CE 167 Midterm #2
Fall 2000
Prof. C.W. Ibbs

Solution Manual

Question #1 [5 points apiece--10 points total]

The following questions pertain to the book *From the Ground Up*. Keep answers concise and to the point.

(a) The book goes into great detail about problems with the building excavation. Describe (briefly but in detail) the causes and ramifications of the problem.

The contractor was excavating the pit for the foundation too much too fast (in other words, they were removing soil in "windows" that were too large, causing the sides of the excavation to be unstable). The result of this was that sidewalks and underground pipelines adjacent to the site began to crack, and the lagging system used to stabilize the pit began to fail. Additionally, the resulting rework and schedule delays meant that the excavation costs would end up being more than $6 million (the bulk of the $6 million is due blowing the schedule, and thus missing out on potential rents).

(b) What kinds of insurance and/or bonding could an owner insist that a general contractor have to ensure a problem similar to the one described above will not threaten completion of a project?

The owner could require ***Performance Bonds*** *and you could make an argument for* ***Builder's Risk Insurance.*** *(I gave Brian a lot of discretion for the grading of this question.)*

Question #2 [10 points]

How are responsibilities apportioned with a bill of quantities contract? Who is affected if the quantities are overestimated? How and why?

In a Bill of Quantities (BOQ) contract, the <u>owner is responsible for the quantities</u> and the <u>contractor is responsible for unit prices.</u> If the owner overestimated the quantities, the contractor can be negatively affected because the contractor calculates the unit price based on expected fixed costs ***plus*** *direct (variable) costs and profit. Therefore, the fixed costs are apportioned out over the expected quantity. If this quantity is reduced, then more money per unit is taken up with fixed costs, and there is less money left for direct costs and profit.*

The only advantage for the contractor in having the quantities overestimated is that there will probably be less time pressure to complete the project (there are *fewer units to install). The owner is affected by the overestimation in the sense that he/she will not have to pay as much as originally anticipated. If the quantity estimation is grossly wrong (±15%) then the contract usually allows room for renegotiating a new, fairer unit price.*

Question #3 [10 points]

On the first day of a project, a crew can drive 100 piles with 40 person hours. How long will it take that same crew to drive piles on the 5th day, assuming a learning rate of 0.93?

$n = 0.93$
$K = 40$ *hours/100 piles (first unit)*
$x = 5^{th}$ *unit*

$s = (\log n)/(\log 2) = (\log 0.93)/(\log 2) = -0.1047$

$y_x = K(x)^s \rightarrow y_5 = 40(5)^{-0.1047}$

$y_5 =$ *33.8 hours (or 33:48) to drive 100 piles on the 5th day.*

Question #4 [15 points]

A 500,000 square-foot building was built in Phoenix, Arizona in 1993 with a total cost of construction of $12.5 million. A similar building is proposed for Las Vegas, Nevada in 2000, though it will be 600,000 square-feet. Prepare a preliminary cost estimate considering the following factors:

- The cost capacity factor for this type of building is 0.75
- Inflation has averaged 5% per year
- The location indexes for AZ and NV are 0.91 and 0.85, respectively

$FV_{Arizona\ Plant\ 2000} = PV_{Arizona\ Plant\ 1993}(1 + i)^n = \$12.5\text{ million}(1.05)^7 = \$17.59\text{ million}$

The Arizona plant built in 1993 is worth $17.59 million in year 2000 dollars (you have to compare apples to apples).

