matter how carefully you draw a network of your project, by the time you have finished, it will be at best confusing and at worst a mess. You will have written all of the information on it - descriptions, durations, starts, finishes and floats. You will also have changed it and reworked it a number of times. If you now want to explain to someone how the project will proceed, DO NOT SHOW THEM THE NETWORK. It is your working document, and it will probably mean nothing to someone else. It is not intended to be a document to communicate with others.

What is required is a simplified diagram which clearly shows the key information about the project. This key information includes;

1) A list of all of the activities involved.
2) The duration of each activity.
3) The earliest start and finish times for each activity.
4) The amount of float for each activity.

The diagram we are going to use is called a **bar chart**.

8.2. The Bar Chart

The bar chart is laid out by listing all of the activities of the project down the left hand side of the page, and drawing a scale along the top of the page to represent the time, or duration. The scale must be determined to span the entire period from the start of the first activity to the completion of the last. Adjacent to each activity, a horizontal **bar** is drawn which starts beneath its earliest start time on the scale at the top of the page, and finishes beneath its earliest finish time on the scale.

To clarify this explanation, we will now demonstrate the way in which a bar chart is created for the shop network. Press **B C** to start the program, and list the activities down the side of the screen. Across the top, we draw a scale to cover the project duration of 23 weeks - press **1**. Now we will consider the first activity. This starts in week 0 and finishes in week 6. Therefore we draw a bar from 0 to 6 alongside the activity - press **2**. Next, activity 2 starts in week 6 and finishes in week 10, so draw a bar accordingly - press **3**. The program will continue in this way to draw a bar for each activity if you now press **4**.

The chart now shows at a glance how long each activity will take, and when each will start and finish. As an aid to clarity, it is best to show the critical and non-critical bars in different ways - press **5** to do this. Finally, we can add two more symbols to show the free and interfering float on the end of the appropriate activities. These extended bars can be added to the end of the main bars, by giving them the length of the float period. Hence, the bars will be extended to the latest finish time of each activity. Press **6** to add free float to the chart and **7** to add the interfering float.

The chart you now see is a very much clearer way of presenting the information to others. In fact, this is the way that the Applications Program will present information to you. You will never see the computer's network, which will remain hidden inside the program in algebraic form.

8.3. Review Problem

Now it is your turn to try drawing a bar chart. The computer will make it simple for you by listing the activities of the Acme Aluminium project and setting the scale. Just press **8** to start the process and follow the computer instructions to produce the bars for each activity.

9. Summary & Practice

9.1 Step by Step

The process of performing a Critical Path Analysis is quite straightforward, and you should now feel able to work through a project on you own. Each stage has been explained in the preceding chapters, but for your convenience, here is a full list of all the steps involved:

1) Divide the project into a reasonable number of activities. Do not create too many, but be sure that the duration of each one can be readily calculated.

2) Determine the prerequisites of each activity.

3) Draw a network of the project, numbering each node, and when it is complete, add the activity descriptions and durations.

4) Make a first, forward pass through the network to calculate the earliest start and earliest finish for each activity, and the project duration.

5) Make a second, backward pass through the network to calculate the latest start and latest finish for each activity. Find the activities with zero float and mark in the critical path.

6) Calculate the total, free and interfering float for each non-critical activity.

7) Review the network, deciding whether the overall schedule can be improved by changing individual durations and prerequisites.

8) Reformat the results onto a bar chart to make it easier for others to understand the project.

9.2. More Practice

Finally, before attempting to apply **Project Planner** to your own projects, it would be wise to run through a few sample problems to check your skill. We have two problem sets for you. The first is a series of analysis exercises in which the computer will generate networks with durations and prerequisites marked in. You can do as many as you like, and the computer will always give you a hand if you get stuck.

The second practice exercise is a larger project. You will find it described in Appendix 1, section A1.3. Use the Applications Program to work out a solution for yourself. You will need to read through Chapter 10 to familiarise yourself with it. When you are satisfied with your results, save your work, and load our answer into the Applications Program to see how we saw the problem - it is filed after the Applications Program. Good luck, and press **M P** to proceed with the first series of exercises.

