MADRAS
Management Training Institute

Project Time Management

Project Time Management Processes

➢ **Define Activities**

➢ **Sequence Activities**

➢ **Estimate Activity Resources**

➢ **Estimate Activity duration**

➢ **Develop Schedule**

➢ **Control Schedule**

In some projects, especially with smaller scope, defining activities, sequencing, estimating activity resources, estimating activity duration and develop schedule are viewed as a single process. However processes from define activities to develop schedule shall be done is sequence.

2

6.1 Define Activities

➤ This process involves taking the work packages created in the WBS and breaking them down further in order to reach the activity level.

➤ Activity level is small enough to estimate, schedule, monitor and manage.

➤ These activities are then sequenced in the next process; activity sequencing.

3

6.1 Define Activities

Inputs	Tools & Techniques	Outputs
1. Enterprise environmental factors 2. Organizational process assets 3. Scope Baseline	1. Decomposition 2. Templates 3. Rolling WAVE Planning 4. Expert Judgement	1. Activity List 2. Activity attributes 3. Milestone List

4

Define Activities – Decomposition

➢ Decomposition in WBS subdivide total scope of project in to smaller components and decomposition in define activities subdivide work package in to smaller, more manageable components called activities.

➢ WBS and WBS dictionary are the basis for development of activities.

➢ WBS, WBS dictionary and activity list can be completed together.

5

Templates

➤ Why reinvent the wheel? If similar projects have been completed in the past, rely on the WBS and activity lists from the historical information to serve as a template for the current project.

➤ Templates can also be used to identify typical schedule milestones.

We now know what to do in a project but yet to determine when to do what

Total Scope

WBS

Control Accounts

Work Package

WBS Dictionary

Activities

Rolling Wave Planning

➢ Work that is imminent is planned in detail while work that is way off in the future is planned at a high level.

➢ As the work in the future approaches more and more details are available enabling team to do further planning.

➢ This is a form of progressive elaboration.

6.1 Define Activities : Outputs

1. Activity list

2. Activity attributes

3. Milestone list

Activity List

➢ An **activity list** is a tabulation of activities to be included on a project schedule that includes:

❖ The activity name

❖ An activity identifier or number

❖ A brief description of the activity

Activity Attributes

- **Activity attributes** provide information such as predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity

- Activity attributes describe the characteristics of the activities and are an extension of the activity list.

11

Milestone Lists

➢ Milestones are typically major accomplishments or a significant event of the project and mark the completion of major deliverables or some other key event in the project.

6.2 Sequence Activities

➢ Activity list prepared are now logically sequenced

➢ A **dependency** or **relationship** between activities established.

➢ Dependencies shall be determined in order to use critical path analysis

13

6.2 Sequence Activities

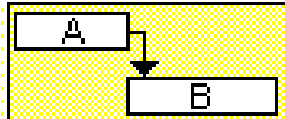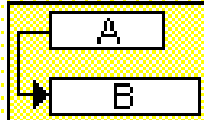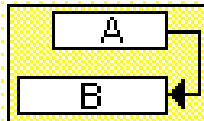| Inputs	Tools & Techniques	Outputs
1. Project scope statement 2. Activity List 3. Activity attributes 4. Milestone list 5. Organizational Process Assets	1. Precedence Diagramming method (PDM) 2. Schedule network templates 3. Dependency determination 4. Applying leads and lags	1. Project schedule network diagrams 2. Project Document Updates

14

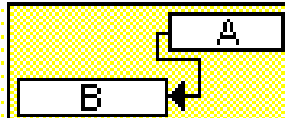# Precedence Diagramming Method (PDM)

➢ A network diagram is drawn after preparation of activity list in order to logically arrange activities in sequence and to show dependencies.

