Chapter 4 Cost Analysis

This chapter deals with the requirements for cost control, the method by which planned cost is calculated, the use of hammock activities for measurement of indirect cost, calculation of value and actual cost of work completed, and computation of the outlook for a project which is in progress. Examples of Cost Analysis output are given. For those with considerable experience of 1900 Series PERT Cost Analysis, there is a concluding section on the use of non-standard record designations.

The subject of cost control is complex, controversial, and subject to many forms of application and interpretation. The facilities in the Cost Analysis program aim essentially at providing a type of control that is directly linked with a network and which, by its nature, must be considered as a method of direct costing; but special cost-oriented activities (called *hammocks*) may be used to provide a medium for indirect cost measurement.

REQUIREMENTS FOR COST ANALYSIS

Management may require the following items of information in order to control costs effectively:

1	*Planned cost* for a proposed schedule	Required for comparison of alternative initial plans.
2	*Value* of work done to date	
3	*Actual cost* to date	Required for comparison with the approved planned cost, so that a project which is under way may be assessed.
4	Revised planned cost (outlook).	

All these figures may be required for the project as a whole, but they may also be calculated for subdivisions of a project, which may be as small as individual activities, but which will more usually be subprojects, or groups of activities designated by their cost codes.

INPUT

To enable the program to calculate these items of cost, it is necessary to add to the information used for Resource Analysis the following:

1 Cost per resource unit for normal usage (*normal cost*)
2 Cost per resource unit for threshold usage (*threshold cost*)
3 Cost per resource unit for usage in excess of the threshold (*super cost*)
4 Time progress data, such as activity start and finish dates and the time to completion of activities in progress
5 Cost progress data, which is the actual cost of completed or partially completed activities, including hammock activities which may cover a group of normal activities.

PLANNED COST

The planned expenditure for all or part of a project is calculated from the unit costs of the resources employed. The computation is performed in three stages.

In the first stage the average cost for each resource in each time period to be considered is worked out. If, for instance, a resource availability has been set throughout the project as

> 10 normal
>
> 4 threshold

where the threshold availability comes from such measures as overtime or subcontracting, and the cost of the resource has been set at

80s per unit for normal usage,

100s per unit for threshold usage,

140s per unit for usage in excess of the threshold.

If in addition, three sample days of a schedule for the project were examined,

on day 71, the usage is 5,

on day 82, the usage is 12,

and on day 87, the usage is 15 for the resource in question.

The calculation for these three days would be:

For day 71, the five man days used are at normal rate (80s) so that the total cost of the resource is 400s, and the average cost per man day is 80s.

For day 82, the twelve man days worked include ten at the normal rate, and two at the higher threshold rate. Thus, the total cost of the resource on this day is 1000s, and the average cost per man day is 83s to the nearest shilling.

On day 87, the 15 man days used are ten at normal rate, four at threshold rate and one at excess rate. The total cost is therefore 1340s, which makes the average cost per man day 89s.

This calculation is carried out for every resource for each time period of the project.

In the second main stage of the calculation the resource usage of individual activities is extended by these average prices to obtain for each activity a planned cost. From the example, it is clear that the cost of an activity depends on where it is scheduled, and the Resource Analysis program tends to schedule activities into areas where the resources which they require are cheap.

In the third and final stage the planned costs obtained for individual activities are aggregated to give the total planned expenditure, time period by time period, for the project. It is at this point that activities may also be considered in groups to give totals for such entities as individual departments and cost centres. The calculations outlined above mean that it is possible to obtain different costs for different schedules of the same project. For instance, the total planned project cost will vary with the amount of threshold resources used. From these figures it is possible to compare the relative efficiencies of two alternative schedules. Most of this reasoning depends on the fact that different costs have been quoted for the normal and threshold use of resources. If no threshold or excess costs are quoted, planned project costs for different schedules will produce the same total, since the number of man days worked is the only criterion, and no account is taken of the distribution. These remarks are made on the assumption that the planned costs are not further analysed by a D.C.F. calculation such as ICL PROSPER which takes into account the date of a cash flow, as well as the amount.

HAMMOCK ACTIVITIES

The calculation of planned costs so far has been solely in terms of direct activity costs. It is not always easy to include all costs on this basis, since items such as overheads often cannot be assigned to individual activities.

In order to overcome this difficulty, the facility of using a *hammock activity* is provided. This resembles a normal activity in every way, except that its duration is not specified on input nor can progress be reported on it. In the course of the Cost Analysis calculation, the length of a hammock activity for a particular schedule is the difference in time between the occurrence of its preceding and succeeding events, and therefore any resource usages or costs attached to it will be included in the project costs for the calculated duration of the hammock.

Examples

If it were necessary to include a charge of £100 per day for each period of a project's duration, a hammock activity from the first event of the network to the last with a daily rate of expenditure of £100 would achieve this, because its calculated length would equal the duration of the project.

