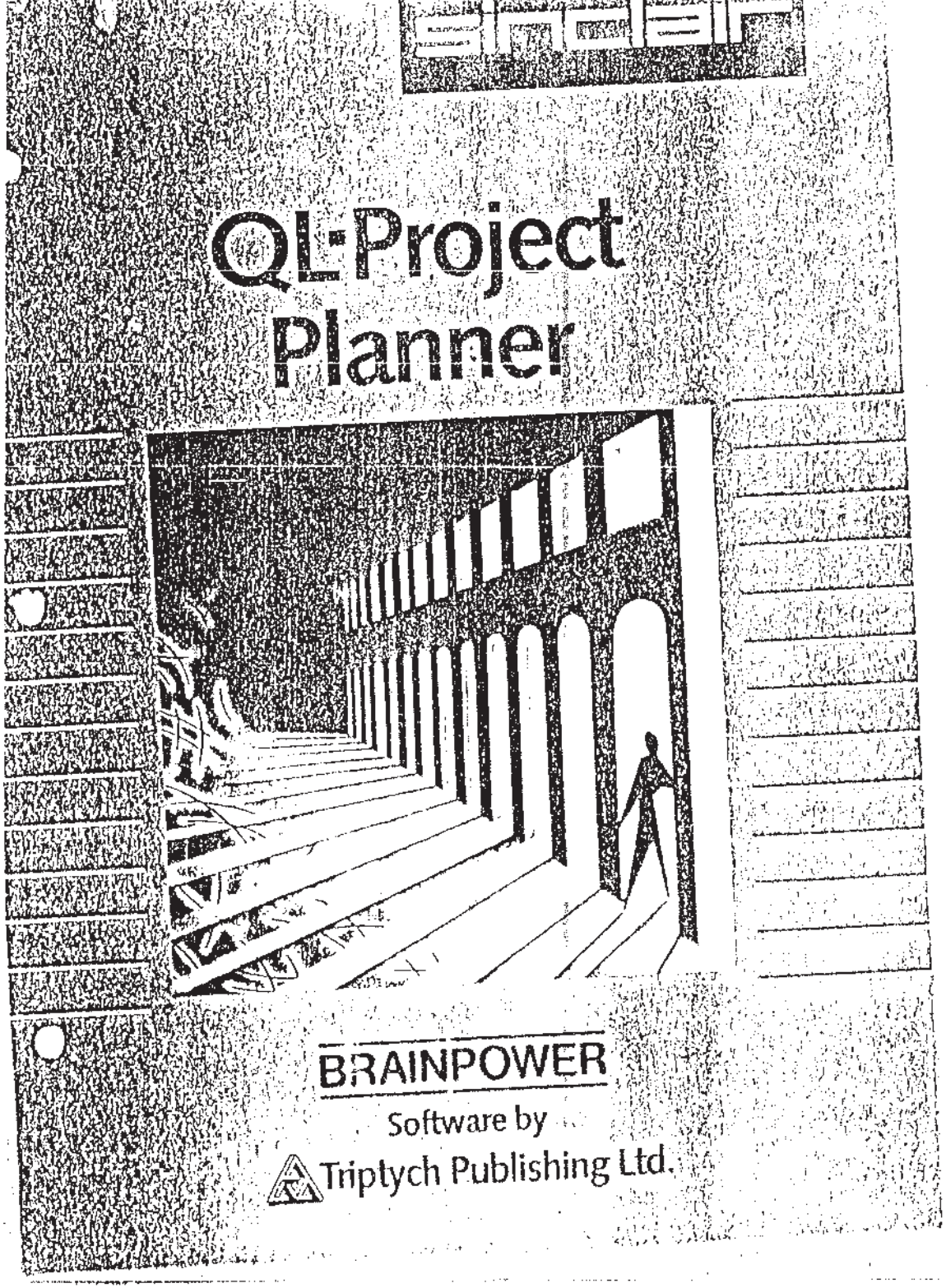

QL.Project Planner

Take control of time on any task

Text book by Stuart Armstrong
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Getting Started

QL. 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, find 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 computer 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 procedure required to load the Teaching or Application Programs into your computer, refer to Appendix 2, where you will find specific instructions for using **QL. Project Planner**.

Contents

Introduction

Welcome

Titles in the BRAINPOWER series are uniquely designed to harness the power of your computer 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 let us know.

QL. 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 the computer.

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

3 The Applications 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, find Chapter 10. There you will discover the detailed instructions for solving your own scheduling problems.

Critical Path Analysis

QL. 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 QL. 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 QL 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 QL 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.

Chapter 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 set up the book 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 your 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 text in colour, such as SPACE or 3. 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 identify 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.

