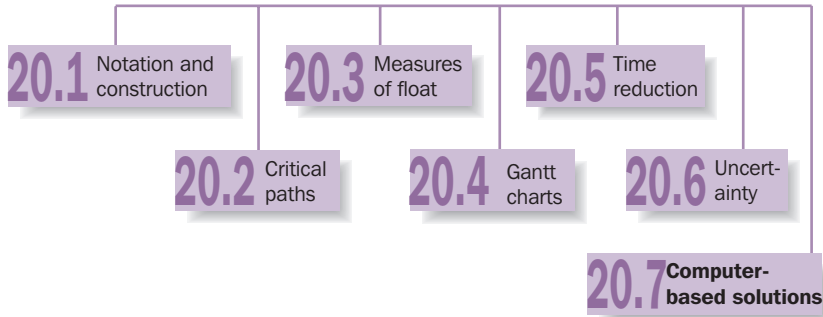


20.7 Computer-based solutions to network problems



As with other quantitative methods, the techniques of network analysis have been made available in computer software. While early applications did little more than take the tedium out of calculating the duration of the critical path and

task start and finish dates the latest versions are capable of supporting planning and management of the largest of engineering and construction projects. This section will look at some of the functions offered by one of the most commonly available pieces of project management software,

Microsoft Project for Windows. There are many other pieces of software

which have similar or more extensive facilities and cost a great deal more to purchase but Project for Windows (PFW) provides a good start in examining the basic features of such software.

20.7.1 Getting started

Assuming that the software has been installed on the computer and is ready for use the first thing to do is get it running by using the mouse to click the PFW icon. The opening screen will look something like that shown in Figure 20.18.



Figure 20.18 The opening screen for Microsoft Project.

As with most Microsoft software, tutorials and introductory options are available and it would benefit the new user to take the time to investigate these sources of information before checking the 'Do not show again' box. What follows assumes that the user has some understanding of the preceding text on networks and has the skills to use keyboard and mouse to enter data into the appropriate areas of the software.

A mouse click on 'Start a New Project' closes the Welcome inset and gives a clear view of the Task Table and Gantt Chart Screen, Figure 20.19.

This screen has the standard features of most Microsoft Windows products – a menu bar, icons for printing, etc., scroll bars for moving the viewing area but with the addition of functions specific to project planning. The working area of the screen is split vertically into a **spreadsheet** like table on the left and **calendar** on the right. Most of what appears can be customized, although there are some limits as to what can be done. The columns of the left-hand spreadsheet area are already titled from a preset selection. Double clicking on a column heading brings up a range of alternative column headings such as planned cost, %completed, etc. Some of these headings are linked to built in calculations such as %completed, some to user-entered data on which the calculations are based, e.g. duration and others are just information fields which have no effect on the operation of the software. Double clicking on the calendar headings allows the resolu-

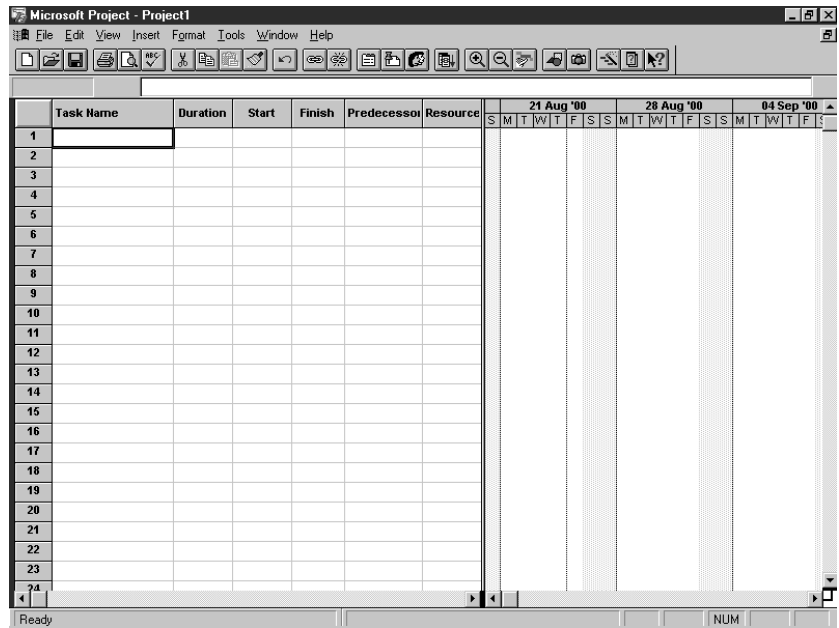


Figure 20.19 The Task Table and Gantt Chart Screen.

tion of the calendar to be changed to show hours, days, weeks, months or quarters with appropriate subdivisions.

