King Fahd University of Petroleum & Minerals

College of Environmental Design

Construction Engineering & Management Department

CEM 510

Construction Planning & Scheduling

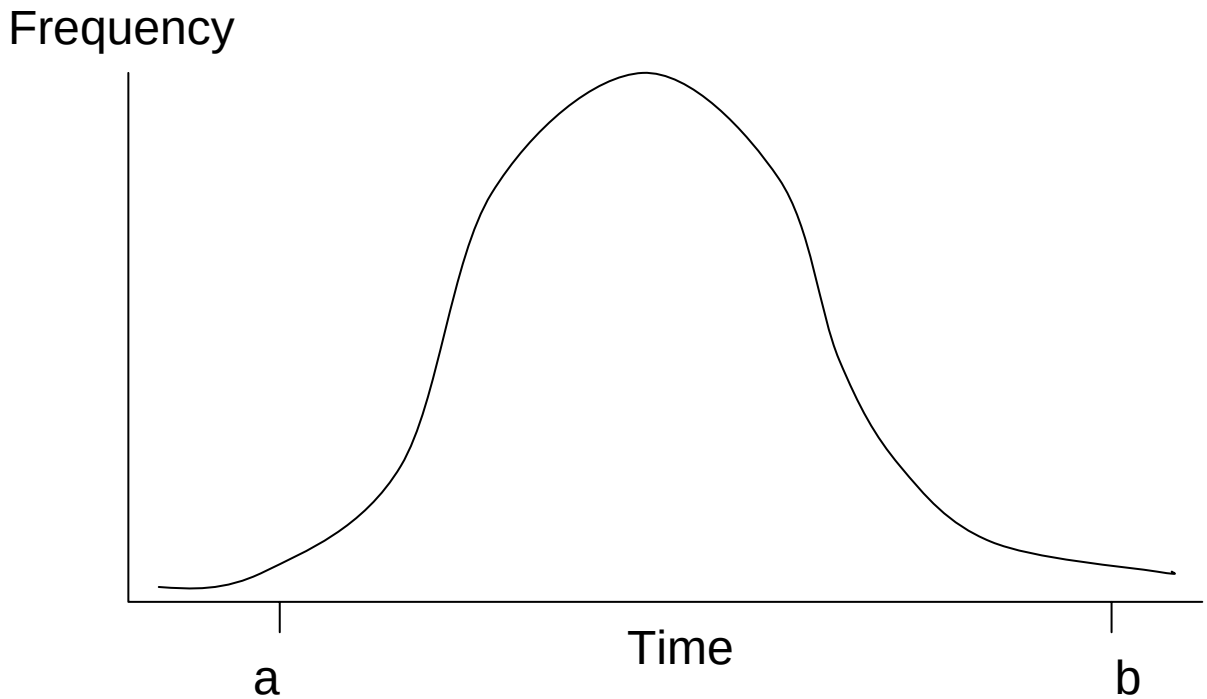
Fall 2005/2006

Program Evaluation and Review Technique (PERT)

PERT

- It is essentially the same type of planning tool as CPM.
- It is seldom used in construction planning except in long-term, highly complex projects.
- It is most successfully used in nonrepetitive business or manufacturing operations.
- Estimating duration of nonrepetitive operations can't be guided by past experience.
- It introduces the concept of variability in estimating durations of nonrepetitive operations.
- Since individual activity durations differ, then there will be some variability in the entire project duration.

PERT



a = Optimistic time (the minimum time to do the job)

b = Pessimistic time (the maximum time to do the job)

PERT definitions

$$\sigma(activity \quad s\tan dard \quad deviation) = \frac{b-a}{6}$$

$$Mean \quad = \quad \bar{x} \quad = \quad \frac{\sum_{i=1}^{n} x_i}{n}$$

$$S\tan dard \quad deviation = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}}$$

PERT definitions

$$Weighted\ \ Average\ \ Duration = \frac{a + 4\bar{x} + b}{6}$$

$$v = \text{variance of an activity} = \sigma^2 = \left(\frac{b - a}{6} \right)^2$$

$$V = Variance\ of\ \ an\ \ Event = v_{1-2} + v_{2-3} + v_{3-4} + \cdots\cdots + v_{ij}$$