10. Applications

10.1 Introduction

The way in which the Applications Program facilities are made available differs slightly between the cassette tape and disc versions. In the cassette tape format, some non essential functions have been incorporated into a secondary program called DATES which follows the main program on the tape. Much of the time, you will find it unnecessary to use this program. The disc version, on the other hand, takes advantage of the rapid random access feature and switches automatically between the main and DATES programs as required. The instructions which follow are designed to support the tape version. Disc users are asked to refer to the panels inset in the text to find where their program differs.

You may have chosen to start with the Applications Program without using the Teaching Program first. If this is the case, and as some stage you find yourself unsure of the meaning of something, consult the index which will refer you to the relevant part of the teaching text.

10.2 Starting the Program

Load the Applications Program in accordance with the instructions in Appendix 2. When the program has loaded, the menu of initial options will be listed:

```
Define a new project
Load a project from cassette
Modify the existing project
Project specifications
Produce a report
Save the existing project
EXIT - add dates to saved data
```

DISC USERS NOTE
Your menu will be slightly different, as follows;

```
Define a new project
Load a project from disc
Modify the existing project
Project specifications
Save the existing project
Add dates to existing data
```

You will see that the first option on the menu has been highlighted on the screen. This means that if you press the **[ENTER]** key, it will perform this operation. If this is not your preferred choice, pressing **[SPACE]** will move the highlight down the list. Use this feature to make your selection, and then press **[ENTER]**. There is no problem if you go past your choice, because the highlight will return to the top of the menu once it has reached the bottom. Try rolling through the list a few times before you make your decision.

If this is your first use of the program, the only option which will make any sense is the first one, `Define a new project`. The use of other options will be explained later in the chapter. In particular, if you wish to load an existing project, refer to section 10.9, 'File Handling'.

10.3 Defining a Project

When you select `Define a new project`, a new menu will appear on the screen:

```
Continue
Project name
Comment
Starting Date      01/01/84
```

The highlight will be resting over `Continue`. This menu allows you to enter some reference information about the project. If you use **[ENTER]**, to select any except the top choice, you will be invited to enter anything you wish to describe the project, and whatever you write will appear on the screen alongside the menu item. We suggest that you use the `Project name` line to identify the file, and the `Comment` line to record such details as the revision number. Each line can have an entry of up to 20 characters. The `Starting date` should be formatted as dd/mm/yy, as in the default entry already showing on the screen. Select `Continue` to go on with the program. You can return to this screen from the main menu if you wish to alter this data, which will appear on any printouts produced by the program, by selecting `Project specifications`.

10.4 Entering Activities

After the project specification screen, the data entry screen will appear. This is presented as a largely blank screen, with three title 'boxes' at the top, and a 'menu' of eight words listed in two rows at the bottom. The first word in the list, `Add`, is highlighted, and you will find that the highlight can be moved through the menu in the usual way by pressing **[SPACE]**. The whole list looks like this:

```
Add       Insert    Modify    List
Move      Delete    Chart     Menu
```

These words are the commands that you use as you enter the details of all the activities of the project. The commands work as follows:

`Add` Add a new activity to the project. This is the first command you must use, because none of the others, except **MENU** will operate until at least one activity exists. Using this command will always add the activity to the end of the list. When an activity is added, the computer will assign it a number for easy reference. The number is not related in any way to the actual sequence of events. Refer to the detailed instructions at the end of this list.

`Insert` This works in exactly the same way as **ADD**, but it lets you put the new activity anywhere in the list you wish. It will ask you which activity in the list you wish the new activity to follow. It will always assume that you wish to insert at the end of the list unless you say otherwise. See the instructions at the end of this list.

`Modify` Allows you to change any of the data for the activities which you have already defined. You can change the data at any time, and you will be using this facility to balance the schedule. Refer to 10.5, 'Editing Facilities'.

`List` This simply lists the activities on the screen, and they appear just as you entered them. This is only of value when you wish to return from the **CHART** option, or when you want to see part of the list which is not on the screen. Refer to 10.7, 'Getting Around'.

`Move` This can be used to change the order of the list of activities. Note that whatever order you sort the activities into, they will always retain the original numbers they were given by the data entry routine.

`Delete` Used to remove an activity from the list. The program will check if the activity to be deleted is a prerequisite of any other. If it is not, then it will be deleted. If it is, you will be warned of this, and if you instruct it go ahead, then the prerequisites of the deleted job will be assigned to its successors. Refer to 10.5, 'Editing Facilities'.