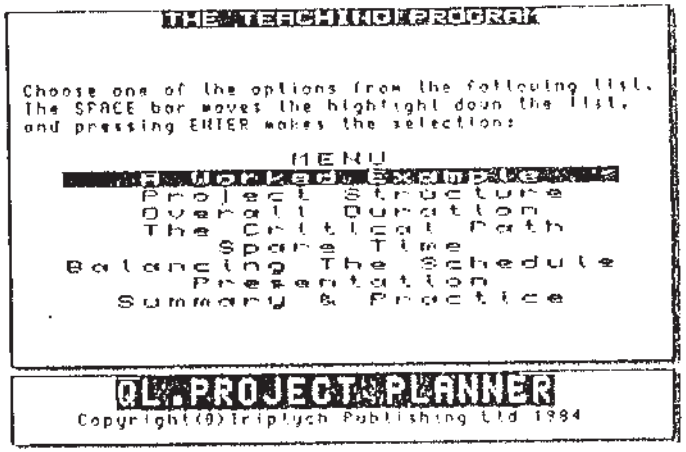
6 PRESENTATION – Produce a Bar Chart with which you can communicate the final sequence and schedule of the project to others.

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 it will present a screen displaying 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. Once an option has been selected, the computer will have to

load another section of the program. This will take a few seconds, 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, moving to the next unit or returning to the Menu described above. 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 a

computer to perform the analysis for you, the network is no longer required. The computer can jump directly to producing a bar chart presentation document.

Chapter 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 38 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 in 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 prerequisite	
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 QL 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 GO and the computer will draw this. The node is numbered to remind us which activity it represents.

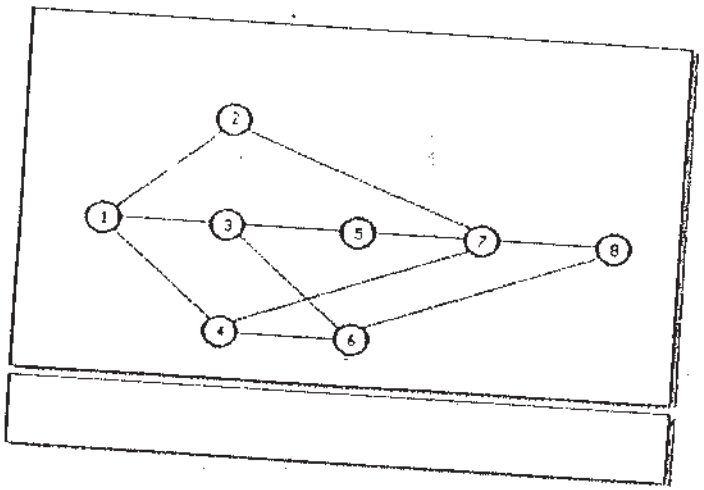
2 Select any activities which have only 1 as a prerequisite. In this case, the activities involved are numbers 2, 3 and 4. We need a circle to the right of node 1 to represent each of them, and then we must draw a line from node 1 to each to represent the prerequisite link – press 1, and the computer 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 much 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 program 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 it could be more convienient 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 just 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 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 8 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 just applied, and use the most complex maths which you need for this program – subtraction!

1 We already know that the finish week 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 above the earliest start and finish times.

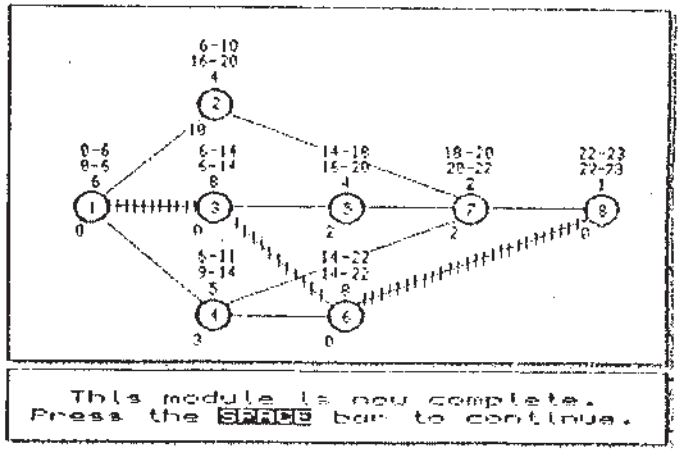
2 Going back to activity 7, we know it must finish in time for activity 8 to start on week 22. Therefore the latest finish week for activity 7 is 22. Subtract the duration of 2 weeks from 22 to find the latest start week 20. Press 4 to display the figures. Notice that for this activity, the latest start 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 14 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 remaining latest times will be displayed.

There now remains one important task to perform before the analysis is completed; 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 repective 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 return to the main menu, 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.

Chapter 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 too 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 three 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 this 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 QL 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, always 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 QL 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 the work. Any 'special' job going through the factory in a different sequence would stand out very clearly.