➢ PDM is a method of drawing network diagram

➢ This is also called Activity on Node (AON)

➢ Activities are represented by boxes, also called nodes, and arrow between boxes to show logical relationship (and hence name AON)

15

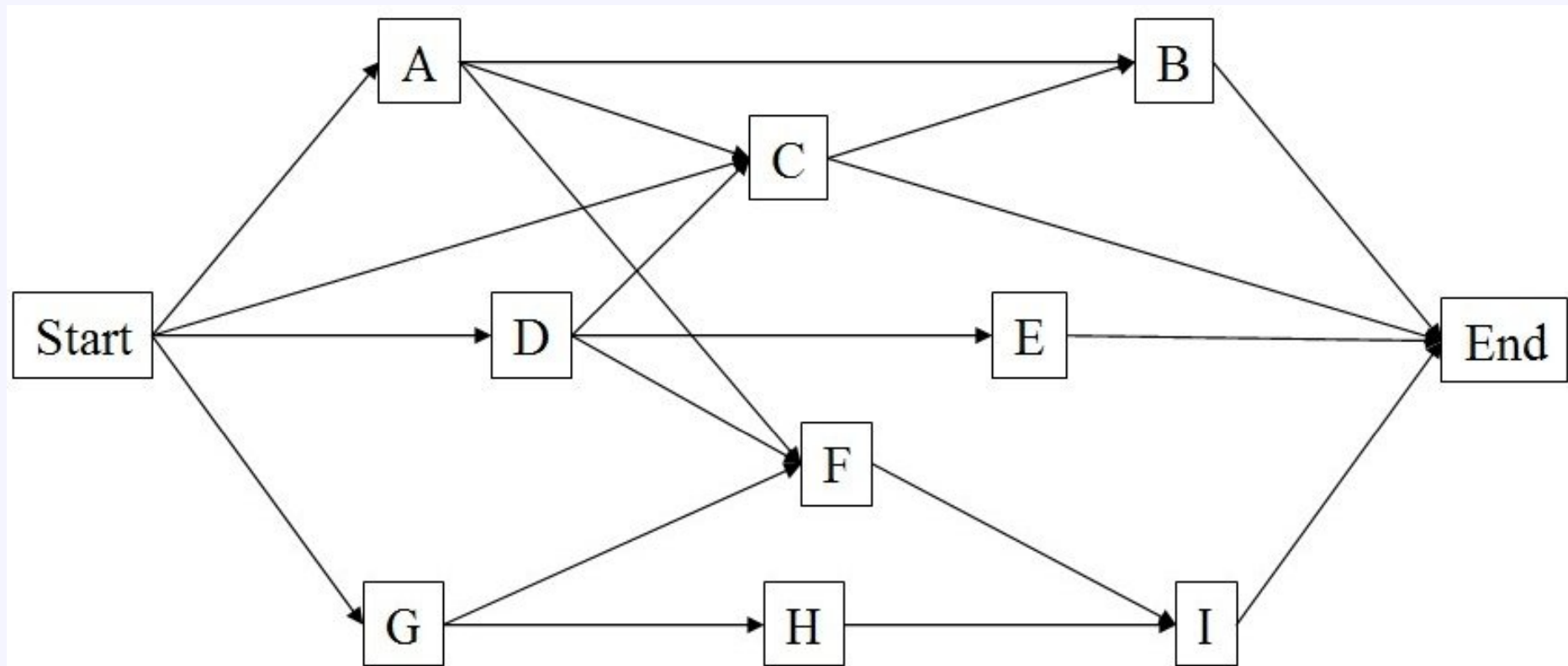# Task Dependency Types

PDM can have four types of dependencies

Task dependencies

The nature of the dependencies between linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project:

Task dependency	Example	Description
Finish-to-start (FS)	A → B	Task (B) cannot start until task (A) finishes.
Start-to-start (SS)	A → B	Task (B) cannot start until task (A) starts.
Finish-to-finish (FF)	A → B	Task (B) cannot finish until task (A) finishes.
Start-to-finish (SF)	A → B	Task (B) cannot finish until task (A) starts.

A Network Diagram drawn with PDM

Dependency Determination

➤ Three types of dependencies:

   ❖ Mandatory dependencies

   ❖ Discretionary dependencies

   ❖ External dependencies

18

Dependency Determination

➤ Mandatory Dependencies:

❖ Mandatory dependencies are those that are contractually required or inherent in the nature of work. This dependency is also called **Hard Logic**.

✓ For example, you can't begin building your house until your foundation is in place.