`Chart` Displays a bar chart of the project. Refer to 10.6, 'Bar Chart Display', and 10.7, 'Getting Around'.

`Menu` Returns the user to the main menu seen at the beginning of the program. You must return to this menu to save the project, or produce any detailed reports.

When Add or Insert is selected, the menu lines at the bottom of the screen are cleared, to provide a space into which you can enter data in the sequence shown in the title box at the top of the screen. At the left of the boxes, a number is displayed. This is the number which the program has assigned to the activity you are about to enter. It will always be the lowest available unused number. Thus if you have deleted an activity, the number released by this process will be assigned to the next new activity. The number does not relate to the order in which the activities are listed. It is just a reference, to identify a particular activity for a number of reasons.

When the menu clears, and a number appears at the bottom left of the screen, the computer is expecting you to type in a description of the activity. You can tell this, because the words Job description at the top of the screen are highlighted. This description can be up to 16 characters long. When you have provided the description, press **[ENTER]**. The computer now expects to be given the duration. (The word Duration is highlighted at the top of the screen). Remember to use the same time units for all activities. For instance, decide at the start to give all times in days, weeks, or months, and keep these units consistent throughout the project. The manager program facilities, which will give you calendar dates, can only be maximised if durations are expressed in days. Any number up to 999 can be used.

Press **[ENTER]** when you have typed in the number, and then the computer is waiting for the prerequisites (see highlit note at the top of screen). These are entered by using the activity numbers, separated by commas. Type in the list and key **[ENTER]**. You do not have to enter data in all of the boxes; you could just create the list of activities, and then go back later using the editing facilities to fill in the rest. If you wish to do this, just press **[ENTER]** instead of providing the period and prerequisites. Up to 10 prerequisites can be defined for each activity, so the program will handle very complex projects.

The program will make some checks to be sure that the prerequisites are legitimate. In particular, you cannot make an activity its own prerequisite, and you cannot loop activities together. For instance, you cannot make 1 a prerequisite of 2, then 2 a prerequisite of 1. If everything is correct, you will be returned to the menu, and you can choose to enter another activity if you wish. Notice that the details of the activity you have entered are now displayed on the screen.

10.5 Editing Facilities

Use the Modify command to select an activity for editing. The program will ask for the activity number - it will assume that you wish to modify the last activity you entered unless you tell it otherwise. The activity specified will be displayed at the bottom of the screen. To edit, just type over what is already in each box as though you were entering the information for the first time. If you wish to leave the contents of a box alone, just key **[ENTER]**, and you will skip on to the next box.

10.6 Bar Chart Display

You can select the `Chart` option to produce a bar chart on the screen. This facility can be used at any time during the development of the project structure. The program will perform the analysis and then you will be asked three questions to format the chart:

`Bar chart from job no?`	Enter the first activity to be listed on the chart when it is drawn.
`from period?(from Ø to _)`	The times given in the brackets are the project start and finish times. You can choose any starting time period, and this will be displayed at the left of the screen.
`Scale?(Between 1 and _)`	The scale is the number of time units to be represented by each character on the screen. The largest scale figure offered will be sufficient to fit the entire project duration on a single screen width. You may choose a smaller scale to view part of the chart in greater detail.

The bar chart presented on the screen should be self-explanatory. The bars show critical and non critical activities, as well as free and interfering floats, using the same symbols introduced in Chapter 8 of the teaching program.


Critical Activity


Non-critical activity


Free float


Interfering float

Note that when you have a chart showing on the screen, you can still use all of the options on the screen menu, and watch new activities or activity changes appear directly on the screen. Use the list option to return to the list of activities.

10.7 Getting Around

The program can handle up to 50 activities per project, but only 10 appear on screen at any one time. Therefore, two ways have been provided to run through all activities, and both work on the `List` and the `Chart` formats:

1) When `List` or `Chart` are selected, you will be asked for the number of the first activity to appear on the screen. Use this method to make large jumps through the list or chart, by giving the number of the first activity you wish to examine.

2) The up and down arrow keys will move the pointer at the left of the screen up and down the list or chart.

In addition, in the `Chart` form it is important to be able to move from left to right to see the whole project if the scale chosen does not show the entire duration. Again, the facilities noted above are available; use the '`from period`' question to set the starting time, and then use the left and right arrow keys to step back and forward in time.

