Chapter 10 – The Project Plan

1. In your own words, describe what is meant by the work breakdown structure. [R]

A work breakdown structure, or WBS, is a tabular breakdown of the entire project that subdivides specific tasks and deliverables that need to be completed in order to accomplish the project objectives. The WBS results from systems engineering efforts.

2. Consider the set of activities, duration (in days), and predecessors for a project given below. [A]

Activity	A	B	C	D	E	F	G	H	I
Duration	3	9	6	6	6	3	2	6	7
Predecessors	-	-	-	A,B	D,B	C	F,E	G	F

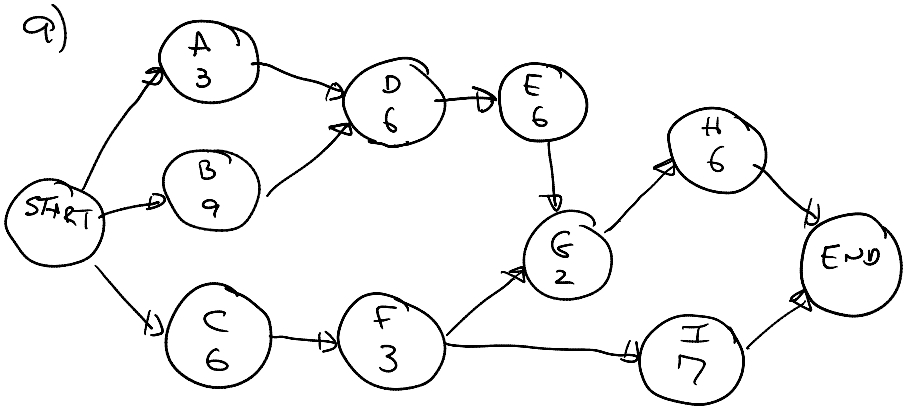
a. Develop a network diagram representation for the project.

b. Determine the critical path.

c. Determine the float time for all activities that are not on the critical path.

Problem 10.2

a)



b) Path — Length

A D E G H — 23 days

B D E G H — 26 days ← Critical path

C F G H — 17 days

C F I — 16 days

c) Float Times

A = 3 days

C = 9 days

F = 9 days

I = 10 days

3. Consider the set of activities, duration (in days), and predecessors for a project given below. [A]

Activity	A	B	C	D	E	F	G	H	I	J	K
Duration	9	12	3	4	5	9	8	3	6	9	1
Predecessors	-	A	A	B,C	C	B	D	F,D	G	H,I	E

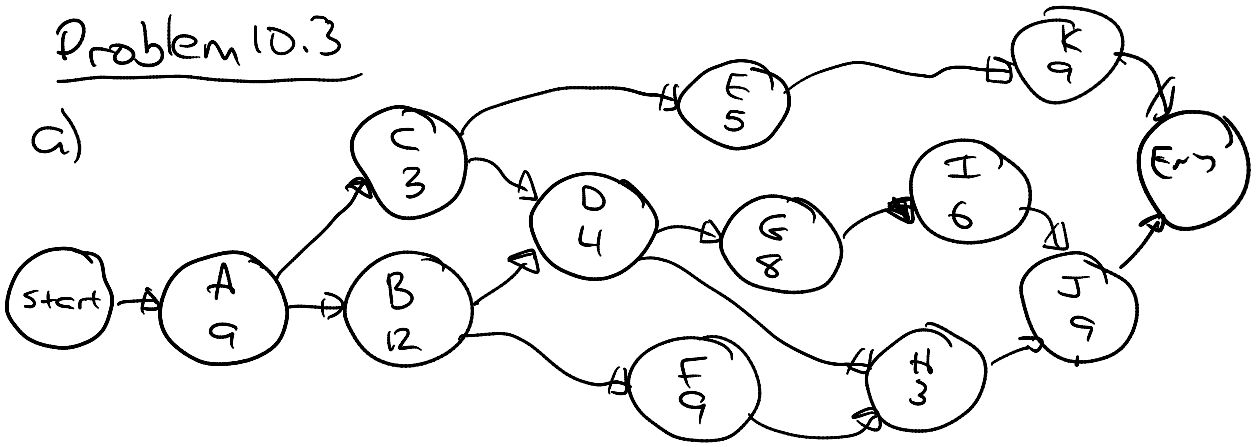
a. Develop a network diagram representation for the project.

b. Determine the critical path.

c. Determine the float time for all activities that are not on the critical path.