3.5 Activity times

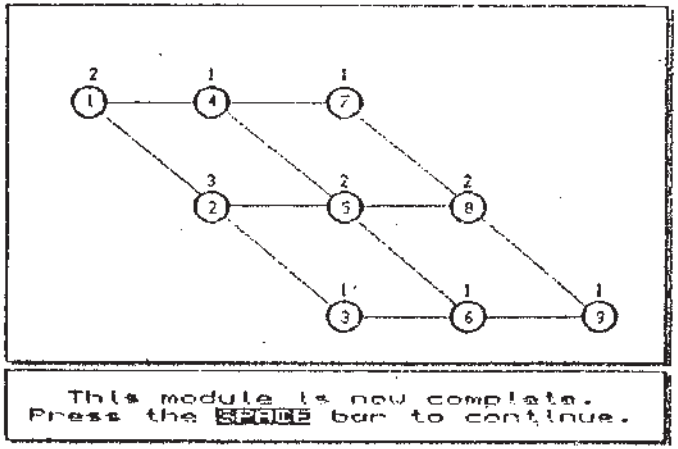
Now that the network has been created on paper, or in this case on the screen, the only other information required before an analysis can be performed is the duration of each activity. Once again, it is impossible to help you with the assessment of these individual durations for your

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 or 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.



Chapter 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 O 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 for 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 numbers have been kept very simple!

Chapter 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 will 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 much 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.

Chapter 6

Spare Time

6.1 Float

Key in S T on the QL 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 program calculate the float for each activity.

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

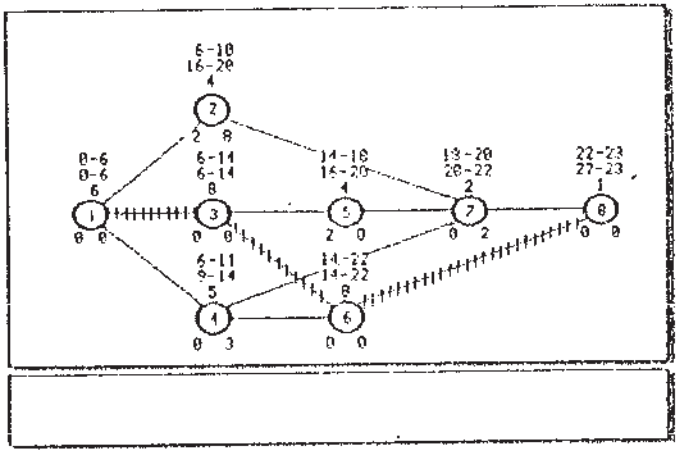
6.2 Free & Interfering Float

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 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 program perform this operation on each node in turn. Note that the program will replace the total float figure with the interfering float. There is no need to display free, 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.

Chapter 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 projection 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.

Chapter 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 float. 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.

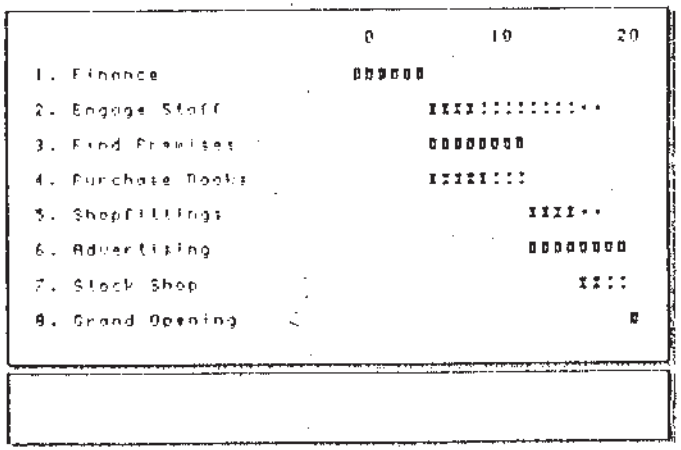
8.2 The Bar Chart

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 program 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 instructions to produce the bars for each activity.

Chapter 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 your 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 QL. 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 program 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 called SAMPLE, and is filed on the Applications cartridge. Good luck, and press M P to proceed with the first series of exercises.

Chapter 10

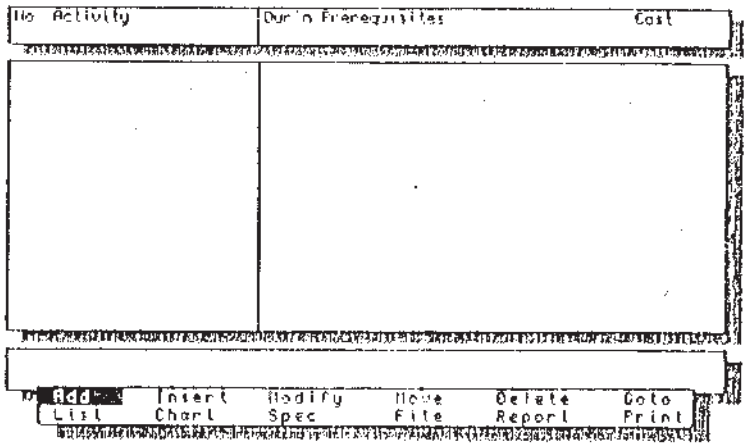
Applications

10.1 Starting the Program

QL. Project Planner is a powerful program. Although we have made the software easy to use and the instructions clear, we recommend that you familiarise yourself thoroughly with both in order to exploit the full power and facilities of QL. Project Planner. Please refer to Appendix 2 for instructions on how to load the program.

