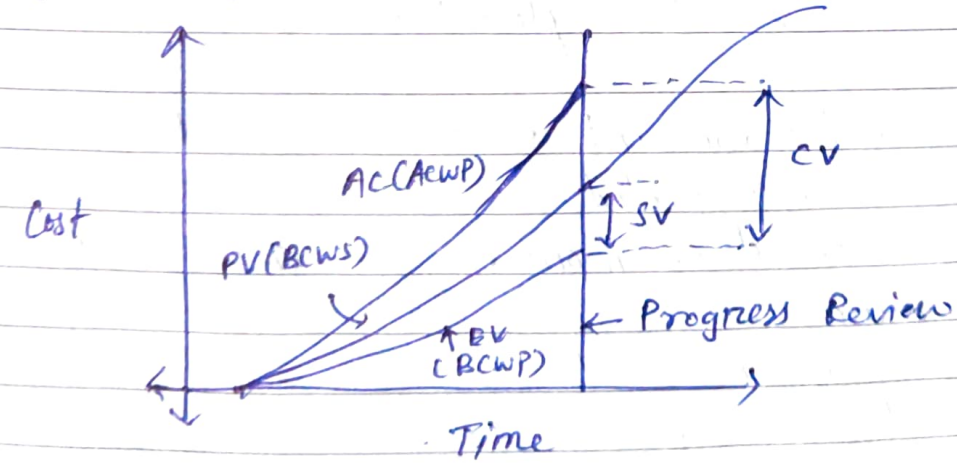
Week-8:

Project Monitoring & Control, Uncertainity in Proj. Schedules.

- Progress of a project depends on work performed not actual cost.
- Schedule Performance = $\frac{\%\text{ as performed}}{\%\text{ as scheduled}}$ (for single activity)
- For % complete for multiple activities, it cannot be work done / Total Qty. as units of each item of work are different. Eg: m^3, T, m^2
- Money & Man-Hours are common units for all activities
- Earned Value Concept Terminologies:
  - BCWS (Budget Cost of Work Scheduled) (original estimate)
  - BCWP (Budgeted Cost of Work Performed) (Value earned)
  - ACWP (Actual of Work Performed Performed) (actually spent)
- Project Performance:



AC: Actual Cost
EV: Earned Value
SV: Scheduled Variance
CV: Cost Variance

Lesson : 2 ;

- Earned Value Method

It compares the SCHEDULED amt. of work with what has actually been performed, to determine if COST, SCHEDULE & WORK (SCOPE) ACCOMPLISHED are progressing as planned.

- BCWS
  - It is the budgeted cost of work scheduled
  - It tells how much work is scheduled to be completed in each period based on value metric (money for us) (S-Curve)
- BCWP
  - It is the budget value of work actually performed
  - The earned value for the work actually completed
    = Σ(Unit Rate * Qty Work Performed)
    = Σ(% Complete * BCWS)
- ACWP
  - It is the amount actually spent on the work completed
  - This could be more or less than the Earned Value
- Scheduled Variance (SV)

SV = (BCWP − BCWS)

- It compares work completed vs work planned
- It helps to identify whether the project is ahead or behind schedule
- Negative value indicated that the project is behind budget schedule.

<0 Behind Schedule
>0 Ahead of Sc.
=0 On Sc.

- **Cost Variance (CV)**
  = (BCWP − ACWP)
  - It compares value of the work completed vs what was actually spent.
  - It helps to identify whether the project is ahead or behind budget
  - Negative value indicates that the project is over budget.
  - CV
    - < 0 Over Budget
    - > 0 Under Budget
    - = 0 On Budget

- **Scheduled Performance Index (SPI)**
  = (BCWP / BCWS)
  - ≤ 1 BS
  - ≥ 1 AS
  - = 0 ONS
  - It helps to identify whether the project is ahead or behind schedule
  - Less than 1 indicates that the project is behind schedule

- **Cost Performance Index (CPI)**
  = (BCWP / ACWP)
  - ≤ 1 O Bud.
  - ≥ 1 U Bud.
  - = 0 On Bud.
  - It helps to identify whether the project is above or below budget
  - Less than 1 means the project is over budget
  - It can be utilised to forecast how much amount will be required to complete the project.

- Forecasting
  - Estimate at Completion (EAC)
    = BAC / CPI (BAC: Budget at Completio
    - Revised project completion budget based on current CPI
    - Several alternate computations of EAC
  - Schedule at Completion (SAC)
    - Update CPM Network to determine this
- Earned value Steps are:
  1.) Calculate values of BCWS - for each period (as planned schedule)
  2.) For update period calculate BCWP from field measurement of Work Performed
  3.) At update period find ACWP - from accts.
  4.) Compare BCWP with BCWS & ACWP to determine project performance indicators. % complete etc.
  5.) Forecast EAC.

Lesson: 3

Uncertainity in Project Scedules:

Uncertainity in Projects:

16 Sunday CPM doesn't directly model uncertainity - no probability based query can be modeled in CPM

- It is inherent char. of all projects
  Dur" Uncertainty, Cost Unc., Quality Unc. etc.