The **calendar bar** is also a first clue that this software is intended for use in the **real world**. The dates shown on the calendar bar are the current and coming days, weeks or months, the date having been picked up from the computer’s date function. Saturday and Sunday are shown with grey vertical strips to show that the software currently considers these to be non-working days.

20.7.2 Entering a project

This chapter commenced by looking at The Ressembler Group’s project to launch a new type of picture frame. The data for this project is as shown in Table 20.8. with the modification that the unique task identifiers have been changed to numbers rather than letters of the alphabet to suit the needs of Project for Windows.

Table 20.8 Ressembler’s new product launch

Activity label	Activity number	Description	Preceding activities	Duration (days)	Resources
A	1	Decide test market area	-	1	1 Staff
B	2	Agree marketing strategy	-	2	1 Staff
C	3	Agree production specification	-	3	1 Staff
D	4	Decide brand name	B	1	1 Staff
E	5	Prepare advertising plan	A	2	1 Staff
F	6	Agree advertising package	E	3	1 Staff
G	7	Design packaging	D	2	2 Staff
H	8	Production of test batch	C	5	1 Staff
I	9	Package and distribute	G, H	10	1 Staff
J	10	Monitor media support	F, D	3	1 Staff

are the results of a network calculation based on those assumptions. On the right-hand side of the screen blue activity bars have appeared for each task synchronized to the assumed start date – this display is a **Gantt chart**.

A few manual changes have also been made to the screen display. The print size has been increased to make it more readable and the vertical split has been dragged to the right to accommodate the larger print. Dragging the centre split left or right allows the user to see more or less of the Gantt chart. Each side of the split has its own scroll controls at the bottom so you can scroll the table and the Gantt chart to see whichever columns or dates you wish. The vertical scroll bar works on both sides of the split at the same time so that the task names stay in line with their related Gantt chart bars.

Figure 20.21 shows the effect of entering the **predecessors** – the logic of the network.

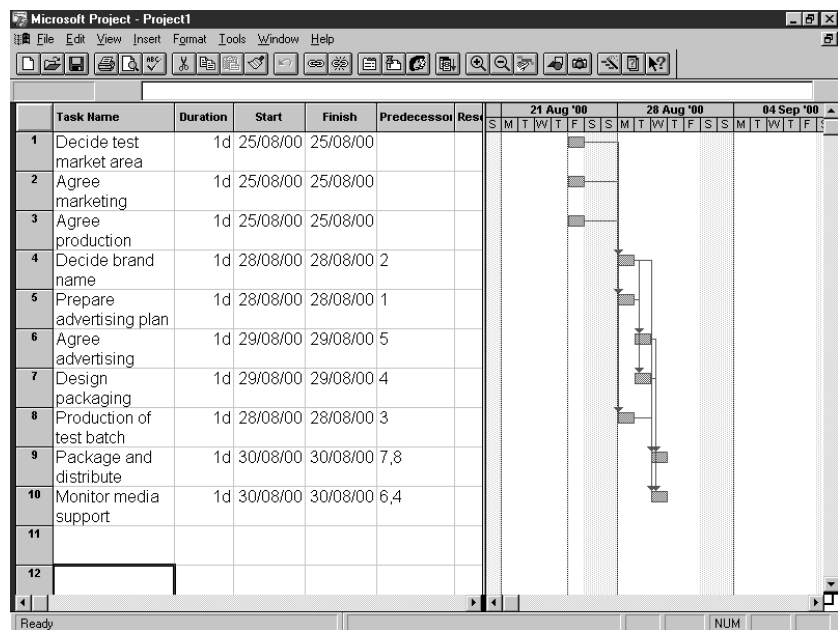


Figure 20.21 The Gantt Chart View with Predecessors Entered.

Tasks 1–3 have no predecessors and the predecessor column is left blank. Task 4 is dependent on task 2, so 2 is entered in the predecessor column. When the entry is complete the return key must be pressed to move on to the next cell or the tick checked on the line above the column titles. Mouse clicking on the next line merely adds that row number to the dependency - this can be annoying if you are used to selecting cells in a spreadsheet by clicking on them. Tasks 9 and 10 do have multiple predecessors. Once the first dependency has been keyed in, any others can be added by mouse clicking the appropriate row. The entry is ended for that cell by pressing return.

