Project Planning & Control

Lesson 4
PERT Background & Assumptions, Stepwise Procedure

Koshy Varghese, Ph.D.
Professor
Building Technology & Construction Management
Department of Civil Engineering
I.I.T. Madras

PERT Background

- Project Management of the Polaris Missile project- **faced uncertainties**
- Developed as an alternate to CPM to enable uncertainty modeling
- By Special Projects Office of the US Department of Defense with Consultants Booze Allen Hamilton in 1957/58.
- Reported to have saved 2 years on project duration

APPLICATION OF A TECHNIQUE FOR RESEARCH AND DEVELOPMENT PROGRAM EVALUATION

D. G. Malcolm,* J. H. Roseboom, C. E. Clark*

Booz, Allen and Hamilton, Chicago, Illinois

and

W. Fazar,

Special Projects Office, U S Navy, Washington, D C

(Received April 27, 1959)

This paper describes the development and application of a technique for measuring and controlling development progress for the Polaris Fleet Ballistic Missile program, Special Projects Office, Bureau of Ordnance, U S Navy Project PERT (Program Evaluation Research Task†) was set up to develop, test, and implement a methodology for providing management with integrated and quantitative evaluation of (*a*) progress to date and the outlook for accomplishing the objectives of the FBM program, (*b*) validity of established plans and schedules for accomplishing the program objectives, and (*c*) effects of changes proposed in established plans In the PERT model, the *R* and *D* program is characterized as a network of interrelated events to be achieved in proper ordered sequence Basic data for the analysis consists of elapsed time estimates for activities which connect dependent events in the network The time estimates are obtained from responsible technical persons and are subsequently expressed in probability terms This model is described Test of the model on a specific component, design of a management control system properly related to existing management systems, reduction to the NORC computer, difficulties in implementation and preliminary results to date are discussed Limitations of the model, and possible refinements and use of the computer model for testing schedules and for management experimentation in resource and performance tradeoffs are described

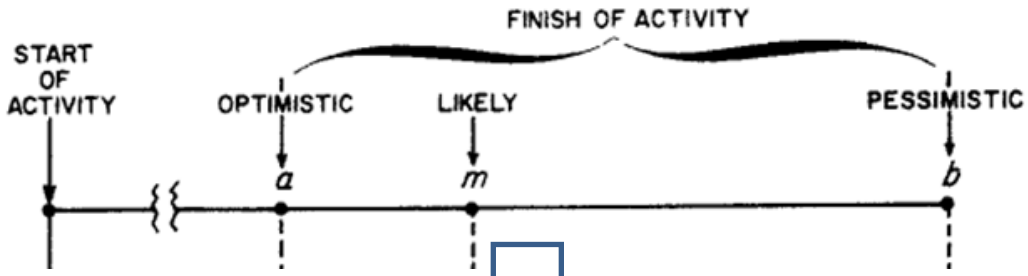
THE THEORY and operating techniques described in this paper were

PERT- Background

- Probabilistic representation of activity duration based on **“expert estimate”**
- CPM based forward pass and backward pass
- Network Diagram – is popularly referred to as “PERT CHART”!! (although developed for CPM)
- Overheads of PERT based schedule is much higher than CPM based schedule – *not widely used in construction*

This lecture will present the PERT method using a AON representation! Original PERT developers used AOA representation – Which is the default for PERT.