$C_{new} = [C_{reference} \times I_{new}]/I_{reference} = [\$17.59M \times 0.85]/0.91 = \$16.43M$

Cost of a new (NV) facility of comparable size is $16.43 million. (Note: this becomes your reference facility)

$Cc = C_{reference} \times [Q_{new}/Q_{reference}]^x = \$16.43M \times [600{,}000/500{,}000]^{0.75} = \$18.84M$

The total preliminary cost of the Las Vegas, NV facility is ***$18.84 million***

Question #5 [12 points]

You have the You have following data:

Cubic yards of concrete	Time to pour (hours)
150	7
250	13
325	25
450	30

Using linear regression, determine approximately how long it will take to pour 400 and 500 cubic yards of concrete.

y = bx + a → equation for a line

x	y	x_i-x_{avg} Δx	y_i-y_{avg} Δy	$(x_i-x_{avg})^2$ Δx^2	$(x_i-x_{avg})(y_i-y_{avg})$ $\Delta x\Delta y$
150	7	-143.75	-11.75	20664.1	1689.1
250	13	-43.75	-5.75	1,914.1	251.6
325	25	31.25	6.25	976.6	195.3
450	30	156.75	11.25	24570.6	1763.4

x_{avg} = 293.75 y_{avg} = 18.75 sum: 48125.4 3899.4

$$b = \frac{\Sigma(x_i-x_{avg})(y_i-y_{avg})}{\Sigma(x_i-x_{avg})}$$

$$a = y_{avg}-bx_{avg}$$

$$b = \frac{3899.4}{48125.4}$$

$$a = 18.75 - (0.081)(293.75)$$

$$a = -5.044$$

$$b = 0.081$$

$$\boxed{y = 0.081x - 5.044}$$

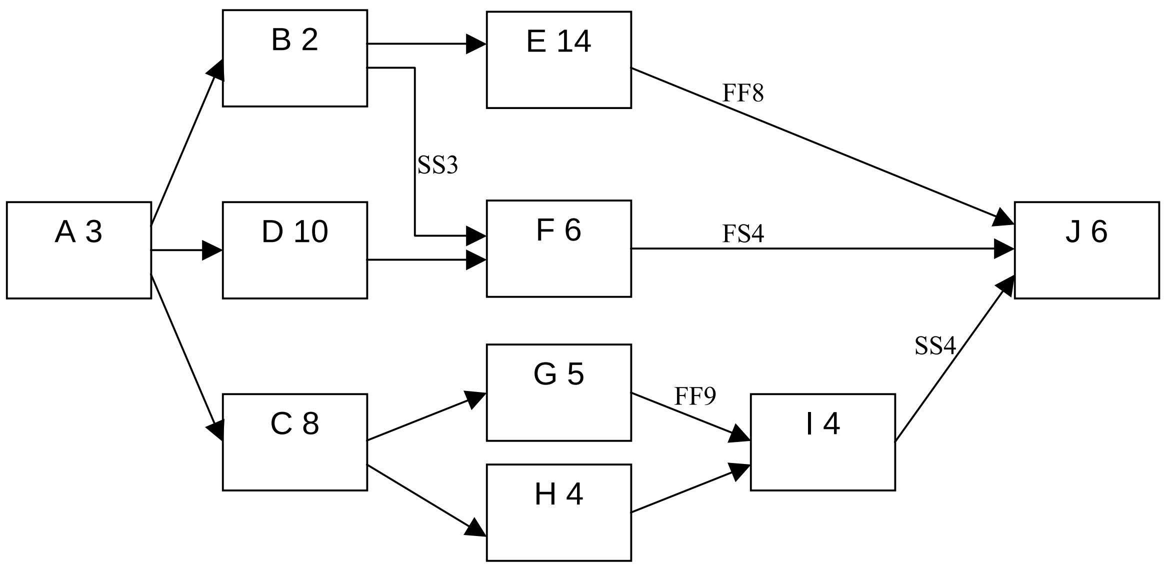
For 400 cubic yards: t = [(0.081)(400)] – 5.044 = 27.35 hours to pour

For 500 cubic yards: t = [(0.081)(500)] – 5.044 = 35.46 hours to pour

(Note: this process produces approximate results)

Question #6 [25 points]

Compute the ES, EF, LS, LF, FF, and TF for the schedule below. Record your answers in tabular format in your bluebook. Durations are listed after the activity name (e.g. Activity A has a duration of 3, Activity B has a duration of 2, etc.).