As the network logic is keyed in the appropriate links will appear on the Gantt chart and the task bars will move to reflect the Earliest Start Date permitted by preceding task durations and the logic. Figure 20.21 illustrates this, and also shows that the software is recognizing the weekend as non-working time and not scheduling work for Saturday and Sunday.

The next set of information to be entered is **the duration of tasks**.

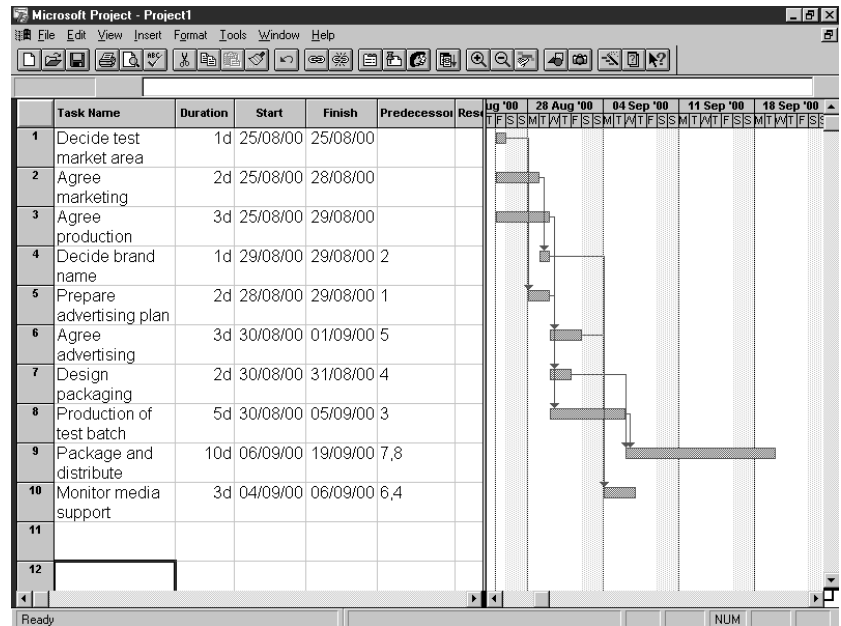


Figure 20.22 The Gantt Chart View with Durations Entered.

Figure 20.22 shows the results of entering the specified task durations. The first task has been given a duration of 1d, 1 day, and as the present start day of the project is Friday it finishes before the weekend. The second task has a duration of 2 days but the Gantt chart bar is 4 days in length to allow for the task spanning the weekend. Allowing a task to be split by a non-working period normally presents no problems but occasionally can be difficult. If, for example, this task of Agreeing Marketing, involved marketing consultants travelling to visit the company we might prefer the 2 days to be sequential so we do not have to pay excessive travelling costs or hotel bills for the consultants staying over the weekend. In this example we could either change the project start date to the Monday or we could move this task to start on Monday. Moving the task can be achieved by clicking on the task bar, holding the right mouse button down and moving the task so that it starts on Monday. The size of the bar and the dates in the table will automatically change to reflect the change. There is however a hidden consequence of moving the bars or changing the calculated dates. Double clicking on row 1 will result in the display of the 'Task Information' inset. Clicking the 'Advanced' tab shows a selection of fields related to the task one of which is identified as 'Type'. This should be showing the default setting of 'as soon as possible'. This means that any change of logic, addition of new tasks, resource levelling, etc. will always have the effect of scheduling this task at its earliest possible start date. In contrast double clicking on a task which has been manually moved from its calculated position and then accessing the 'Advanced' tab will show that type has changed to 'Start no earlier than' or some other constrained type. Any subsequent rescheduling will now treat the manually positioned task as having a fixed earliest start date.

Entering the task descriptions, their precedence and their durations has resulted in the software presenting a project plan in the form of a Gantt chart and a table of task start and finish dates. These indicate that the project com-

mences on 25 August and that the last task is completed on the 19 September; a total of 26 calendar days. In this period there are four weekends each with two non-working days giving a total of 8 days lost to the project. The number of working days spent on the project is 26 minus 8, a total of 18 working days. This is the same as shown in Figure 20.11, the resource graph for the project drawn to carry out manual levelling.