When the program has loaded, you will notice that the screen is divided into four sections, each of which is called a window. For the rest of this chapter these windows will be referred to by their functions:

HEADING window
DISPLAY window
PROMPT window
MENU window



The **HEADING** window contains definitions describing the information shown in the **DISPLAY** window below it. Headings in this window will change according to the status of the program but will always describe the events directly below them.

The **DISPLAY** window occupies the main part of the screen. All the data and processed information about your project will be displayed here in the form of words, numbers and charts. When certain options are activated, the top two windows will be redrawn as one to show subsidiary information.

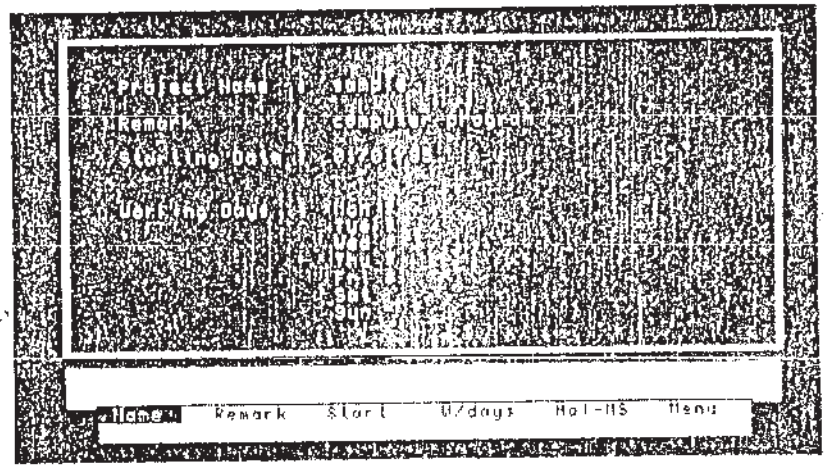
The **PROMPT** window is used for two main functions. When the program requires an 'input', or entry, a reminder message will display the type and format of information needed. For certain inputs the program will assume a 'default' setting with the most likely response. These defaults will be shown in this window and may be accepted or edited in the same way as any other input. This window will also contain warning messages if an illegal entry has been made. Reminder messages appear in green and warning messages in red. The window may be used for both prompt and entry messages simultaneously.

The **MENU** window at the bottom of the screen contains a list of options which the program is able to perform. The chosen option is highlighted with a green cursor. Selecting options from this list makes operation of the program quick and easy. The list may contain one or two lines of options and changes according to the status of the program, but the method of operation of the **MENU** window remains constant. The ◆ and ◆ arrow keys move the green cursor left and right and the ▲ and ▼ arrow keys move it up and down. The SPACE bar has the same effect as the ◆ arrow key. To operate the menu, move the cursor to the option of your choice and press ENTER. Certain options will generate different screens but each will be supported by its own menu. The menu which appears when the program first loads is known as the main menu. You can return to this from other parts of the program by selecting the **Menu** option from subsidiary menus.

The top line of the main menu controls activities within the **DISPLAY** window and the bottom line activates other program functions.

10.2 Setting the Scene

Every project will have an individual set of specifications which describe the environment in which it is set. You should enter the specification for your project before entering any other data. Select **Spec** from the main menu and press ENTER; a new screen and menu will appear.



Specification options are selected from the menu in the usual way and fulfil the following functions:

Name: Use up to 20 characters to enter the name of your project. The name will appear in the display window as you type; press ENTER to accept the entry. If you have a project resident in memory the question 'Do you wish to clear current project? Y/N' will appear in the **PROMPT** window. Respond accordingly with Y for yes and N for no. If you do clear a project the reminder message 'Initializing' will appear in the **PROMPT** window while the program resets itself.

Remarks: Enter any remarks you wish to make about the project in up to 20 characters. Press ENTER to accept your entry.