It is clearly possible to connect a large number of activities over different parts of the project to represent such things as various overheads, men standing by, equipment tied up and so on. Further, the fact that a responsibility and cost code can be attached to a hammock activity means that its contribution can be included in the correct subtotals when a breakdown of project totals is being carried out.
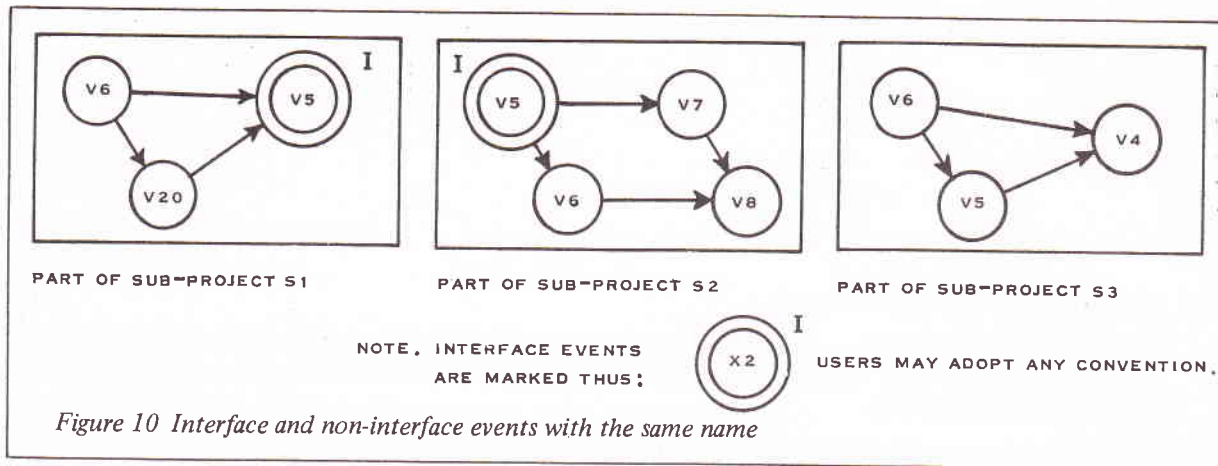
Hammocks may also be used in making allowance for a penalty clause or bonus payment for the completion of a project, and for producing high-level management reports. Their great advantage in this respect is that they have

SUBPROJECTS AND SKELETONS

It is often convenient to divide a large network into smaller sections, know as *subprojects*. The input formats for activities and events have a field for a subproject code. When this code is used, the same event names may be used in different subprojects without any risk of confusion, since normally the program treats the subprojects as separate entities. There are inherent advantages in this system; for example, subcontractors may draw up their section of a project network independently of anyone else, and in addition secrecy can be maintained where necessary, since the people who must be consulted on the drawing of part of the network need never see the whole.

There are cases, however, where these subprojects must be interconnected: this connection is achieved by the use of *interface events*. If an event in one subproject is denoted as an interface event, it is treated as identical to any other event which has the same name in another subproject and which is also designated as interface. Figure 10 shows parts of networks for three subprojects. Each subproject includes two events named V5 and V6. In S1 and S2, event V5 is marked as an interface event: the program will therefore treat V5 in S1 and V5 in S2 as the same event. However, as event V5 in S3 is not marked as interface the program will not consider it as identical to event V5 in any other subproject. The three events named V6 will all be treated as different events.

If scheduled or progress dates are to be applied to an interface event, they must be applied to every subproject in which the interface event occurs.

Figure 10 *Interface and non-interface events with the same name*

Within figure: PART OF SUB-PROJECT S1 / PART OF SUB-PROJECT S2 / PART OF SUB-PROJECT S3

NOTE. INTERFACE EVENTS ARE MARKED THUS: USERS MAY ADOPT ANY CONVENTION.

A further advantage of splitting up large projects into subprojects is the possibility of *skeletonisation*. This is a process which enables the PERT package to deal with a larger network than would otherwise be possible on computers with the given amount of core store. A *skeleton* is a network which shows only interface events and the longest path between them. When a subproject is skeletonised, its effect on other subprojects is unchanged. Figure 11 shows the networks and skeletons for two subprojects. The program produces skeletons for each subproject; these skeletons will usually be less than one-tenth of the size of the original network, They are combined into one skeleton for the whole project, and Time Analysis is performed in the usual way. The event times obtained thus are used as scheduled dates on the original subproject networks when they are re-analysed.

An event may be specified as a skeleton event. This signifies that the event should be retained during the skeleton-isation process, but that it is not an interface event: therefore events with the same name in other subprojects will not be identified with the skeleton event.

TIME ANALYSIS

The purpose of the Time Analysis program is to reduce multiple time estimates to an expected time and to use these estimates of activity durations as specified by the user in calculating the following:

1   The earliest and latest dates at which events may be achieved

2   The earliest and latest start and finish dates for activities

3   The amount of total float on activities, and the slack on events

4   The critical path through the network

This calculation shows whether any scheduled dates imposed are likely to be achieved. If no scheduled dates are imposed on the end date or dates of the project, the program assumes that these are to be achieved as early as possible.

The results produced by the Time Analysis program are preserved on the PERT data file.