20.7.4 The PERT chart view

The project can be viewed as a network diagram by selecting PERT chart from the View Menu. Figure 20.23 shows the screen displaying the PERT chart for the Ressembler project.

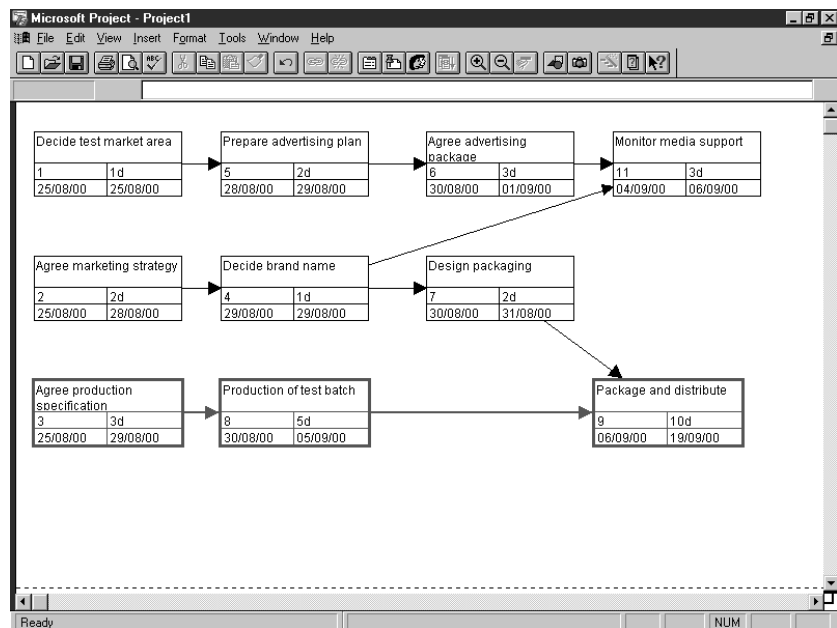


Figure 20.23 The PERT Chart View.

What is displayed is actually a **precedence diagram** not a PERT chart. A feature of PERT is the use of optimistic, expected and pessimistic durations for tasks, allowing a probability calculation to be made for the project finish date. As PFW itself will only allow one value for task duration it cannot produce a PERT chart.

The precedence diagram provided by this software, and most other software, differs significantly in appearance from the activity-on-arrow (AOA) diagrams used to manually draw a network but performs exactly the same function. The boxes represent the tasks and show their description, unique identifier, duration, start date and finish date. What is displayed in the task box can be changed using Box Styles from the Format Menu. The arrows serve only to show the linking logic between tasks but allow linkages not available with AOA diagrams. The AOA diagrams drawn in the preceding text are all based on finish–start links, the preceding task must be finished before its successor can start. However, consider a project such as painting a large bridge. The primer coat may be ready for top coat after a day of drying, but it could take a week to completely primer coat the structure. The best logical link between these activities would be ‘start to start with a 1-day lag’, i.e. whenever primer coating starts, top coating follows a day

later. Double clicking on an arrow in the PERT view brings up an inset that allows the linkage type to be changed and lags or leads to be entered.

The lower three activity boxes in Figure 20.23 have a slightly heavier border and are red on screen to indicate that they are the **critical path**; 3, 8, 9.

The screen as shown has been rearranged from the way in which it was first presented by the computer by dragging the boxes into positions on the screen which give the clearest representation of the network. As computers have no sense of the aesthetics of diagrams, the PERT chart first presented can be very messy and difficult for the human eye to sort out. Re-arranging the diagram has no effect on the logic of the network. Tasks can however be added or removed and links changed in the PERT view if the user wishes to do so and is happy working in this graphical environment. Such changes are reflected in changes to the data in the Gantt chart and task table.

20.7.5 Adding resources

Returning to the Gantt Chart View, sliding the vertical screen split to the left reveals more columns, including one headed 'Resource Names'. If this column is not present insert a new column and select the 'Resource Name' field to head it. Keying in 'Staff' in the Resource Name cell of the first task automatically creates a resource named 'Staff'. Resources can be individuals (Fred Bloggs), groups of workers (painters) or physical equipment (crane, test bed, etc.). The example project uses only one resource type 'staff' for all tasks so the entry in the first cell can be copied and pasted to all other Resource cells. Task 7 however uses two staff where the other tasks only require one. Double clicking on row 7 brings up the 'Task Information' inset as shown in Figure 20.24.