PERT Assumptions--1



With the assumptions

that the standard deviation of the distribution $\sigma(t_e)$ could be adequately estimated as $\frac{1}{6}$ of $(b-a)$ and that the beta distribution, $f(t) = K(t-a)^{\alpha}(b-t)^{\gamma}$, is an adequate model of the distribution of an activity time, it was possible to develop equations for calculating t_e and $\sigma^2(t_e)$

$$t_e = \tfrac{1}{3}[2m + \tfrac{1}{2}(a+b)], \quad (1)$$

$$\sigma^2(t_e) = [\tfrac{1}{6}(b-a)]^2 \quad (2)$$

Expected Activity Duration $(t_e) = (a + 4*m + b) / 6$

Std.Dev. $\sigma(t_e) = [(b-a)/6])$ *hence* Variance. $\sigma^2(t_e) = [(b-a)/6]^2$;

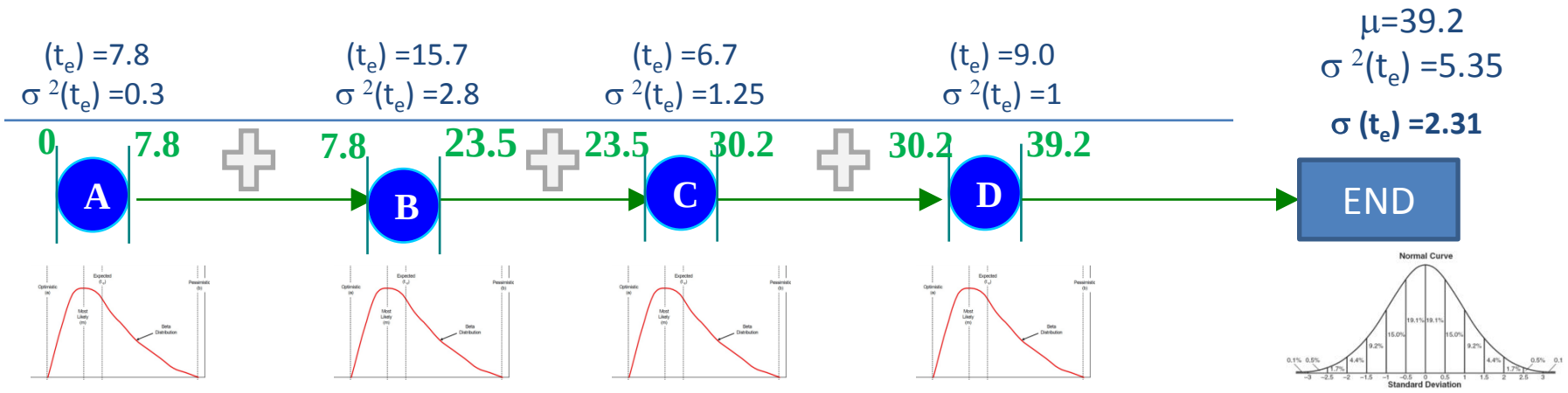
PERT Assumptions--2

Central Limit Theorem is Applicable:

1. Distribution of the sum will be approximately normal regardless of the individual distributions

2. Mean of the sum is the sum of individual means

3. Variance of the sum is the sum of the individual variances



PERT Assumptions -3

- There are enough activities in the network/path to make the central limit theorem valid.
- Critical path is long enough in time so that there is no overlapping of distributions & the distributions are assumed to be displaced.
- If there are 2 or more critical paths, then path with larger variance would be deemed critical.

PERT – STEPWISE PROCEDURE

1. Given Information – Activities, Predecessors & 3 estimates of duration (a,m,b) for each activity- Draw the network.

2. Calculate (t_e) for each activity using the formula $(t_e) = (a + 4*m + b) / 6$

3. Calculate Standard Deviation $\sigma(t_e) = [(b-a)/6]$ and Variance $\sigma^2(t_e)$ for each activity

4. Using the calculated (t_e) (for each respective activity) as the duration do the forward and backward pass calculate ES,EF,LF,LS

5. Determine Critical Path & Project Duration *(this duration is the mean of the normally distributed Project Duration - Proj Dur)*

PERT – STEPWISE PROCEDURE

6. Calculate sum of variance of activities on the critical path ($\Sigma\sigma^2(t_e)$ *critical). This is the variance of the normally distributed project duration. Find Stdev of project duration*

7. Use the normal distribution Z value tables to calculate: (i) probability values associated with a given a duration; (ii) duration values associated with a probability.