✓ Contract says prototype must be approved prior to start work.

19

Dependency Determination

- Discretionary dependencies:

  - These dependencies are the preferred order of activities. It is defined by the project management team based on the knowledge of best practice in each field.

  - These relationship are also known as soft logic, preferred logic, or preferential logic.

  - Discretionary dependencies shall be fully documented since they can create arbitrary total float values and can limit later scheduling options.

  - When fast tracking is applied, normally these dependencies are reviewed or removed.
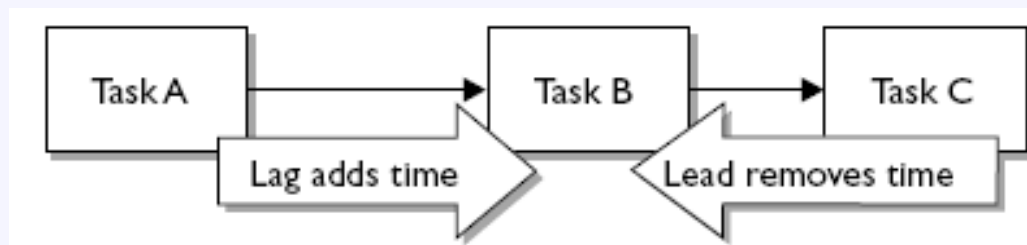
20

Dependency Determination

- ➢ External dependencies

  - ❖ As its name implies, these are dependencies outside of the project's control.

  - ❖ Example include the delivery of deliverable of another project, or the decision of a committee, lawsuit, or expected new law.

Applying Leads and Lags

➢ A Lead may be added to start an activity before the predecessor activity is finished. The successor activity may be started prior to completion or predecessor.

Ex: Furniture may be installed 2 weeks prior to completion of painting (Finish to start relationship with 2 weeks lead)

➢ Lag introduces waiting period between activities. Lag introduces a delay in the successor activity

Schedule Network Templates

➤ Schedule network diagram from a previous projects or standard templates from PM software my be used to speedup network preparation.

➤ Network template may include entire project or part of project and templates used for portion of project are also known as sub networks or fragment networks.

➤ Subnets are very useful if repeated work is involved (identical floors or identical modules in software development)

23

6.2 Sequence Activities : Outputs

1. **Project Schedule Network Diagrams** :

➢ Are schematic displays of the project schedule activities and the logical relationships among them.

➢ It can be produced manually or by using a project management software

   Project Schedule Network Diagrams are not final schedule For the exam, know that, in its pure form, the network diagram shows just dependencies

2. **Project Document Updates**

6.3 Estimate Activity Resources

➢ All projects, from the smallest to the largest, require resources.

➢ The term resources in this case does not mean just people; it means all the physical resources required to complete the project.

- ❖ People

- ❖ Equipment

- ❖ Materials

25

6.3 Estimate Activity Resources

Inputs	Tools & Techniques	Outputs
1. Enterprise environmental factors 2. Organizational process assets 3. Activity list 4. Activity attributes 5. Resource calendar	1. Expert Judgment 2. Alternatives analysis 3. Published estimating data 4. Bottom-up estimating 5. Project Management Software	1. Activity resource requirements 2. Resource breakdown structure (RBS) 3. Project Documents Updates

6.3 Estimate Activity Resources : Input

Resource Calendar :

➢ Resource calendar will give Information on which resources are potentially available during planned activity period.

➢ Resources include people, material and equipment

➢ A composite resource calendar will include availability, capabilities and skills of human resource.

➢ Holidays of human resource are normally included in a composite resource calendar.

6.3 Estimate Activity Resources : Tools and Techniques

1. Expert Judgment

2. Alternative Analysis

3. Published Estimating Data

4. Bottom-up Estimating

5. Project Management Software

6.3 Estimate Activity Resources: Tools and Techniques

1. Expert Judgment

2. Alternative Analysis

    ❖ Many activities can be completed in different ways and using various resource allocations. Alternative analysis is used to choose the best way to complete an activity.

    ❖ You can also consider make-or-buy analysis when determining alternatives. Hiring a tower crane may be less costlier than buying in short term perspective but buying may be better for organization in long term.