Start: This option sets the start date for the project and *must* be set in order to work out calendar dates. The date should be set in the format days/month/year. Type the

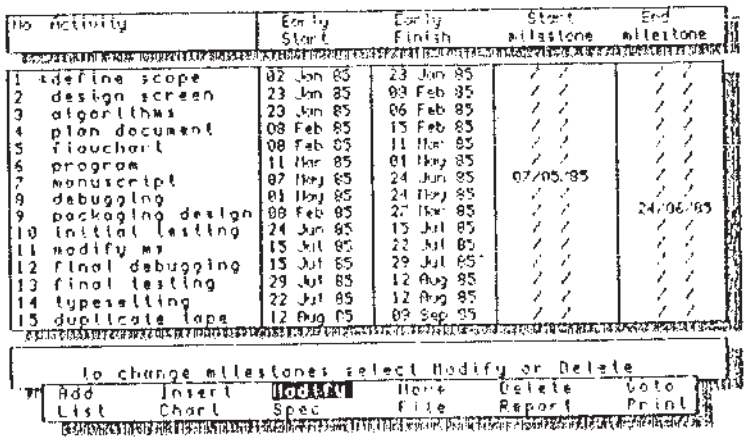
two numbers for the days then press ENTER, then the month and press ENTER, then the year and press ENTER.

W/Days: This enables you to define precisely the structure of your working week, from Monday to Friday. This is indicated in the DISPLAY window by the asterisk adjacent to the working days. When you select this option a flashing cursor will appear on the top asterisk. To set or cancel a working day, use the SPACE bar to move down to the selected day and press ENTER. This will change the day from a working day to a non-working day and vice-versa. The cursor will automatically move down to the next day when ENTER is pressed. After one pass through the week, you will exit from the option automatically.

Hol-MS: This option has two functions; to set irregular non-working days in the project calendar, (such as Bank and National holidays) and to set milestone dates. The use of milestones is explained in detail in section 10.8. When you select this option by pressing ENTER the message 'Press "H" or "M"' to set Holidays or Milestones will appear in the PROMPT window. Press either the H or the M key accordingly.

Holidays: You may set up to 80 holidays in any number of years. First you must enter the year in which you wish to define the holidays. This must be a year between 1961 and 2025; the year from the start date if set in Spec will be offered by default (if not, then 1985). When you have typed in the year, press ENTER and a calendar for the first six months of that year will be drawn in the display window. The pattern of working and non-working days will reflect the pattern set in the W/Days option. If a 5 day week has been adopted, all the weekends will appear in green. To set a holiday move the cursor to the chosen day, and press the SPACE once. Use the arrow keys to move the cursor inside the individual months. To move from month to month press SHIFT and the arrow keys together. Repeat this process for as many different years as are required. Press ENTER to return to the menu; a 'sorting' message will be displayed while the program manipulates the data.

Milestones: This option can *only* be used when a project is resident in memory. The application and use of milestones is described in detail in section 10.8. Press M to activate the milestone option. You will be returned to the DISPLAY screen and the program will list all the activities and calculate their earliest start and finish dates. The two right hand columns of the screen are for the 'start' and 'end' milestones. Press SHIFT and ← or → together to move the activity indicator arrow (at the left of the activity name) to the desired activity. To add a milestone select Modify from the menu; a green cursor will flash in the 'start milestone' column. Set the start milestone date as usual; enter the days, month and year pressing ENTER each time. To set an 'end milestone' press ENTER three times and the cursor will move into the 'end milestone' column. Set the date as usual. You cannot set a start *and* end milestone for the same activity. To delete either a start or end milestone select Delete from the menu and the milestones for the desired activity will be deleted. A maximum of 10 milestones may be entered. See section 10.8 for further details.



The Milestone Display

10.3 Entering Your Project

The Entry Sequence

Return to the Main Menu. The following section will deal with entering a new project. To load an existing project from Microdrive or disk drive refer to section 10.4. Select the Add option from the main menu, an activity number, an indicator arrow and a flashing cursor will appear in the top left of the DISPLAY window. Type in the activity description in up to 16 characters and press ENTER. The cursor will move automatically to the next entry, (duration). Type in the Duration in up to 3 digits and press ENTER. Again the cursor will move across to the next entry, (Prerequisites). Activities may be dependent on many prerequisite activities and the program will accept up to 10 separate prerequisites. For a single prerequisite, type in the prerequisite activity number and press ENTER. For multiple prerequisites, type in each one separated by a comma, and press ENTER *only* when you have finished the list. The cursor will now move across to the final field, (Cost). The program will sum individual activity costs to calculate the total project cost and these should be entered here. When you press ENTER for the final time the cursor will disappear from the DISPLAY window and you will be returned to Main Menu control.

The activity numbers which appear on the left of the screen are for reference only and have no sequential significance. You do not need to enter all the dtails for each activity in order to proceed and you have the facility to build the project details up as you go along. To enter a null or 0 entry for any of the activity details simply press ENTER without typing anything. The cursor will move automatically to the next field and the entry will be left blank. Prompt messages will be displayed to help you throughout the entry sequence.

