

Why

The planning, organization, and management of complex projects requires keeping track of many activities with various dependencies (especially in term of time - some must finish before others can begin) and demands on resources. Among the tools for organizing such projects are the visual network models in PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method). This activity focuses on constructing the network from a list of activities and dependencies and developing a spreadsheet model usable for calculating early and late times and slack to find the critical path.

LEARNING OBJECTIVES

1. Work as a team, using the team roles
2. Understand the design of a project network and be able to construct a PERT chart network and a chart of Early and Late times..
3. Be able to find early and late times for the activities, and the slack for each activity.
4. Identify the critical activities and critical path (or paths) from the Early/Late times
5. Be able to interpret the network in terms of the effect of delays

CITERIA

1. Success in working as a team and in fulfilling the team roles.
2. Understanding of the material by all team members
3. Success in completing the exercises.

RESOURCES

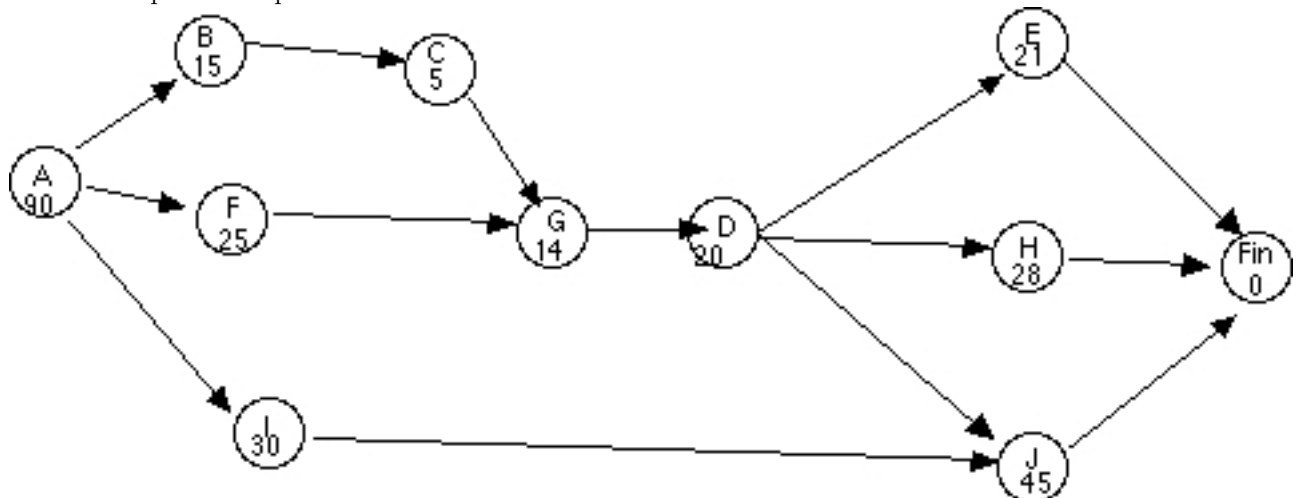
1. The handout on project networks from Wednesday
2. Your text – sections 5.1 - 5.3
3. 50 minutes

PLAN

1. Select roles, if you have not already done so, and decide how you will carry out steps 2 and 3
2. Work through the exercises given below you will submit one (team) copy of the work, with the usual reports [see the syllabus]
3. Assess the team’s work and roles performances and prepare the Reflector’s and Recorder’s reports including team grade.
4. Be prepared to discuss your results

MODEL

(The Klonepalm example in the text (pp. 260–268) is modeled by the network shown here. Working by hand with the network gives the table shown below the network. The Excel file Excel-klonepalm.xls available on Blackboard provides equivalent calculations..



The table of times (calculations shown below) is :

Activity	ES	EF	LS	LF	Slack	Critical?
A	0	90	0	90	0	Yes
B	90	105	95	110	5	
C	105	110	110	115	5	
D	129	149	129	149	0	Yes
E	149	170	173	194	24	
F	90	115	90	115	0	Yes
G	115	129	115	129	0	Yes
H	149	177	166	194	17	
I	90	120	119	149	29	
J	149	194	149	194	0	Yes
Fin	194	194	194	194	0	Yes

The project will require 194 days.

The critical path is A-F-G-D-J-Fin

We obtain the Early times working forward (finding these is faster than saying them):

A has no predecessors, can start at time 0 days and finish after 90 days

B has only A as predecessor, can start after 90 days, finish after $90 + 15 = 105$ days

F has only A as predecessor, can start after 90 days, finish after $90 + 25 = 115$ days

I has only A as predecessor, can start after 90 days, finish after $90 + 30 = 120$ days

C has only B as immediate predecessor, can start after 105 days, finish after 110 days

G has both C and F as immediate predecessors, can start after $\text{Max}\{110, 115\} = 115$ days, finish after $115 + 14 = 129$ days

D has only G as immediate predecessor, can start after 129 days, finish after $129 + 20 = 149$ days

E has only D as immediate predecessor, can start after 149 days, finish after $149 + 21 = 170$ days

H has only D as immediate predecessor, can start after 149 days, finish after $149 + 28 = 177$ days

J has D and I as immediate predecessors, can start after $\text{Max}\{149, 120\} = 149$ days, finish after $149 + 45 = 194$ days

Fin has E, H, J as immediate predecessors, can start after $\text{Max}\{170, 177, 194\} = 194$ days, finish after 194 days.