6.3 Estimate Activity Resources

3. Published estimating data

❖ Estimating data may include organizational guidelines, industry rates or estimates, production rates, and so on.

4. Bottom-up Estimating

❖ When an activity cannot be estimated with a reasonable degree of confidence, the work within the activity is decomposed into more detail.

❖ The resource needs are estimated.

❖ These estimates are then aggregated into a total quantity for each of the activities resources.

30

6.3 Estimate Activity Resources

5. Project Management Software

❖ Project Management software can help estimate resource needs and document resource availability. It may also produce an RBS, resource rates, calendars, and availability.

6.3 Estimate Activity Resources : Outputs

1. Activity Resource Requirements

2. Resource Breakdown Structure

   ❖ A **resource breakdown structure** is a hierarchical structure of the identified resources by resource category and resource type .

   ❖ E.g. of resource categories : labor, material, equipment , supplies etc

   ❖ Resource Types can include the skill level, grade level, etc

3. Project Document Updates : documents that may get updated, include, but not limited to :

   ❖ Activity List, activity attributes, resource calendars , etc

6.4 Estimate Activity Durations

➢ Here the network diagram is updated by estimating duration for each activities.

➢ The Activity Duration Estimating process attempts to estimate the work effort and number of work periods needed to complete each schedule activity.

➢ A person or team most familiar with work of the project shall estimate duration to make it more accurate.

➢ All data and assumptions used for estimation shall be documented for future analysis (remember this, we need this information during risk management process)

33

6.4 Estimate Activity Durations

Inputs	Tools & Techniques	Outputs
1. Enterprise environmental factors 2. Organizational process assets 3. Project scope statement 4. Activity list 5. Activity attributes 6. Activity resource requirements 7. Resource calendars	1. Expert Judgment 2. Analogous Estimating 3. Parametric estimating 4. Three-point estimates 5. Reserve analyses	1. Activity duration estimates 2. Project Documents Updates

34

6.4 Estimate Activity Durations : Tools & Techniques

1. Expert Judgment

2. Analogous Estimating

   ➤ Analogous estimating uses information from a previous, similar project, such as duration, budget, size and complexity for future project.

   ➤ Analogous estimating is also known as top-down estimating and is a form of expert judgment using historical information.

   ➤ Analogous estimate is generally less costly and time consuming but generally less accurate.

   ➤ This estimate will be more accurate if previous project is similar in nature and not just in appearance.

35

6.4 Estimate Activity Durations : Tools & Techniques

3. Parametric Estimating

❖ Parametric estimate uses a statistical relationship between historical data and other variables.

❖ More accurate than analogous estimate

❖ Example : A resource will take 20hrs per module and hence 1000 modules will take 50hrs (50X20 = 1000hrs)

❖ Estimation is done by multiplying quantity of work by labor hours per unit of work.

36

6.4 Estimate Activity Durations : Tools & Techniques

4. Three Point Estimates (PERT)

❖ A three-point estimate uses average of optimistic, most likely, and pessimistic estimates and hence improving the accuracy.

❖ **Most likely estimate (t_M) –** The realistic and most likely estimate

❖ **Optimistic estimate (t_O)** is the best case scenario.

❖ **Pessimistic estimate (t_P)** assumes the worst case scenario

37

4. Three-Point Estimates

PERT analysis calculates An Expected t(E) activity duration using a weighted average of three estimates :

$$t(E) = [t_o + 4t_m + t_p]/6$$

➢ PERT analysis consider estimation uncertainties and risks and hence accuracy of estimate is improved.

PERT

PERT Formulas

➢ PERT Duration $t(E) = [t_o + 4t_m + t_p]/6$

➢ Standard Deviation of Activity = $[t_p - t_o]/6$

➢ Variance of an Activity = $([t_p - t_o]/6)^2$

PERT Calculations

Activity	O	M	P	PERT	SD	Variance	Range
A	14	27	47	28.167	5.500	30.250	28.167+/- 5.500
B	41	60	89	61.667	8.000	64.000	61.667+/-8.000
C	39	44	48	43.833	1.500	2.250	43.833+/-1.500
D	29	37	42	36.500	2.167	4.694	36.500+/-2.167

If all activities are on critical, then total estimated project duration = sum of PERT values for each activities

<u>Standard Deviation shall not be added</u>. Add variance of each activities and take square root of sum to get standard deviation for total project.

