

Lab 6

Project Crashing

Before this practical, you should have learned the Critical Path Method (CPM). CPM helps to answer the questions like:

- What is the total time to complete the project
- What are the scheduled start and finish dates for each task
- What tasks are critical and must complete in time in order not to miss the deadline

Another technique that we will be learning is the how to crash a project. For example, by looking at the critical path of the project and we realize that meeting the desired completion date is impossible unless we can shorten some selected activity time. This shortening of activity time which usually can be achieved by adding more resources is referred to as “crashing”. However, the added resources associated with crashing activity time usually result in added project costs, so we will want to identify the activities that cost the least to crash and then crash those activities only the amount necessary to meet the desired project completion time. We will use the following scenario to learn all the above techniques mentioned.

There are 2 parts to be carried for this practical :

- Part 1 : Construct the project network diagram using the CPM approach
- Part 2 : Use Linear Programming technique to shorten the project schedule (also known as crashing the project schedule)

Part 1: Construct the project network diagram using the CPM approach

Frank’s Fine Floats is the business of building elaborate parade floats. The company crew has a new float to build for the Christmas parade and they want to use CPM to manage the project.

The activities identified for the project are tabulated below.

Activity	Description	Immediate Predecessors	Completed Time (days)
A	Initial Paperwork	-	6
B	Build Body	A	4
C	Build Frame	A	3
D	Finish Body	B	6
E	Finish Frame	B	3
F	Final Paperwork	B,C	10
G	Mount Body to Frame	E,F	2
H	Install Skirt to Frame	G	6
I	Decorate at Site	D, G	8

- Develop a network diagram for this project.
- Identify the critical tasks.

Part 2: Use Linear Programming technique to shorten the project schedule (Project Crashing)

In the above scenario, we derive that the project completion time will be 30 days. Which activities should be crashed in order for the project to be completed in 26 days?

To determine just where and how much to crash activity times, we need information on how much each activity can be crashed and how much the crashing process costs. Hence, we must ask for the following information:

- Activity cost under the normal or expected activity time
- Time to complete the activity under maximum crashing (i.e., the shortest possible activity time)
- Activity cost under maximum crashing

The following table provides the information needed:

Activities	Description	Normal		Crash	
		Time	Cost (\$)	Time	Cost (\$)
A	Initial Paperwork	6	800	5	10,000
B*	Build Body	4	1000	4	1000
C	Build Frame	3	5000	2	10,000
D	Finish Body	6	15000	3	30,000
E	Finish Frame	3	18,000	2	25,000
F	Final Paperwork	10	30,000	7	48,000
G*	Mount Body to Frame	2	10,000	2	10,000
H	Install Skirt to Frame	6	45,000	5	80,000
I	Decorate at Site	8	35,000	4	65,000

*indicates activity that cannot be crashed

We want to find out from the given information that which activities should be crashed – and by how much – in order **to meet the 26 days project completion deadline at minimum cost!** Note that activities B and G cannot be crashed at all!

This is not a simple question to solve if we try to do it manually. Instead, we are going to use the technique of Linear Programming for minimum cost crashing to help us find out the answer. The following guide shows how the Linear Programming Model can be constructed using the Microsoft Excel spreadsheet.

Step 1: Define the objective to be achieved in this case

Let $x_A, x_B, x_C, x_D, x_E, x_F, x_G, x_H$ and x_I be the decision variables (number of days to reduce) for crashing the activity A, B, C, D, E, F, G, H and I respectively. We want to achieve minimum cost in crashing the schedule. Therefore, the objective function is defined as:

Step 2: Identify the constraints

There are 3 categories of constraints to be defined in this case.

- i. The maximum number of days can be crashed for each activity
- ii. The predecessor relations between activities and the start time and reduction.
- iii. The total duration of the **critical tasks** must be less than 26 days

Define these 3 categories in the model.

Note: A predecessor relation of $A \rightarrow B$ can be modelled by the following inequality:

$$y_B \geq T_A - x_A + y_A$$

where y_B is the start time of activity B ,
 T_A is the normal activity time of activity A ,
 x_A is the time reduction of activity A , and
 y_A is the start time of activity A .

Step 3 : Run Excel Solver to find the optimal solution

From the result, the additional cost incurred at minimum will be \$ _____ and the recommended days to crash for each activity are:

<i>Activity</i>	Number of Days to crashed
A	
B	
C	
D	
E	
F	
G	
H	
I	

Conclusion:

Crashing the project schedule refers to shortening the activity times by adding _____ and hence usually increases _____.

Extra Exercise:

Recall that we drew the project network diagram to find the project completion time of 30 days. Could we have found out what this original project completion time is without drawing the network diagram? (*Hint: Use the spreadsheet we just created.*)