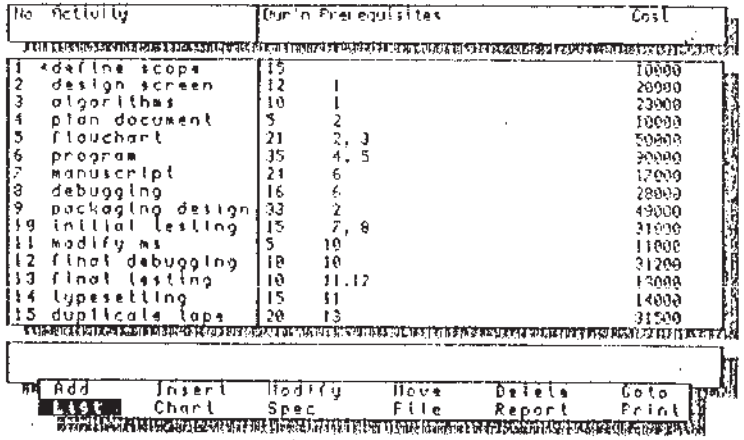
To add the next entry, simply repeat the entry sequence process above. The program will accept up to 60 different activities.

Editing Facilities

You may enter your activities in any order and in an incomplete form. The program has many editing facilities to allow you to manipulate the project and ask 'what if' questions later. The following facilities are available from the main menu:

List: This option will produce a list of all the activities in the same form as that on the entry sequence. The list may be 'scrolled' up and down within the DISPLAY window. To do this SHIFT and → or ← together to move the activity indicator arrow up or down. Hold these keys down and the arrow will repeat. When the arrow reaches the top or bottom of the screen (and other activities remain hidden) the new screen will scroll into the window.

Add: This will add an activity to the end of the current list. Operate this function as for the entry sequence.



Display window showing the list of source data

Insert: If you wish to add a new activity in between existing activities, use this function. Position the activity indicator arrow against the activity *above* where you wish to insert. Move to Insert on the main menu and press ENTER. A new blank line will appear with a new activity number. The entry sequence is performed as usual.

Modify: This will allow you to alter data you have already entered. Position the activity indicator arrow against the activity you wish to alter and select Modify from the main menu. The green cursor will appear over the first character of the activity description. Use the usual QL facilities to add, delete or change data in each field. To

move on to the next field, whether or not you have made a modification, simply press ENTER.

Move: If you wish to re-order the list of activities, use this option. Position the activity indicator arrow against the activity you wish to move. Select **Move** from the main menu and a message will appear in the **PROMPT** window asking for the activity number *below* which you wish to move. Type in the number and press ENTER – the chosen activity will now move.

Delete: Use the option to delete an activity. This option should be used with great care as deleting prerequisites from one activity can cause deletions and changes throughout the project. Position the activity indicator arrow against the activity you wish to delete and press ENTER. The message in the **PROMPT** window will ask 'Deleting job No n. Y/N'. Respond accordingly with Y for yes and N for no.

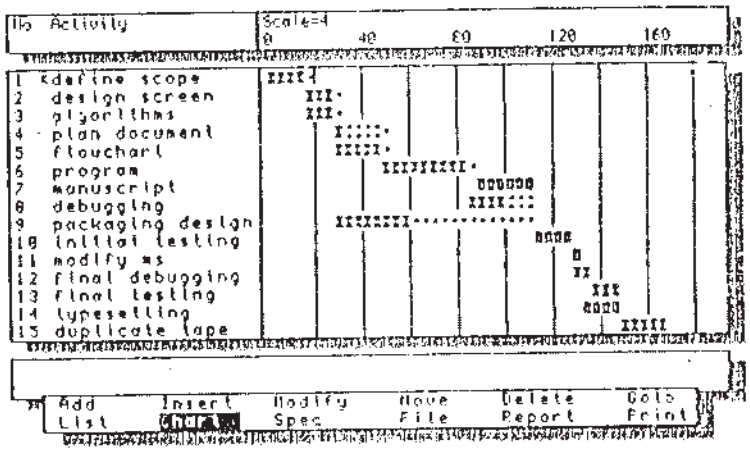
Goto: When you have a large project in the program, this option will enable you to move immediately from one activity to another. Select **Goto** from the main menu and type in the number of the activity to which you wish to move; the indicator arrow will now appear against the selected activity, or the nearest number to it if the selected activity does not exist. Thus, you can use **Goto** Ø to move to the top, and **Goto** 99 to move to the bottom of the list.

10.4 Extracting Information

The preceding instructions have dealt with the entry and manipulation of your initial data. This raw data must now be processed into useful management information to be extracted from the program in a variety of different forms:

The **chart** is an important and extremely useful function which graphically represents your project as a bar chart and can be used to show instantly the effects of change.