Working back, to obtain Late Finish and Late Start times, we get:

Fin has no successors: must finish after 194 days, so must start after $194 - 0 = 194$ days.

J has only Fin as immediate successor, must finish after 194 days, must start by end of $194 - 45 = 149$ days

H has only Fin as immediate successor, must finish after 194 days, must start by end of $194 - 28 = 166$ days

E has only Fin as immediate successor, must finish after 194 days, must start by end of $194 - 21 = 173$ days

D has E, H, J as immediate successors, must finish by the end of $\text{Min}\{173, 166, 149\} = 149$ days, must start by the end of $149 - 20 = 129$ days

G has only D as immediate successor, must finish after 129 days, must start by the end of $129 - 14 = 115$ days

C has only G as immediate successor, must finish after 115 days, start by end of $115 - 5 = 110$ days

B has only C as immediate successor, must finish after 110 days, start by end of $110 - 15 = 95$ days

F has only G as immediate successor, must finish after 110 days, start by end of $115 - 25 = 90$ days

I has only J as immediate successor, must finish after 149 days, start by end of $149 - 30 = 119$ days

A has B, F, I as immediate successors, must finish after $\text{Min}\{95, 90, 119\} = 90$ days, must start by 0 days.

Slack (using $\text{LS} - \text{ES}$, could also use $\text{LF} - \text{EF}$):

A: $0 - 0 = 0$ -critical

B: $90 - 65 = 25$

C: $110 - 105 = 5$

D: $129 - 129 = 0$ -critical

E: $173 - 149 = 24$

F: $90 - 90 = 0$ -critical

G: $115 - 115 = 0$ -critical

H: $166 - 149 = 17$

I: $119 - 90 = 29$

J: $149 - 149 = 0$ -critical

Fin: $194 - 194 = 0$ -critical. Of course Start and Fin(if present) will always be critical since the critical path goes all the way through the network. In fact, the critical path is the *longest* path through the network.

It represents the longest sequence of events that must be completed, and thus sets the minimum time for completion.

To set up Excel for the calculations (see the Excel sheet for this example) follow the instructions on the handout (also available through Blackboard - notes section - as Excel for Project Networks. The spreadsheet Excel-klonepalm.xls (also on Blackboard) can be used as a semi-template (you may have to add rows, you will have to adjust the calculations for ES and LF to correspond to the network actually being modeled)

For ES for an activity, you use “= Max(list (by clicking and using commas) of immediate predecessor EF values)” (EF is simply ES + duration) For LF you use “Min(list (by clicking and using commas)) of immediate successor LS values)” (and LS is simply LF – duration)

EXERCISES

The Quickbuck Construction Company is building a house. They have the following list of activities, precedences, and (very optimistic) durations for the project.

ACTIVITY	PREDECESSOR	EXPECTED DURATION (days)
A. Excavation	-	5
B. Pour foundation	A	2
C. Outside plumbing	A	6
D. Framing	B	12
E. Inside plumbing	D	10
F. Wiring	D	9
G. Roofing	D	5
H. Brickwork	B	9
I. Plumbing inspection	C,E	1
J. Shingling	G	2
K. Cover walls	F,I,J	3
L. Interior finishing	K	9
M. Exterior finishing	G,H	7
N. Landscaping	M	8

- Show the Project network [PERT network] for the project
- Find (by hand) the early start and early finish times for the activities. What is the minimum time required to complete the project?
- Develop an Excel model (based on the handout ExcelforProjectNetworks.pdf from last class and the Excel-klonepalm.xls example) and use it to give the critical path (list the activities in order)
 - What will happen to the completion date if the outside plumbing work takes 12 days instead of 6?
 - If excavation takes an extra three days, what will this do to the completion date?
 - If additional workers are hired to speed up the framing work by two days, what will happen to the completion date? What activities will be rescheduled?
 - What will happen to the completion date if the roofer runs over on another job, which he finishes on day 22 of this project (So he is ready to start after day 22)? What activities will be rescheduled?
 - If bad weather causes roofing to take an extra three days and shingling to take an extra two days, what will happen to the completion date? What will have to be rescheduled?

READING ASSIGNMENT (in preparation for next class meeting)

Sections 5.5 – 5.6

SKILL EXERCISES:(hand in - individually - at next class meeting)

P.312 #6 Draw the network but use Excel for the calculations—so you should expect to have paper to hand in plus an Excel workbook to send