In the example above, range will be 170.167 +/-10.060

6.4 Estimate Activity Durations : Tools & Techniques

5. Reserve Analysis

- ❖ *Contingency Reserve time* —also called *buffer* or *time reserves*

- ❖ Reserve is added to account for schedule risk.

- ❖ You might choose to add a percentage of time or a set number of work periods to the activity or the overall schedule.

- ❖ If not done properly can lead to padding

- ❖ Contingency reserve shall be clearly identified and documented for future analysis

41

6.4 Estimate Activity Durations : Outputs

1. Activity Duration Estimates

    ❖ Activity duration estimates reflect how long each activity will take to complete.

2. Project Document Updates : documents that may be updated include, but not limited to :

    ❖ Activity Attributes : You will update the activity attributes with the duration estimate and the assumptions you used when deriving the estimates.

    ❖ Assumptions made in developing the activity duration estimate such as skill level and availability

42

6.5 Develop Schedule

➢ The *Develop Schedule* process is the heart of the Planning process group.

➢ The creation of the project schedule is iterative. It's rare for a schedule to get created, approved, and implemented without some iterative examination, arrangement, and management input—though on smaller projects it may be possible.

43

6.5 Develop Schedule

- ➢ Schedule Management Plan

  - ❖ *A Guide to the PMBOK* notes that the schedule management plan (a subsidiary of the project management plan) is produced as part of the Develop Project Management Plan process and contains the criteria for formatting, developing, and controlling the project schedule.

44

6.5 Develop Schedule

- ➤ Uses results of the other time management processes to determine the start and end date of the project

- ➤ Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project

6.5 Develop Schedule

Inputs	Tools & Techniques	Outputs
1. Organizational process assets	1. Schedule network analysis	1. Project Schedule
2. Project scope statement	2. Critical path method	2. Schedule data
3. Activity list	3. Schedule compression	3. Schedule baseline
4. Activity attributes	4. What-if scenario analysis	4. Project Document Updates
5. Project schedule network diagrams	5. Resource levelling	
6. Activity resource requirements	6. Critical chain method	
7. Resource calendars	7. Adjusting leads and lags	
8. Activity duration estimates	8. Scheduling Tool	
9. Enterprise environmental factors		

46

Tools & Techniques

1. Schedule Network Analysis.

   ❖ Schedule network analysis is a technique that generates the project schedule. It employs a schedule model and various analytical techniques, such as critical path method, critical chain method, what-if analysis, and resource leveling to develop the schedule.
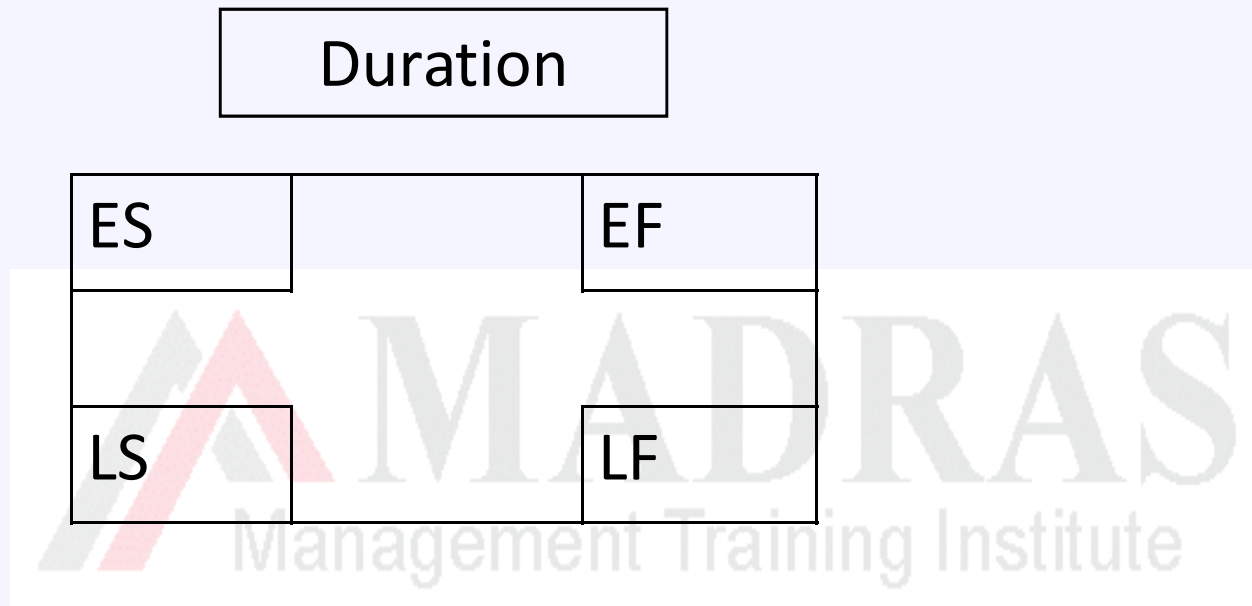
Tools & Techniques