Note: It is assumed that most readers are already familiar with network techniques, and therefore the methods used by Time Analysis are not explained here. A suitable text book should be consulted for this information, such as H.S. Woodgate, *Planning by Network*, Business Publications, 2nd edition 1967 or J. Moder and C. Phillips, *Project Management with CPM and PERT*, Reinhold, New York, 1964.

Definition of earliest and latest dates and float

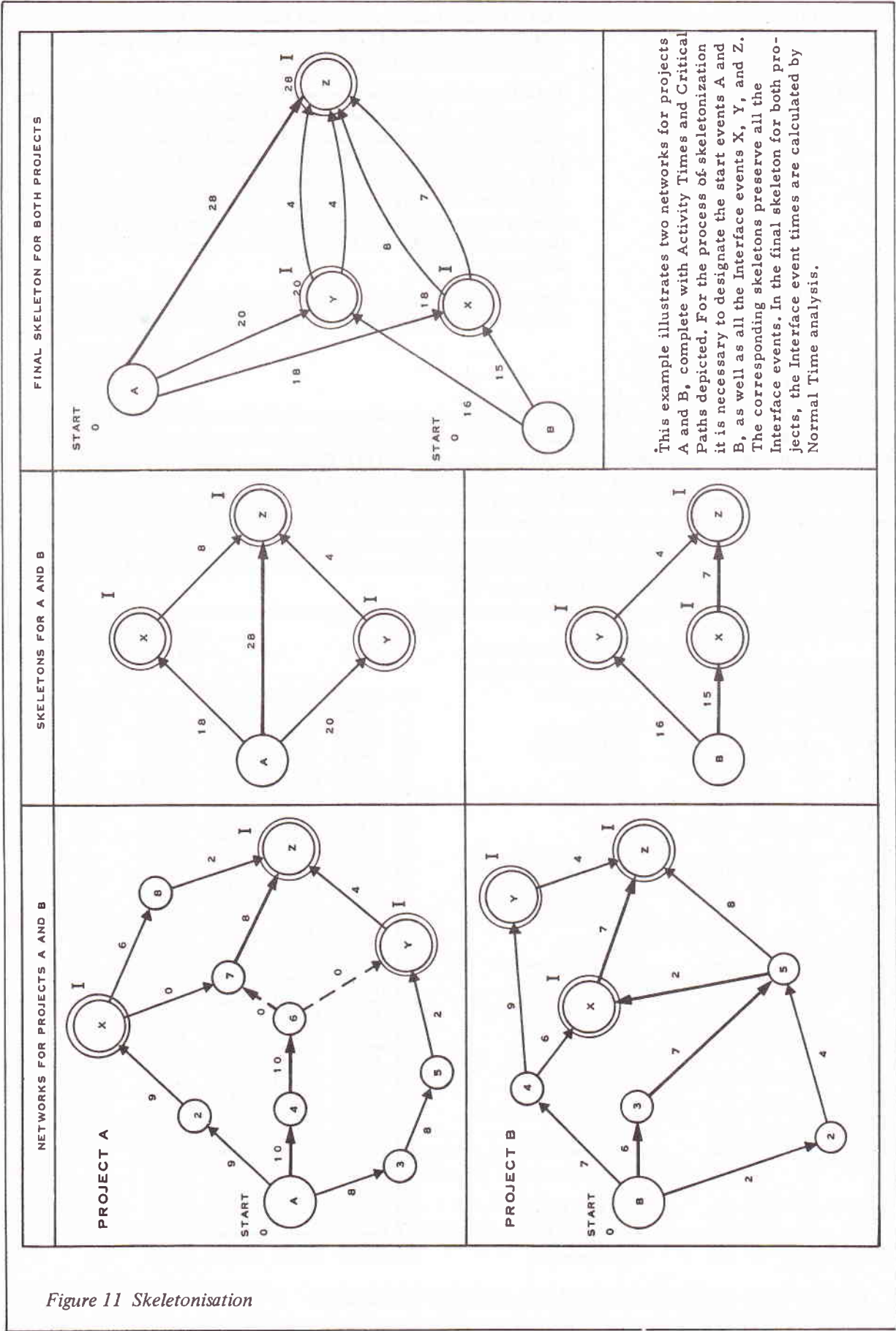|	
EARLIEST START	This is the earliest date on which an activity may be started, taking into account the time needed to complete all the preceding activities in the network path starting from TIME NOW. It is calculated on working days, and any specified holidays are excluded.
EARLIEST FINISH	This consists of the activity's earliest start plus its duration. It is calculated on working days, and any specified holidays are excluded.
LATEST START	This consists of the activity's latest finish minus its duration. It is calculated on working days, and any specified holidays are excluded.

Figure 11 Skeletonisation

This example illustrates two networks for projects A and B, complete with Activity Times and Critical Paths depicted. For the process of skeletonization it is necessary to designate the start events A and B, as well as all the Interface events X, Y, and Z. The corresponding skeletons preserve all the Interface events. In the final skeleton for both projects, the Interface event times are calculated by Normal Time analysis.