Starting on Day 0:

Activity	ES	EF	LS	LF	TF	FF
A	0	3	0	3	0	0
B	3	5	7	9	4	0
C	3	11	3	11	0	0
D	3	13	5	15	2	0
E	5	19	9	23	4	4
F	13	19	15	21	2	2
G	11	16	11	16	0	0
H	11	15	17	21	6	6
I	21	25	21	25	0	0
J	25	31	25	31	0	0

Starting on Day 1:

Activity	ES	EF	LS	LF	TF	FF
A	1	4	1	4	0	0
B	4	6	8	10	4	0
C	4	12	4	12	0	0
D	4	14	6	16	2	0
E	6	20	10	24	4	4
F	14	20	16	22	2	2
G	12	17	12	17	0	0
H	12	16	18	22	6	6
I	22	26	22	26	0	0
J	26	32	26	32	0	0

Question #7 [18 points]

An activity on the critical path of a project was scheduled to be completed in 15 weeks with a budget of $50,000. During a performance review that took place 5 weeks after the activity was initiated, it was found that 40% of the work had already been completed and the actual cost was $22,000. A second review was performed 10 weeks after the project was initiated, and it was found that 60% of the work had been completed and the actual cost was $45,000.

Total time = 15 weeks @ $50,000 = $3333.33/week

a) Calculate the earned value of the activity after 5 and 10 weeks.

Week 5:

Earned Value = BCWP

$BCWP_5 = (\$50{,}000)(40\%) = \$20{,}000$

$BCWP_{10} = (\$50{,}000)(60\%) = \$30{,}000$

b) Calculate the cost and schedule indices after 5 and 10 weeks.

CI = BCWP/ACWP *SI = BCWP/BCWS*

$CI_5 = \$20{,}000/\$22{,}000 = 0.91$
$SI_5 = \$20{,}000/[(\$3333.33)(5 \text{ weeks})] = 1.20$

CI_{10} = \$30,000/\$45,000 = 0.66
SI_{10} = \$30,000/[(\$3333.33)(10 weeks)] = 0.90

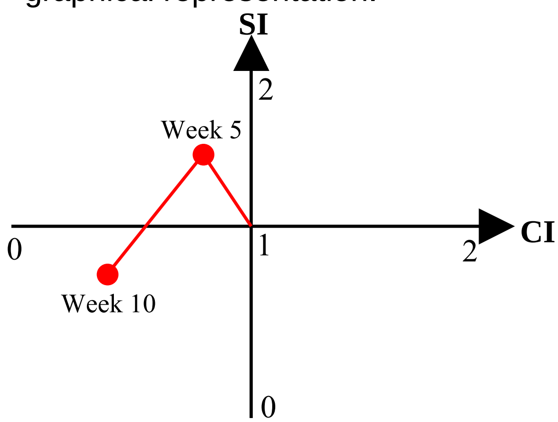
c) Calculate the cost and schedule variances after 5 and 10 weeks.

CV = BCWP – ACWP *SV = BCWP—BCWS*

CV5 = \$20,000 - \$22,000 = -\$2000
SV5 = \$20,000 – [(\$3333.33)(5 weeks)] = \$3333.33

CV10 = \$30,000 - \$45,000 = -\$15,000
SV10 = \$30,000 – [(\$3333.33)(10)] = -\$3333.33

d) Discuss the progression of the project between weeks 5 and 10. Is the progress getting better or worse? Why? Supplement your answer with graphical representation.



At week 5, the project is ahead of schedule, but has overspent the budget estimated for that point in time.

At week 10, the project is behind schedule <u>and</u> has *overspent the budget estimated for that point in time.*

So, the project went from bad to worse, and is now in the worst possible position: Over budget and over schedule.

Equations

$y = a + bx$

$a = \overline{y} - b\overline{x}$

$$b = \frac{\Sigma(x_i - \overline{x})(y_i - \overline{y})}{\Sigma(x_i - \overline{x})^2}$$

$y_x = k(x)^s$

$$s = \frac{\log n}{\log 2}$$