When you have finished entering your project data you will have a list of activities and their attributes in the **DISPLAY** window. Select **chart** from the main menu and press ENTER. A message will appear in the **PROMPT** window asking for a scale and you will notice that the green cursor is flashing over a default scale. The default scale offered will ensure that the whole project will appear on one screen width in the display window. You may either accept the default scale by pressing ENTER or type a different scale of between 1 and the default scale. The program will display a bar chart in the **DISPLAY** window, against the activity list.



The Chart

In the **HEADING** window at the top, a scale of the time units will appear above a vertical grid. Notice that each bar on the chart is displayed by a number of characters joined together. The scale is the number of time units represented by an individual symbol. The symbols indicate the status of each activity and show critical and non-critical activities as well as free and interfering floats. The symbols used are the same as those introduced in Chapter 8 of the Teaching Program. All critical activities are coloured red. Note that when a scale other than 1 is used, the bar may not exactly reflect the activity duration. If the scaled approximation is reduced to less than 1 character, then the **Dummy Period** symbol shown overleaf will appear.

Critical activity	oooooooooooooooooooooooooooooooooooooooo
Non Critical activity	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Free float	::
Interfering float	....
Zero-period activity	x
Dummy Period	:

You may scroll up and down the chart by moving the activity indicator arrow using SHIFT and the ▲ and ▼ arrow keys together. If you have chosen a scale less than the default scale you will not be able to see the whole project on one screen width. To scroll the chart screen to the left and right use SHIFT and ◀ and ▶ arrow keys together and the screen will scroll half a screen width in the chosen direction.

To enable you to watch the effects of change to the project instantly, you can operate all of the editing facilities while viewing the chart. All of the options on the top line of the MENU are available and fulfil the same functions as are listed in section 10.3. If **Add**, **Insert** or **Modify** are chosen a blank line will be drawn at the activity indicator arrow and and the flashing green cursor will appear. Reminders will appear in the **PROMPT** window to help you. When you have completed the entry, the chart will automatically be redrawn to display the effects of the change. If you wish to make multiple changes to a project you may find it easier to use the List option, return to the list, make the changes and then redraw the chart. The editing facilities are listed in detail in section 10.3.

10.5 Recording and retrieving project files

File operations occur when you either save (record) or load (retrieve) information to or from a 'file device'. A file device is any form of mass data storage and the four main types available for your QL are Microdrive cartridges, floppy disks, hard disks and silicon disks. If you are using a disk-based system refer to your disk operating system manual to find out the appropriate device name.

The options for all file operations are found by selecting file from the MENU. A new screen and menu will appear with the following options. Select them in the usual way;

Dir: This option should be used to obtain a directory or catalogue of any file device attached to your QL. When you press ENTER, a PROMPT message will ask for the name of the device, offering mdv2 (for Microdrive 2) by default. Type in the device code (if different from mdv2, this will become the default) and press ENTER, the **DISPLAY** screen will turn black and a catalogue of files will appear. The device code for Microdrives is 'mdv' followed by the drive number. For other device codes consult the device operating system manual.

Save: Use this option to record your projects on a file device. Type in the device name (you will be offered mdv2 by default) press ENTER then type in the file name in up to 10 characters. The file will be saved to the selected device and, when the operation has finished, the **PROMPT** messages will disappear and you will be returned to menu control. It is good practice to save your work at regular intervals, say every 20 minutes, and when you finish a work session. Your project need not be complete before using this option, but, if you are saving work regularly during a session, note that fresh versions of the same file will not overwrite old versions. You must either delete the old file of the same name before saving the new, or, preferably, save different versions as different names (e.g. test1, test2) and delete the early versions later. Each project will need approximately 33 sectors of free space on a Microdrive cartridge; to check that you have enough space free, use the Dir option. All project files will automatically be saved with the prefix 'data_'; **do not** enter this as part of the file name when loading or saving.

Load: The load option operates in a similar way to **Save** but retrieves project files from file devices. Type in the device name (you will be offered mdv2 by default) and press ENTER. Type in the name of the project file you wish to load and press ENTER. The file will now be

the MENU. A subsidiary menu will appear listing the printing options. Select an option by pressing ENTER and a hard copy will be produced. The following options are available from the Print menu:

Spec: This will print the specification sheet and holiday details and all milestone details.

List: This will produce a complete list of the project activities, their durations, prerequisites and costs.

Chart: This will print a copy of the complete bar chart. It will be this chart that you will usually use to monitor your project or to display it to others.

Unit: This will print the report of each activity with the duration, early and late starts and finishes and all float details shown in time units.

Dates: This will print the early and late start and finish dates of each activity.

10.8 Milestones

In general the program assumes that the earliest date on which an activity can begin depends on that activity's prerequisites. Similarly, the latest finish date is determined by the activities which follow. Sometimes this is not strictly the case. Perhaps the start of an activity depends not only on its project prerequisites but also upon some event external to the project, for example the delivery of goods. In this situation, the external event could delay the start of an activity and change the critical path. In other circumstances, a project could have some intermediate completion criteria, such as finishing a stage of the project by a certain date These intermediate key dates are called **milestones**.

