Event 1 is “start job” and event 7 is “job finished”. The activity called A is a part of the job which must be done before activities D and E can be started. B must be done before C can be started. C must also be done before D can be started. For example, a job may be “planting a fence post” using two men. Activity B is “get post-hole digger”. While this is being done, activity A is “get fence post”. Activity C is “dig hole”. Activity D is “put post in hole”. Activity G is “hold post in hole”. Activity H is “tamp dirt in hole”.

You would be wasting time to plant only one fence [post using CPM, but this shows how activities and events fir together in a network. The hardest part involved when using CPM, but the most useful, is simple putting down on paper what must be done in what order.

Finding the critical path

After deciding upon a network of activities and events which are necessary to complete a job, two time and cost estimates must be made for each activity. These estimates are referred to as normal (minimum-cost maximum-time estimate) and crash (minimum-time maximum-cost estimate). To get the best results from CPM, estimates must be based on jobs with which times and costs can be drawn with a large amount of confidence. Let us try this with the network shown below:

The estimates can be entered in a table showing each activity and its two estimates.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Activity | Normal | | Crash | |
|  | Time | Cost | Time | Cost |
| A | 12 | £ 280 | 6 | £ 1,000 |
| B | 6 | 260 | 2 | 820 |
| C | 4 | 160 | 2 | 360 |
| D | 10 | 220 | 6 | 620 |
| E | 4 | 160 | 2 | 240 |
| F | 4 | 100 | 2 | 260 |
| G | 6 | 260 | 2 | 820 |
| H | 12 | 280 | 6 | 1,000 |
|  |  | £1,720 |  | £5,120 |

Now, let us look at the following different paths that are indicated on the network.

|  |  |
| --- | --- |
| Path | Normal Time |
| ADH | 12 + 10 + 12 = 34 |
| BCDH | 6 + 4 + 10 + 12 = 32 |
| BCDFG | 6 + 4 + 10 + 4 + 6 = 30 |
| ADFG | 12 + 10 + 4 + 6 = 32 |
| BEG | 6 + 4 + 6 = 16 |

The critical path is defined as the path which takes the longest normal time to complete. It is identified by the heavy black series of arrows. ADH is the critical path in the previous network. The cost is £1,720 to complete the total job in the 34 days indicated. If we put all the activities on a crash basis we could get the job done in 18 days, however, the cost would be £5,120.

Costing and Scheduling

To determine which activity could be reduced in time at a minimum of cost, we need to compute the cost-slope formula is shown below.

You can also think of the cost-slope as “pounds per day increase” for reducing scheduling time.

Now, how so we reduce schedule time? A simple rule is to look at the critical path activity which has the lowest cost-slope. In ADH, activities A and H have a cost-slope of 120. D has a cost-slope of 100. Looking at our cost/time table, we find that D is common to all paths except BEG and that it can be reduced to a minimum of 6 days. If we do this, our cost will rise £100 per day or £400 to a total of £2,120.

Our new path/time table will look like this:

|  |  |
| --- | --- |
| Path | Normal Time |
| ADH | 12 + 6\* + 12 = 30 |
| BCDH | 6 + 4 + 6\* + 12 = 28 |
| BCDFG | 6 + 4 + 6\* + 4 + 6 = 26 |
| ADFG | 12 + 6\* + 4 + 6 = 28 |
| BEG | 6 + 4 + 6 = 16 |

\*minimum or crash time.

ADH is still the path to work on. We cannot reduce D anymore, so we have to work on A or H. Let us pick A and then reduce it by two days at £120/day. For £240 we can reduce path ADH to 28days. Our total project time is now 28 days; our total cost £2,360. Our new path/time table is:

|  |  |
| --- | --- |
| Path | Normal Time |
| ADH | 10 + 6\* + 12 = 28 |
| BCDH | 6 + 4 + 6\* + 12 = 28 |
| BCDFG | 6 + 4 + 6\* + 4 + 6 = 26 |
| ADFG | 12 + 6\* + 4 + 6 = 28 |
| BEG | 6 + 4 + 6 = 16 |

\*minimum or crash time.

Now we have to look at the tow paths ADH an BCDH since they are both 28 days. Which activity has the lowest cost slope? C and D each have one of 100. We cannot reduce D any further. C should be the best choice by our rule. But is it in this case?

If we reduce C, then ADH is still 28 days and we have not reduced the total project time. H will have to be our choice because by reducing H we reduce both paths. We already have two paths of 26 days, so H should not be reduced by any more that 2 days at £120/day. We now have a total project time of 26 days at a total cost of £2,600. We have 4 paths of 26 days each in which all activities must be done on time.

This exercise has indicated how you could cut 8 days from the schedule at a cost of £880. If you have a bonus-type contract, some perishable crop depending upon your project, or future business will be gained, this type of do-it0yourself CPM can really pay off.

Optimum Schedule

Reducing the schedule of a job to the point in time where it can be done for the lowest cost per day depends upon looking at all costs. In our crash and normal cost figures we just look at labor, materials and time. We arrived at a time by stopping with a 4 equal paths. In most jobs there are fixed costs that have to be figured such as rent, insurance, and interest being paid. These combined costs might look like the following figure. As the figure shows, doing the job at point A would produce the lowest total direct cost point. If you do not know what the fixed and direct costs are on any particular job, you are then in a poor position to decide the least cost point for the total job.

GRAPH

Slack Path Analysis

We have shown you how to reduce total job time to a min