10.8 Reports

To create reports of the project, you must first return to the main menu by selecting `Menu` on the screen menu. From the main menu, select the `Produce a report` option. This will reveal yet another menu as follows:

```
Return to main menu
   Hard copy list
Screen tabular report
Hard copy tabular report
   Hard copy bar chart
```

Three of the options produce a report to an Amstrad DMP1 printer if you have one available. Three types of report are available:

`List`	List inputs; number, description, duration and prerequisites.
`Tabular`	A list showing number, description, duration, early and late starts and finishes, free, interfering and total floats.
`Bar chart`	A printout of the bar chart in the same format as it appears on the screen. The bar chart can be scaled to fit on a single page width if required, but if a larger scale chart is required, the program will print as many pages as required. If you select this option, you will be asked whether you are using 80 or 132 column printer.

The tabular report can also be provided on screen, but owing to space restrictions, it is divided into three parts, displayed on yet another menu:

```
Duration; Early start; Early finish
Duration; Late start; Late finish
Total, free and interfering float
```

Select your preference in the usual way, to display your report on the screen.

DISC USERS NOTE

The disc version has an extended report menu which is the same as the one found on the cassette `DATES` program - refer to 10.10. To access this facility, select '`Add dates to existing data`' on the main menu.

10.9 File Handling

When you have fully defined a project, the main menu provides the facility to save your project as a file. When this is selected, the computer will ask you for a file name for the project, and will then start the saving operation. Follow the instructions on the screen very carefully. When the project file has been saved, keep a record of the name used so that you can recall it when required. If you press **[ENTER]** without giving a file name, you will be returned to the main menu, and the save operation will be cancelled.

Loading a project from tape or disc is simply the reverse procedure. Select the appropriate menu option, and follow the instructions on the computer screen.

10.10 The Time Manager

If you have the cassette version, there is a second program on the tape, following the Applications Program. This is the `Time Manager`. The disc version of the program has this facility integrated into the main menu. If a project has had its duration specified in days, and it has been saved as a tape file, the Time Manager will add a calender to all of the reports. The only extra information required is the starting date, and some details about non-working days. Load and run Time Manager (the program is called `DATES`), and you will obtain the following menu:

```
Load a project from cassette
   Project specifications
      Produce a report
```

To use the program, you must first load a project file, so select the first option and load the project you wish to use.

When this is done, select the second option, `Project specifications`. You will find the data you originally entered plus some additional items:

```
Continue
Project name
Comment
Starting date
Working Days        Monday     *
                    Tuesday    *
                    Wednesday  *
                    Thursday   *
                    Friday     *
                    Saturday
                    Sunday
Special Days
```

You may wish to modify the data on the first three lines, and you can select them in the usual way. Remember that the starting date you give on this screen will be taken as the first day of the project. The program checks the day of the week for that date.

The working days assumed by the project are Monday to Friday. If you wish to change this, select `Working days`. A cursor will appear to the right of `Monday`. If there is a '*' showing, then this is a working day. To change it to a non working day, press **[ENTER]**, the '*' will disappear and the cursor will jump to `Tuesday`. To leave it as it is, press **[SPACE]**, and the '*' will be left unchanged. This principal works the other way as well. **[ENTER]** will delete the '*' if it is there and insert '*' if it is not. Continue selecting `Working days` and adjusting the '*'s until they suit your project.

The last option on the screen is `Special days`. If you select this, you can submit a list of dates for holidays which fall in the project period. If you wish to remove a date from the list, just enter it again, and it will disappear. You need not worry whether the special days fall on non-working days defined in the previous option; no date will be taken into account more than once.

When the date specification is complete, return to the main menu by selecting `Continue`. From here, you can move on to the `Produce a report` facility. This provides the same types of report as were available in the main program - refer to section 10.8. The key difference is that all of these reports will include the calendar dates as well as the day numbers, and all are available to both screen and printer. You should use this facility to analyse your project in detail.

DISC USERS NOTE

On the disc version, all of these project specification and report options which include the calendar feature are available directly from the main menu, by selecting the command `'Add dates to existing data'`.

APPENDIX 1

Sample Problems

A1.1 The Shop Establishment Project

This is the project used as the Worked Example, and as a demonstration case in some of the other chapters.