Task ID	Task Name	Duration	Start	Finish	Units	Resource
5	Prepare advertising plan	2d	28/08/00	29/08/00	1	Staff
6	Agree advertising	3d	01/09/00	05/09/00	5	Staff
7	Design packaging	1d	30/08/00	30/08/00	4	Staff[2]
8	Production of test batch	5d	30/08/00	05/09/00	3	Staff
9	Package and distribute	10d	06/09/00	19/09/00	7,8	Staff
10	Monitor media support	3d	06/09/00	08/09/00	6,4	Staff
11						
12						

Figure 20.24 Adding Resource Usage.

Selecting the Resources Tab displays several fields and a Resource Table for this specific task. Staff is shown in the first row of the inset table as we have already entered this in the column – other resources could be added in the other

rows so that the task employs multiple resources. Selecting the '1.00' in the units column next to staff and keying in '2' increases the requirement of staff for this task to the set level. In this screen shot 'Duration Type' is set as Resource Driven not Fixed Duration and the consequent halving of task duration can be seen in row 7. Changing to Fixed Duration returns the task duration to 2 days. The number of units allocated is shown in brackets in the Resource Names column.

While the software has automatically created a resource named 'staff' it knows nothing about this resource and will only have given it the default values. Figure 20.25 shows the Resource Sheet selected from the View menu.

	Resource Name	Initials	Group	Max. Units	Std. Rate	Ovt. Rate	Cost/Use	Accrue At	Base Calendar	Co
1	Staff	S		3	£10.00/h	£15.00/h	£20.00	Prorated	Standard	
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

Figure 20.25 The Resource Table.

The entry on the resource sheet shown in Figure 20.25 has been amended to show max. units as 3, the number of staff available for this project, their standard rate as £10.00 per hour, overtime rate as £15.00 per hour and a cost/use of £20.00. Pro-rated indicates that costs will accrue on an hourly basis so that if 2 hours of actual work are reported then £20 will be added to actual costs. The resource calendar is shown as standard, which means that this resource is taken to be available during all normal working days and hours. An individual calendar can be created for each resource which reflects availability for longer working hours or weekend working and shows any annual holiday periods.

In the real world a company such as Ressemblers would probably have already created a full resource table for the year showing all its staff, their working hours and holidays. As PfW can handle multiple projects this table would be available to all projects being undertaken by the company and scheduling would reflect use of resources on other projects. Such complexity is beyond the intended scope of this text.

20.7.6 Resource levelling

Having entered detailed values for the 'staff' resource it is now sensible to look at the use of that resource. Figure 20.26 shows the view obtained by selecting 'Resource Graph' from the View menu.

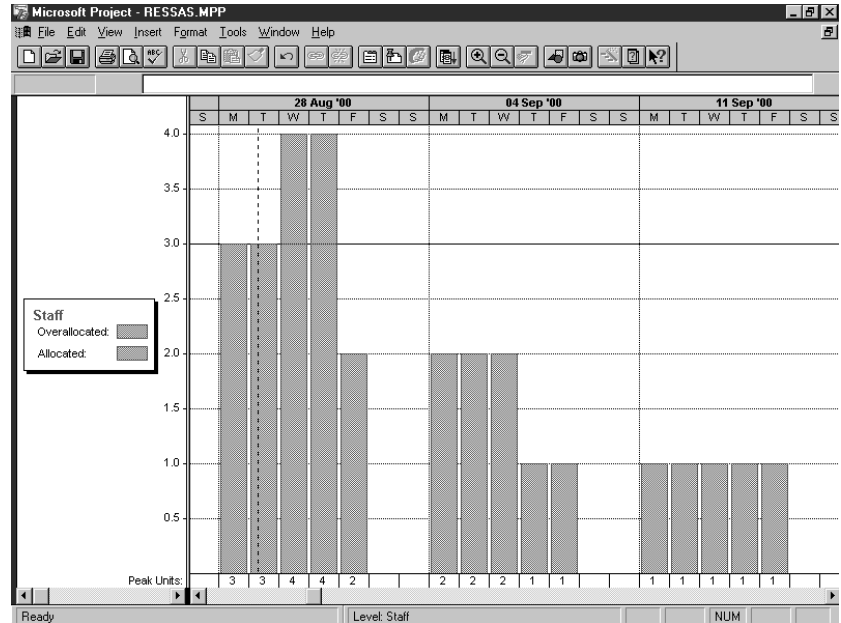


Figure 20.26 The Staff Resource Graph.