Once the activity's start and finish dates have been calculated by the program, you are free to use the process described in 10.2 to define up to 10 milestones, delaying the earliest starts of some activities and advancing the latest finish of others. The critical path will now be altered accordingly. Note that a start milestone which falls before the earliest start of the activity involved, or an end milestone which falls

before the earliest finish will be ignored by the program. Once the critical path has been recalculated, you can return to the milestone setting routine in **HOL-MS** to see which milestones fall before these dates and have thus been ignored. You should then adjust your schedule and your plans accordingly. If you plan to set a number of milestones, it is preferable to set them a few at a time, starting with the most significant, and observing how the critical path changes.

Milestones are also useful for linking a number of smaller projects together. The starting dates of certain activities in one project can be linked to finishing dates of prerequisite activites in other project. With practice, many such uses will be found for this facility of QL Project Planner.

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)	Pre-requisites
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)	Pre-requisites
1	Cut parts for window no. 1	2	None
2	Assemble window no. 1	3	1
3	Glaze & pack window no. 1	1	1
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 has 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 cartridge.

Activity Number	Description	Duration (in days)	Pre-requisites
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

Starting the Program

Load the Teaching, or Applications program according to the following instructions:

Teaching Program

1 Remove any Microdrive cartridges from the QL.
2 Turn the machine on (or reset it).
3 If you want to use the Teaching programs, insert Teaching 1 in Microdrive 1 (left hand side), and Teaching 2 in Microdrive 2 (right hand side).
4 If you want to use the Applications program please refer to the following section.
5 Press F1 to select the monitor or F2 for TV.

The programs will now load and run automatically. The loading process may take some time to complete. To make a backup copy of each Teaching Program, place the original cartridge in Microdrive 2 (right hand side) and insert a blank cartridge in Microdrive 1 (left hand side). Type **lrun mdv2_backup**, a screen message will appear, press ENTER and a backup copy will be made on Microdrive 1.

Applications Program

This program is protected by a 'key' mechanism which prevents illegal copying. The way this works is that though the program can be copied freely, it can only be run if the original 'key' cartridge is in drive 2. To run the program for the first time, you will have to make a copy on a blank cartridge as follows:

To copy the program – this must be done on first time use.

1 Reset your QL.
2 Press F1 (for monitor) or F2 (for TV).
3 Put the original Applications Program cartridge in Microdrive 2 (right hand side).
4 Insert a blank cartridge in Microdrive 1 (left hand side).
5 Type in lrun mdv2_config and press ENTER. Microdrive 2 will now operate.
6 A series of 4 instructions will appear on the screen. Simply press ENTER after each.
7 The Cartridge in Microdrive 1 will now be formatted and the Applications Program copied automatically. This may take some while, during which there may be significant pauses – DO NOT TOUCH YOUR QL until the message "Copying Complete" appears *and* the Microdrives stop running.
8 If a failure occurs in this routine, an error message will be displayed. Repeat this sequence from 1, ensuring you read the instructions carefully. If the error messages "Format Failed" or "Bad Medium" appear, you should replace the cartridge or disk you are using.
9 If you now wish to run the program, remove the cartridges and reset the machine. Replace the working copy in Microdrive 1 (left hand side) and the original program in Microdrive 2 (right hand side).
10 Press F1 or F2 as appropriate and wait until the program has loaded and the initial screen is displayed. The original cartridge in Microdrive 2 may now be withdrawn.

In normal use:

11 Reset your QL.
12 Follow the instructions from 9.
13 You may make as many security copies as you like, but you must *always* load the program with the original or 'key' installed.

For other devices:

14 You may configure the program and data devices for any medium.
15 Follow the sequence from 1 to 3. Any combination of devices may be used for program transfer. The messages use the following terms:

Source device: The device from which you are copying – usually mdv1 or mdv2, but may be a disk.

Program device: The device on which you wish to save the working copy of the program.

Data device: This is the default device used for data storage during program operation.

16 All device names must be 4 characters long. If you are unsure of the device name, consult the device manual.

Running the program from another device:

17 If you are using a disk system which incorporates autobooting from disk, insert the working copy in the disk drive and the 'key' (original) in Microdrive 2. Reset your QL and press F1 or F2 to load the program.
18 If the device does not have an autoboot facility, reset your QL and insert the 'key' (original) cartridge in Microdrive 2. Put the working copy in the disk drive and type lrun****_boot and press ENTER (where **** is the device name).

Please note, you will not be able to copy any more than one Applications Program per disk. If you wish to use the program on disks then we recommend you allocate one whole disk to your program and data files.

Index

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 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.
Milestone, an intermediate key date for the start or finish of an activity.
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 an **Activity**.