2. Critical Path Method

❖ The critical path method is a schedule network analysis technique that is performed using the schedule model.

❖ The critical path method calculates the early start and finish dates, and late start and finish dates for all schedule activities

Network Diagram Nodes

	Duration	
ES		EF
LS		LF

ES = Earliest date an activity can be started

EF = Earliest date an activity can be completed

LS = Latest date an activity can start

LF = Latest date an activity can be completed

Floats

➢ Floats are not same as lead or lag

➢ Lead or lags are introduced (manually) to correct the sequence while float is calculated in CPM method

➢ Float = LS-ES or LF-EF

➢ Float for all activities on critical path will be zero

➢ If lead or lag is introduced to activities

- Duration of activities may change (Increase or Decrease)

- Critical path may change. CPM calculation is not affected but total duration of project may alter.

- Lead reduces the duration and hence negative value and lag increases the duration and have positive value.

50

Types of Floats (or Slacks)

➢ Total Float – The amount of time an activity can be delayed without delaying the **project end date** or milestone.

➢ Free Float – The amount of time an activity can be delayed without delaying the early start date of **successor activity**

➢ Project Float – The amount of time a **project** can be delayed without delaying an externally imposed project completion date (other than calculated by CPM) by customer. Normally project floats are zero unless CPM calculations shows an earlier completion date than required by customer.

51

3. Critical Chain Method

➤ Team members have a tendency to pad activity duration estimates to account for uncertainties. Activity duration extends due to padding.

➤ According to Parkinson's Law, "**Work expands to time it is given**"

➤ **"Student Syndrome"** – Many people will start to fully apply themselves to task just the wake of deadline.

➤ Due to padding, activity expands to the time given and most of the work associated with activity will be done near the deadline.

➤ Buffer built in to each activity is inefficient and normally lead to extended schedule. Critical chain method removes buffers from activities and manage them separately.

➤ It is unlikely that all activities will suffer delays (Insurance idea)

52

3. Critical Chain Analysis

➢ Remove buffers from individual activities in conventional CPM

➢ Calculate critical chain using CPM

➢ Enter resource and recalculate the critical path. Normally critical path alters and now the path is called resource-constrained critical path.

➢ Now add one buffer at the end of the critical chain to protect the target finish date due to slippage in critical chain. This is called **project buffer**.

➢ Critical chain normally have non critical paths feeding (or connected) to critical path. In order to protect critical path due to slippage in non critical path, another buffer is placed at the end of non critical path, before it get connected to critical path. This is called **feed buffer**. 53

3. Critical Chain Analysis

➢ Project manager now manages the Project Buffers and Feed Buffers instead of floats in traditional CPM

➢ Trends now can be analyzed from the use of buffers

➢ Result are more committed and stringent schedule.

4. Resource Leveling

➢ Critical path is calculated using CPM.

➢ Resources are loaded to activities based on actual availability or considering conflicts.

➢ Resource leveling often result a change in originally calculated Critical Path.

➢ Preference is normally always given to critical path activities and floats available for non critical path is used during leveling.