Problem 10.3

a)



b)

Paths	Length	
ACEK	26 days	
ACDGIJ	39	
ACDHJ	28	
ABDGIJ	48	← Critical path
ABDHJ	37	
ABFHJ	42	

c)

Task	Float
C	9 days
E	22
F	6
H	6

4. Explain why a network diagram cannot contain cycles. A cycle is a sequence of activities where you can travel back to an activity already visited. [R]

A network diagram is a directed graph focused on the progression of activity paths for the completion of a project. Cycles are prohibited, because each of the nodes represents an activity that must be completed before continuing on. Therefore, you are unable to travel back to an activity once it has been accomplished.

5. Describe the advantages and disadvantages of the network diagram and the Gantt chart representations for a project. [R]

Network Diagram		Gantt Chart	
(+)	Allows for a graphical visualization of a project	**(+)**	Effectively shows the WBS and timeline for completion
(+)	Allows for a quantitative analysis of a project	**(+)**	Greater ability to encapsulate amount of info required for an in-depth project on a single page
(+)	Provides a graphical representation of activities and their dependencies	**(-)**	Inability to show dependencies between activities (until current software)
(+)	Identifies the critical path and float times for activities	**(-)**	Does not identify critical path and float times
(-)	May be difficult to include the amount of info required for an in-depth project on a single page		
(-)	May be difficult to make a large project in a easy-to-read format		

6. Assume that the following data has been determined for the development and sale of a new digital thermometer for home use: development cost = $250,000, production investment = $500,000, annual production volume = 20,000 units per year, and the sales lifetime is 7 years. Assuming a variable production cost of $5 per unit, determine: (a) the sales price necessary to break even within 2 years, and (b) the profit expected over the estimated sales lifetime. [A]

(a) The objective is to determine the sales price, n, necessary to break even in 2 years. The fixed costs are the sum of the development costs and production investment. So

$$\textit{fixed costs} = \$(250{,}000 + 500{,}000) = \$750{,}000.$$

This leads to a total cost for 40,000 units sold (2 years) of

$$\textit{total cost} = \$750{,}000 + 40{,}000 * \$5 = \$950{,}000$$

The revenue for a sale price of n dollars is

$$\textit{revenue} = 40{,}000 * \$n$$

Setting the revenue and total cost each equal at the break-even point produces

$$40{,}000 * \$n = \$950{,}000$$

Solving for the final sales price gives

$$n = \underline{\mathbf{\$23.75}}$$

(b) Profit is the differential between the total revenue and the total cost and is expressed as

$$profit = total\ revenue - total\ costs.$$

For an expected volume of 20,000 units per year over 7 years

$$profit = n * \$23.75 - (\$750{,}000 + n * \$5)$$

$$= 140{,}000 * \$23.75 - (\$750{,}000 + 140{,}000 * \$5)$$

$$profit = \underline{\mathbf{\$1.875\ million}}.$$

7. Describe the difference between the cost estimation models in equations (7) and (8) and the COCOMO cost estimation model. [R]

The cost estimation models found in equations (7) and (8) as simplistic models that offer only one input to the estimator – the number of lines of code (KLOC). This assumes that there is a linear relationship between the number of people on a team and the time it will take to develop a product. This is referred to a "mythical man-month." In fact, factors such as experience, team size, technology used, and the timeframe required all have an effect on the overall cost estimation. The Constructive Cost Model (COCOMO) takes in consideration all of these factors to estimate costs and determine how many engineers are needed to complete projects of a given complexity.

8. Consider a software development project that has a team of 50 software development engineers. The team has proposed a design and estimates that it will require 500,000 lines of code to complete the project. The average cost to the company for an engineer is $90,000 per year, including salary, benefits, and overhead. Estimate (a) the time required to complete the project, and (b) the labor costs. [A]

(a) Based upon the given values, the following model is most appropriate:

$$effort = a(KLOC)^b = 5.2(500)^{0.91} = 1486 \text{ person - months.}$$

Since there are 50 developers on the project, the estimated time is determined by dividing the effort by 50, to produce an estimated time of **<u>29.7 months</u>**.