T_E = *Expected time of an event based upon activity weighted averages*

PERT definitions

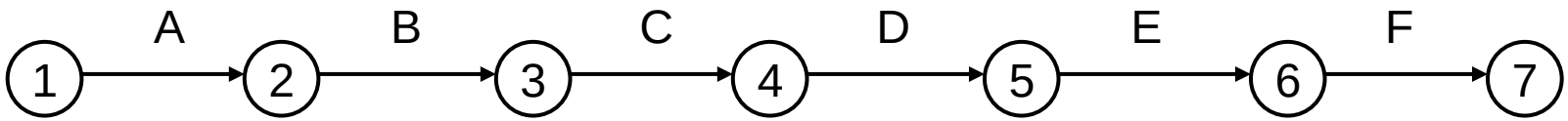
$$\sigma_{T_E} = Standard\ Deviation\ of\ the\ expected\ time\ of\ an\ event = \sqrt{V}$$

$$T_S = Event\ time\ (early\ or\ late)\ for\ which\ probability\ is\ needed$$

$$Z = \frac{T_S - T_E}{\sigma_{T_E}}$$

Example

- **These activities define the critical path of an arrow network diagram. The activities duration are in the table.**



Activity	a (optimistic)	b (pessimistic)	x (average)	Weighted average
A	2	9	4	4.5
B	3	7	6	5.667
C	4	6	5	5.0
D	2	6	3	3.333
E	6	12	10	9.667
F	5	10	7	7.167

Example (Contd.)

- **Calculate Event times**

Optimistic	**0**	**2**	**5**	**9**	**11**	**17**	**22**
Pessimistic	**0**	**9**	**16**	**22**	**28**	**40**	**50**
Weighted average	**0**	**4.5**	**10.167**	**15.167**	**18.5**	**28.167**	**35.333**

- **Calculate the activity variances**

$$v_A = \left(\frac{9-2}{6} \right)^2 = 1.3611$$

$$v_B = \left(\frac{7-3}{6} \right)^2 = 0.4444$$

Example (Contd.)

$$v_C = \left(\frac{6-4}{6} \right)^2 = 0.1111$$

$$v_D = \left(\frac{6-2}{6} \right)^2 = 0.4444$$

$$v_E = \left(\frac{12-6}{6} \right)^2 = 1.0000$$

$$v_F = \left(\frac{10-3}{6} \right)^2 = 0.6944$$

- **Suppose that we want to determine the probability of event 7 (project completion) by a certain time.**

Example (Contd.)

$$T_E = 35.333$$

$$\sigma_{T_E} = \sqrt{V_7}$$

$$V_7 = v_A + v_B + v_C + v_D + v_E + v_F$$

$$V_7 = 1.3611 + 0.4444 + 0.1111 + 0.4444 + 1.0000 + 0.6944$$

$$V_7 = 4.0554$$

$$\sigma_{T_E} = \sqrt{4.0554} = 2.0138$$

Example (Contd.)

- **With these values, we can calculate the value of Z:**

$$Z = \frac{T_S - 35.3333}{2.0138}$$

The value of Z are found in the PERT probability table

- **Determine the probability that the project will be completed by the expected time.**

$$T_S = T_E = 35.333$$

$$Z = \frac{35.3333 - 35.3333}{2.0138} = 0$$

Example (Contd.)

Probability (from table) = 0.50 or 50%

- **Determine the probability of completion by the 37th day:**

$$T_S = 37.00$$

$$Z = \frac{37.00 - 35.3333}{2.0138} = 0.829$$

Probability = 0.8 or 80%

- **Determine the probability of completion by the 32th day:**

$$T_S = 32.00$$

Example (Contd.)

$$Z = \frac{32.00 - 35.3333}{2.0138} = -1.654$$

Probability = 0.058 or 5.8%

- **Determine the schedule time for a probability of completion of 90%:**

From the table: Z = 1.3 for 90 percent

$$1.3 = \frac{T_S - 35.3333}{2.0138}$$

$T_S = 37.947$ days

Example (Contd.)

- **Determine the schedule time for a probability of completion of 100%:**

From the table: Z = 3.0 for 100 percent

$$3 = \frac{T_S - 35.3333}{2.0138}$$

$T_S = 41.37$ days