- Can be addressed through risk analysis and management
- Modeling and managing duration uncertainity & risk is an important part of project planning & control
- PERT was developed to address the needs of projects which are being done for the first time.

Probabilistic Duration :-

- Prob. Dur^n Distrib^n is used to acct. for the uncertainity in activity dur^n estim^n.
- The duration of a particular activity is assumed to be a stochastic variable that follows a certain distribu^n as show: (from historical data or expert estimate)
  - Normal Distrib^n
  - Beta Distrib^n etc
- Distribution Fitting
  - which distribution model our data fit appropriately.
    Eg: Exponential, Normal, Triangular etc.
  - Beta Distrib^n is best. Dist-fit
- In Critical path method (CPM), the values were deterministic (days) whereas in prob. approach a prob. distrib^n defines it's duration
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- Historical Data & Simul^n Issues:
  1) Not easily available
  2) Even available, the data may not be appropriate for current activity / project
  3) Simul^n is computing intensive
  4) Simul^n is popular approach today but limited to leading companies.

Lesson: 4: PERT

- developed as an alternate to CPM to enable uncertainity modeling in Polaris Missile Project
- Background:
  - Prob. represent^n of activity duration based on "expert estimate"
  - CPM based forward pass & backward pass
  - N/w Diagram - popularly PERT Chart
  - Overheads of PERT based schedule is much higher than CPM based schedules

- PERT assumptions
  (1) With the assumptions that the standard deviations of the distribution $\sigma(t_e)$ could be adequately estimated as $\frac{1}{6}(b-a)$ and that the beta distribution, $f(t) = K(t-a)^{\alpha}(b-t)^{\beta}$ is an adequate model

- Expected Activity Duration (t_e)
  $= (a + 4*m + b)/6$
  a: optimistic time
  m: most like time
  b: pessimistic time.

- ② Central Limit Th^m is Applicable i.e.
  i) Distrib^n of the sum will be approximately normal regardless of the individual distributions
  ii) Mean of the sum is the sum of individual means
  iii) Variance of the sum is the sum of the individual variances.

③ • There are enough activities in the network to make the central limit theorem valid
  • Critical path is long enough in time so that there is no overlapping of distributions. ~~of~~ The distributions are assumed to be displaced
  • If there are 2 or more critical paths, then path with larger variance would be ~~then~~ deemed critical.

- PERT - Stepwise

9 ① Given: Activities, Predecessors & 3 estimates (a, m, b) Draw the Network

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

11 ③ Calculate Std. Devi^n $\sigma(t_e) = [(b-a)/6]$ & Variance $\sigma^2(te)$ for each activity

12 ④ Using t_e do the forward & backward pass calculate ES, LS, EF, LF

1 ⑤ Determine CP & Project Dur^n.

⑥ Calculate sum of variance of activities on the CP. ($\Sigma \sigma^2(t_e)$)

⑦ Use the normal distrib^n Z value tables to calculate:

2 (i) prob. values associated with a given duration

(ii) durn^n values associated with a prob.

3 Lesson 5: Example:

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Activity	Predecessor	a	m	b
		Optimistic	Likely	Pess.
A	-	10	16	20
B	A	7	10	20
C	A	5	7	8
D	B	15	18	21
E	C, B	25	30	32
F	D	6	9	12
G	E, D	21	25	28
H	F, G	6	8	9

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Determine:

(i) ML Project Dur^{n} = ?

(ii) Critical Path ?

(iii) P(PD >= 95d) = ?

(iv) P(PD <= 85d) = ?

(v) P(85d <= PD <= 95d) = ?

(vi) P(PD <= ?) = 0.90

①, ②, ③

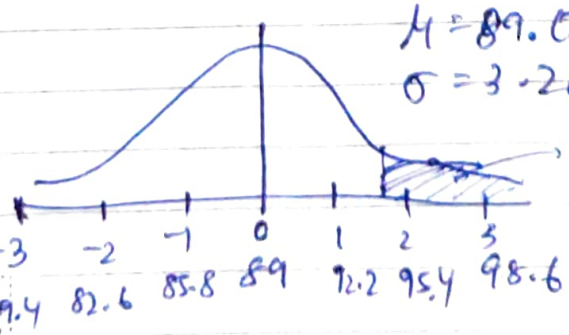
Activity	t_e	σ	σ^2
A	15.2	1.67	2.78
B	11.2	2.17	4.69
C	6.8	0.50	0.25
D	18.0	1.00	1.00
E	29.5	1.17	1.36
F	9.0	1.00	1.00
G	24.8	1.17	1.36
H	7.8	0.50	0.25

④ Do Backward & Forward Pass in N/w Diag.

⑤ Critical Path : A B E G H

Variance = $\Sigma \sigma^2(t_e)$ = 10.44 (A, B, E, G, H)

Std Dev = 3.2 days



$z = 1.88 \Rightarrow \left(\frac{95-89}{3.2}\right)$

P = 0.0301