(b) The labor costs for development are determined from the number of person-months and the average monthly salary of a development engineer as

$$labor\ cost = 1486 \text{ person – months} * \frac{\$90000}{\text{year}} * \frac{1 \text{ year}}{12 \text{ months}}$$

$$labor\ cost = \underline{\mathbf{\$11.15\ million}}.$$

9. Consider a software development project where the team has proposed a design and estimates that it will require 200,000 lines of code to complete. The average cost to the company for an engineer is $110,000 per year, including salary, benefits, and overhead. Estimate (a) the number of engineers needed to complete the project within 18 months, and (b) the labor costs. [A]

(a) Based upon the given values, the following model is most appropriate:

$$time = \frac{effort}{persons} \rightarrow persons = \frac{effort}{time} = \frac{a(KLOC)^b}{time} = \frac{5.2(200)^{0.91}}{18} = \underline{\mathbf{36\ engineers}}$$

(b) The labor costs for development are determined from the number of person-months and the average monthly salary of a development engineer as

$$\textit{labor cost} = 646 \text{ person} - \text{months} \times \frac{\$110000}{\text{year}} \times \frac{1 \text{ year}}{12 \text{ months}}$$

$$\textit{labor cost} = \underline{\textbf{\$5.92 million}}.$$

10. Project Application. Develop a project plan for your project. A format and guideline for developing the plan is contained in Section 10.7. [P]

Note: A good project plan usually comes from a good systems engineering effort that identifies clearly the elements of the design. Thus the major tasks can be identified and assigned to different team members. As indicated in Section 10.7, the major elements are the WBS, Gantt chart/network diagram, and cost/resource estimation. We have our students develop the WBS and Gantt Chart using Microsoft Project. The Gantt Chart capability is nice in that it also shows the dependencies (network diagram) in the timeline format.

The Project Plan
CENBD 480/EE BD 480 - Engineering Design Concepts Penn State Behrend

Reading: Chapter 10
This is a team assignment for the project.

A well developed project plan will help the team in the execution of the project next semester. The plan will be utilized to monitor your team's progress and to gauge your adherence to schedule. The faculty members realize that things can and will change as the project proceeds. However, the plan will provide guidance for benchmarking the team's progress. Your team must develop a project plan and submit it by Friday **December 15, 2006** at midnight. The elements of the project plan for this class are the following:

1) ***The Work Breakdown Structure (WBS)***. See Table 10.1 of the book for an example. Your WBS should have columns for:
    - ID
    - Activity Name
    - Duration
    - Predecessors
    - People (Resource column in Microsoft lingo)
    - Deliverables
    - Lab Resources

The WBS will be created from the Microsoft Project *Task Sheet* view as demonstrated in class. You will need to add columns in the *Task Sheet* view for the Deliverables and for the Lab Resources. In terms of the people assigned to a given task, put those in the Resources column in Microsoft Project (that is the unfortunate terminology used by the software). Also, be sure to include the following milestones (milestone = a task that has a duration of 0 days) in the plan:

- Team Design Review: March 5th - March 9th.
- Final Report Due: April 27st (all work should be complete by this time).
- Final Presentations to faculty: April 30th - May 4th.
- Senior Design Conference: May 5th.
- Team Member Evaluations: February 9th, March 9th, April 6th, May 4th.

All project timelines should start on January 16, 2007 and end on May 4, 2007.

2) ***GANNT Chart.*** A GANNT chart from the GANNT Chart view. You will need to edit the timescale so that the major timescale (*middle tier* in Microsoft lingo) is months and minor timescale (*bottom tier* in Microsoft Lingo) is weeks. You adjust this by right clicking the timescale in the GANNT chart view and selecting the *timescale* option – you will then see options for *middle tier* and *bottom tier*.

3) ***Development Cost Estimates.*** In a Microsoft Word Document, identify the following 2 items:

    - Cost Estimates (parts, components, software, etc.) costs. Include **a table** with all parts needed listed. Include only those parts that need to be purchased. There should be a **sum total estimate** of parts costs that need to be purchased.

- Internal Resources. Please indicate if you will need to use any of the following Behrend resources (this helps me get everything setup for next semester, so the projects can start smoothly):
    - *Printed Circuit Boards.* Do you plan to use them in your design? How many? Estimated dimensions (just a rough idea helps)? When do you estimate that you will need them (identify this in the project plan)
    - *Mechanical Fixtures.* Will you need any mechanical items built by our technicians? If so, what are they? When will you need them (again identify in project plan)?
    - *Computers.* Will you need any special computer resources in the Senior Design Lab? They are typically for doing development work that can't be done on the networked computers that are available in the senior lab or in the electronics labs (i.e. you need to interface to bench-top hardware, have special software, special operating system needs).
    - *Test & Measurement Equipment.* Do you need any non-standard equipment for the project? (We have basic electronics setup available on the senior design benches – o'scopes, meters, logic analyzers, power supplies, etc). Will you be using the senior design room or in the electronics labs for the project (or both)?

Assignment Submission Instruction:

Submit the following in an ANGEL Dropbox (I will print out what I need):

1. A softcopy of the Microsoft Project file.
2. A softcopy of the Microsoft Word file that has the development cost estimates.