Activity Number	Description	Duration (in weeks)	Prerequisites
1	Arrange a source of finance	6	None
2	Engage the staff	4	1
3	Find some premises	8	1
4	Purchase a stock of books	5	1
5	Install the shopfittings	4	3
6	Preparing an advertising campaign	8	3,4
7	Stock up the shop	2	2,4,5
8	The grand opening	1	6,7

A1.2 Acme Aluminium

This is the project used in the teaching program as a review exercise.

Activity Number	Description	Duration (in days)	Prerequisites
1	Cut parts for window no. 1	2	None
2	Assemble window no. 1	3	1
3	Glaze & pack window no.1	1	2
4	Cut parts for window no.2	1	1
5	Assemble window no.2	2	2,4
6	Glaze & pack window no. 2	1	3,5
7	Cut parts for window no. 3	1	4
8	Assemble window no. 3	2	5,7
9	Glaze & pack window no. 3	1	6,8

A1.3 The Computer Program

A computer software company is preparing a timetable for the production of a new home computer program. The software manager hs divided the task into the activities in the following list. A worked solution to this project will be discovered in a file called SAMPLE, on the applications tape or disc.

Activity Number	Description	Duration (in days)	Prerequisites
1	Define the scope of the program	15	None
2	Design the screen layouts	12	1
3	Develop the program algorithms	10	1
4	Outline plan of documentation	5	2
5	Program flowchart	21	2,3
6	Program	35	4,5
7	Documentation Manuscript	24	6
8	Program Debugging	16	6
9	Packaging design	33	2
10	Initial field testing	15	7,8
11	Modify Manuscript	5	10
12	Final Debugging	10	10
13	Final field testing	10	11,12
14	Documentation Typesetting	15	11
15	Tape Duplication	20	13
16	Packaging Production	27	9
17	Print Documentation	21	14
18	Final Packing	10	15,16,17

APPENDIX 2

Loading Procedures

A2.1 Cassette Version

The Teaching Program is on Cassette No. 1 and the Applications Program is on Cassette No. 2. Both programs load and auto run as follows: Press **[CTRL]** and the small **[ENTER]** key (on the numeric key pad) at the same time. Then press **[PLAY]** on the cassette recorder then press **[SPACE]**. Do not turn the tape recorder off until the main screen display, is displayed.

A2.2 Disc Version

The Teaching and Applications Programs are both on a single Disc. Insert the disc in the drive and key `RUN"TEACH` **[ENTER]** to run the Teaching Program, or `RUN"APPLY` **[ENTER]** to run the Applications Program. Leave the disc in the drive when you are using either program, because the computer will need to access it from time to time.

NOTE:

Please do not work with your original disc. Make a back-up copy using the `DISCCOPY` command explained in your disc drive manual. When using the Applications Program, you can access any drive for data, but the program itself must be in drive A on an unprotected disc. If you only have a single disc drive, you will need room on the program disc to save your data. To provide this space, delete all of the programs which use the words '`TEACH`' or '`SAMPLE`' (be sure you have another copy of them first!!).

Glossary

Activity, one of the parts into which the whole project has been divided.
Bar Chart, a diagrammatic representation of the project timetable.
CPA, abbreviation for **Critical Path Analysis**
CPM, abbreviation for **Critical Path Management**.
Critical, an **Activity** is critical, if a change in its **Duration** will change the duration of the whole project.
Critical Path, the sequence of **Critical Activities**.
Critical Path Analysis, the analysis of a project to determine which components, or **Activities** are **Critical**.
Critical Path Management, using **Critical Path Analysis** to manage a project.
Duration, the length of time a single **Activity**, or the entire project will take - **Activity Duration**, or **Project Duration**.
Float, the amount of spare time available to an **Activity**.
Free Float, that part of an **Activity**'s **Float** which can be used without having any effect on any other activity.
Interfering Float, that part of an **Activity**'s **Float** which, if used, will not affect the **Project Duration**, but will reduce the float of other activities.
Network, a diagrammatic representation of the relationships between the **Activities** of a project.
Node, the symbol used on a **Network** to represent an **Activity**.
Prerequisite, those **Activities** which must be completed before the subject activity can commence.
Successor, those **Activities** which cannot commence until the subject activity is completed.
Total Float, the sum of **Free** and **Interfering Floats** of and **Activity**.

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(Program keywords are in CAPITAL letters)