The graph shows the level of resource and the times at which it is required by the current plan. At present four staff are required for 2 days in the second week of the project. This exceeds the total number of staff available and this **excess demand** is shown in red on the screen. In fact, the staff resource was shown in red in the Resource Sheet which also indicated the existence of an overload.

Several remedies are possible. The total number of staff available could be increased, the working calendar could be modified to allow weekend or overtime working or the tasks could be adjusted from their earliest start dates to make best use of the existing resource. In extreme cases the logic of the project could also be reviewed.

The Tools menu allows the user to both carry out resource levelling, i.e. make best use of existing resources, and remove its effects. The later is important since if the results of resource levelling are an unacceptable increase in project duration it may be necessary to go back to the unlevelled schedule, implement some of the other remedies for overload and then Resource Level again. Figure 20.27 shows the screen with the Resource Levelling inset displayed.

Clicking on 'Level Now' invokes the levelling function. This is best left as a manual choice as 'Automatic' can have some unanticipated effects during the planning stage of a project. Figure 20.27 shows the data after it has been levelled, the inset has been recalled for the sake of the illustrative figure.

The task table shows that task 6 'Agree Advertising' has been moved later by 2 days to remove the overload. As a consequence this activity now spans a weekend. Activity 10 has also moved to a later start time as it is dependent on activity 6.

Figure 20.28 shows the revised graph for the staff resource after levelling with resource usage held within the maximum of three staff.

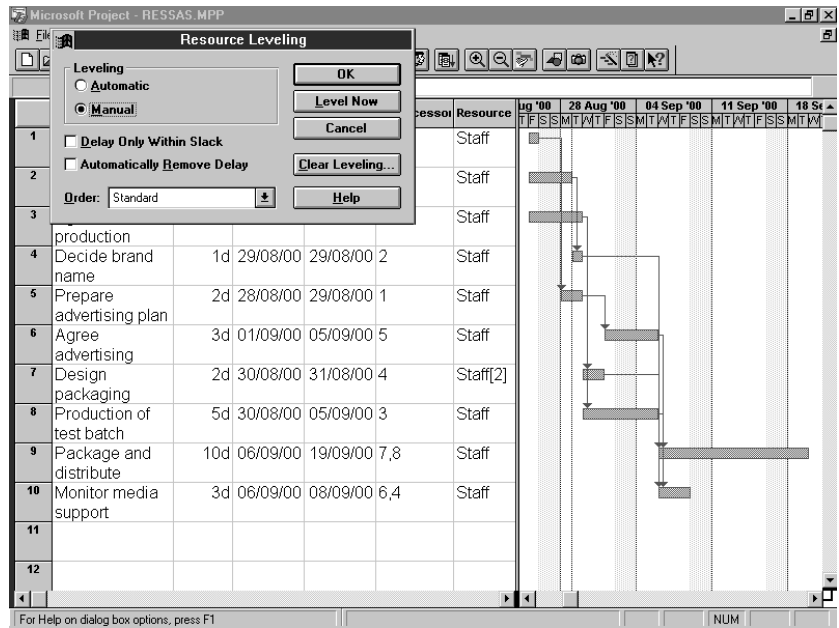


Figure 20.27 The Resource Levelling Function.

