Appendix 2

Critical Path Analysis

WHAT'S A CRITICAL PATH?

Any and every project is made up of a number of activities, some of which depend on others being completed before they can start. We saw how, when building a house, the foundations have to be finished before the walls can be started and the roof can't be put on until the walls are up, but digging the rain water soakaway can be done at any time.

The *critical path* is that sequence of interdependent activities that together determine the duration of the project. Activities on the critical path do not have any time between completing one activity and starting the next. Identifying that critical path determines the length of the project, and each activity on it must be completed in the allocated period of time otherwise the whole project will overrun. Activities not on the critical path can overrun within a period of time, called the "float," which does not affect any critical activity.

Critical path analysis (CPA) is one of a number of tools—all now available as software packages—that have been developed to allow the project manager to calculate the time required for completion of the project and to see which are the critical activities.

ACTIVITY LIST

The first step in CPA is to prepare a list of all the activities that make up the project and, for each, identify the duration and dependent activities, that is, activities that have to be completed before another can start. Let's use the house building example as shown in Table A2.1.

NETWORK DIAGRAM

We can now draw a network of arrows and nodes (Figure A2.1)—the so-called *activity on arrow* diagram—in which the arrows represent the activities (each

Engineering Money: Financial Fundamentals for Engineers, by Richard Hill and George Solt

Table A2.1

Activity	Description	Duration (Weeks)	Dependent (Activities)
A	Access road	3	
B	Footings	2	
C	Foundations	2	A, B
D	External walls	6	C
E	Internal walls (lower)	4	C
F	Floors	2	E
G	Internal walls (upper)	3	F
H	Roof trusses	2	D
J	Roof tiles	2	H
K	Gutters/drain pipes	1	J
L	Soakaway	1	

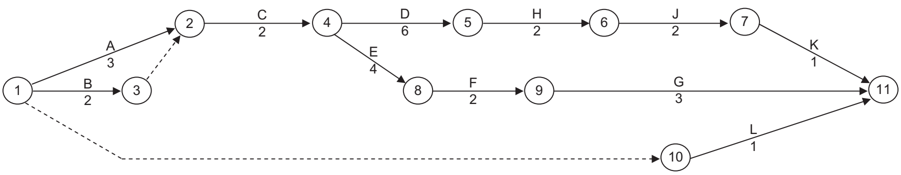

Figure A2.1 Activity on arrow diagram.

identified with the duration marked on it) and the *nodes* (sometimes called *events*) are the start or completion of an activity. This shows how the activities depend on one another The dotted line connecting node 3 to node 2 is a *dummy activity*. This shows dependence and means that activity C cannot start until activities A and B have both been completed. Dummy activities have no duration.

We can now assign to each activity an *earliest start time* (EST) by looking at the longest activity path that precedes it. That will take us to the earliest time at which we can reach node 10, which is completion of the project (in this case 16 weeks). So:

EST for activity C = EST for activity A + duration of activity A = 0 + 3 = 3.
EST for activity D = EST for activity C + duration of activity C = 3 + 2 = 5.
EST for activity E = EST for activity C + duration of activity C = 3 + 2 = 5.
EST for activity F = EST for activity E + duration of activity E = 5 + 4 = 9.
EST for activity G = EST for activity F + duration of activity F = 9 + 2 = 11 and so on.

Doing the same thing in reverse, starting at node 10 and working backward, gives us the *latest start time* (LST) for each activity. So:

Table A2.2 Critical path Data

Activity	Duration	EST	LST	Float
A	3	0	0	0
B	2	0	1	1
C	2	3	3	0
D	6	5	5	0
E	4	5	7	2
F	2	9	11	2
G	3	11	13	2
H	2	11	11	0
J	2	13	13	0
K	1	15	15	0
L	1	0	15	15

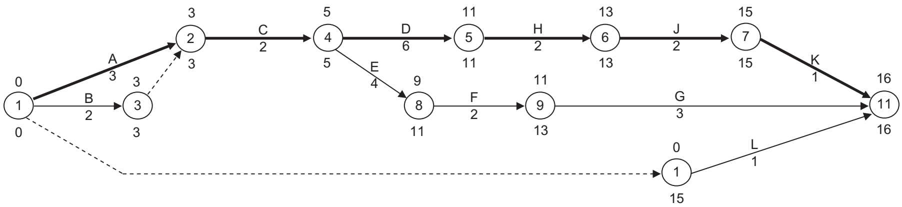

Figure A2.2 CPA diagram.

LST for activity G = 16 – duration of activity C = 16 – 3 = 13.

LST for activity F = LST for activity C – duration of activity F = 13 – 2 = 11.

LST for activity F = LST for activity F – duration of activity E = 11 – 4 = 7 and so on.

The difference between the latest start time and the earliest start time for each activity is the *float*. The path with zero float is the critical path (see Table A2.2).

We can now mark on each node the earliest start time and latest start time for the following activity and also highlight the critical path (Figure A2.2).

The numbers above the nodes are called the *earliest event times* (EET) and represent the earliest starting time for the start of the next activity. The numbers below are the *latest event times* (LET) and represent the latest possible start time for the next activity that will achieve the project time, which is the sum of the times on the critical path and is shown on the last node. The nodes on the critical path always have the same earliest event time (EET) and latest event time (LET). It is usual practice to include this information in the node as shown in Figure A2.3.

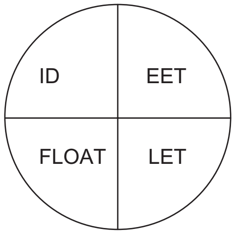

Figure A2.3 Node symbol.

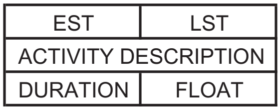

Figure A2.4 Activity on node symbol.

Note that this is only one approach (and the simplest) to setting out critical path analysis, and there are several different ways of presenting the network diagram and of annotating it with durations, times, and float. In some versions, called either *activity on node* diagrams or *precedence* diagrams, the nodes represent activities and the arrows or lines represent the relationships of activities and their precedence. The convention in this system is to use a rectangular node like that shown in Figure A2.4.