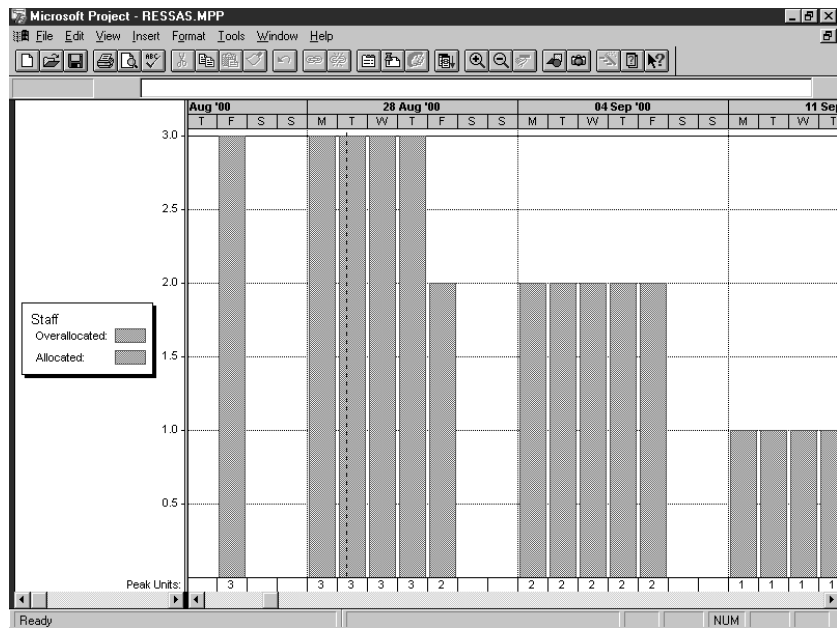


Figure 20.28 The Staff Resource Graph after Levelling.

20.7.7 Project statistics and reports

Figure 20.29 shows the project summary for the stage in planning currently reached. This inset is obtained from the File Menu, Summary Info., Statistics. More detailed reports can be produced but as printouts rather than screen displays.

The statistics inset gives a current (planned) duration of 18 (working) days for the project, a start date of 25 August and finish date of 19 September. Based on

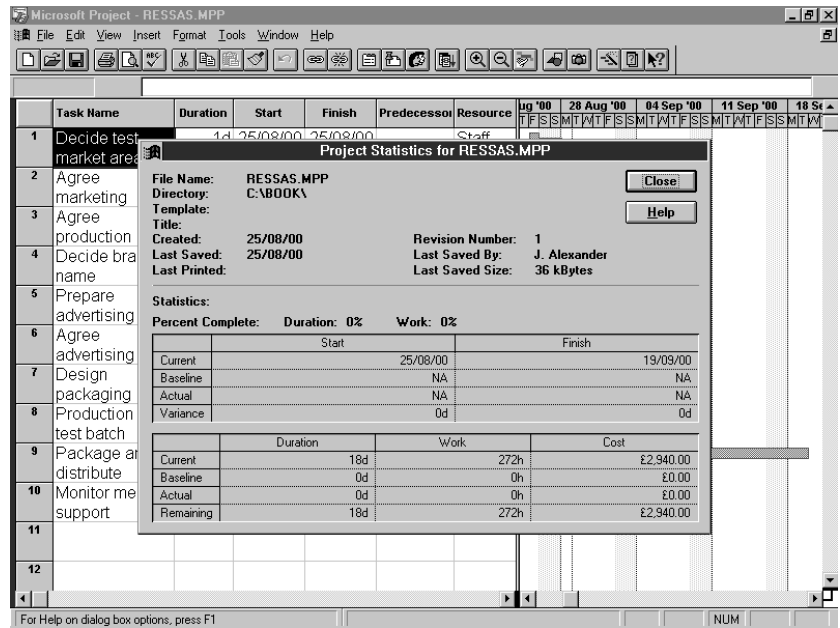


Figure 20.29 The Project Summary.

the costs entered for using staff the overall cost of the project is £2940 for 272 hours of work.

When planning is judged to be complete and accepted by the participants the project can be saved with a 'Baseline' which effectively freezes the plan. During execution of the project problems encountered may require some **replanning** of remaining activities which will change the 'current' plan. Having a frozen baseline always allows actual performance to be compared with the original as well as the current plan.

As the work progresses returns on actual work done can be entered at regular intervals so that the project can be effectively managed.

20.7.8 Concluding comments on the use of project management software

The coverage of PFW as an example of project management software is limited by the space available in this book. The software is rich in features to support realistic planning and monitoring of real-world projects. Learning to use such software for the occasional small project is probably not worth the effort but doing so for larger projects and situations where an organization manages its workload as a series of projects would be of great benefit.

In such larger projects uncertainty needs to be taken into account and can be dealt with by add-on software such as @Risk for Project. This piece of software allows probability distributions to be associated with both task durations and costs. The add-on uses Microsoft Excel to run multiple Monte Carlo trials with the data and then feeds back the results to PFW so that the most likely project durations and cost are displayed. The effects on the plan of uncertainty can then be evaluated and manual interventions made to address uncertainty and minimize cost and duration.

Computer-based solution of network problems is now a large and mature subsection of quantitative methods which allows extensive manual and automatic manipulation of the basic data using experienced qualitative judgement to arrive at manageable project plans.