➢ This may also result is near critical path to become critical which may increase the risk.

5. What-If Scenario Analysis

➢ What-if scenario analysis uses different sets of activity assumptions to produce multiple project durations.

❖ For e.g., what would happen if a major deliverable was delayed or the weather prevents you from completing a deliverable on time ?

❖ What-if analysis weighs these questions and their assumptions and determines the feasibility of the project schedule under these conditions.

➢ Monte Carlo analysis use a range of probable activity durations for each activity, and those ranges are then used to calculate a range of probable duration results for the project itself.

❖ It runs the possible activity durations and schedule projections many times to come up with the schedule projections and their probability, critical path duration estimates, and float time.

56

6. Adjusting Leads and Lags

➢ Leads and lags are now adjusted to get a realistic schedule.

57

7. Schedule Compression

➢ Schedule compression is the method of shortening the project schedule **without changing the scope**.

➢ Need for compression occurs if a customer need a date prior to end date shown in original schedule or to bring back a project schedule back to baseline.

❖ Crashing – This approach adds more resources to activities on the critical path to complete the project earlier. Crashing almost always result in increased cost. Many options are considered and the option with maximum compression with minimum cost impact is selected.

❖ Fast Tracking –Critical activities that would normally be done in sequence are allowed to be done in parallel or with some overlap. Fast track may result in rework and increases the risk. Communication requirements increases during fast tracking.

58

8. Scheduling Tool

➤ Automated scheduling tools expedite the scheduling process by generating start and finish dates based on the inputs of the activities , network diagrams, resources and activity durations.

➤ A scheduling tool can be used in conjunction with other project management software applications as well as manual methods

59

Planning Package

➢ Scope of work may not be complete while schedule development and team need to wait till further information is available.

➢ Team need to proceed with schedule development for other work where scope is clear now.

➢ A planning package is placed now in WBS, below control account, and schedule development is done with approximate estimate.

➢ Planning package contains known work content but team have no enough details to decompose till activities.

6.5 Develop Schedule : Outputs

➢ The Schedule Development process has 4 outputs:

1. Project schedule

2. Schedule baseline

3. Schedule Data

4. Project Document Updates

6.5 Develop Schedule : Outputs

1. Project Schedule

❖ The purpose of the Schedule Development process is to determine the start and finish date for the each of the project activity.

❖ The project schedule should be approved and signed off by stakeholders and functional managers.

✓ This assures that they have read the schedule, understand the dates and resource commitments, and will likely cooperate

62

6.5 Develop Schedule: Outputs

➢ The schedule can be displayed in a variety of ways:

❖ Project Schedule Network Diagram

❖ Gantt Charts/ Bar Charts

❖ Milestone Charts

6.5 Develop Schedule : Outputs

2. Schedule Baseline

➢ A schedule baseline is a specific version of the project schedule developed from the schedule network analysis .

➢ It is accepted and approved by the project management team as the schedule baseline with baseline start dates and baseline finish dates .

➢ The schedule baseline is a component of the project management plan

64

3. Schedule Data

➢ The schedule data refers to documenting the supporting data for the schedule.

➢ The minimum amount of information in this output includes:

❖ Milestones

❖ Schedule activities and activity attributes

❖ Documenting the assumptions and constraints

  ✓ Supporting Details

    ▪ Resource Requirements , Alternative Scheduling, Schedule Contingency Reserves

65

6.5 Develop Schedule : Outputs

4. Project Document Updates :

Documents that might get updated include , but not limited to :

1. Activity Resource Requirements

2. Activity Attributes

3. Calendar

4. Risk Register

66

6.6 Control Schedule

- ➢ Schedule Control is concerned with :

1. Determining the current status of the project schedule

2. Influencing the factors that create schedule changes

3. Determining that the project schedule has changed, and

4. Managing the actual changes as they occur

6.6 Control Schedule

Inputs	Tools & Techniques	Outputs
1. Project Management Plan 2. Project Schedule 3. Work performance Information 4. Organizational Process Assets	1. Performance Reviews 2. Variance analysis 3. Project management software 4. Resource Levelling 5. What-if scenario analysis 6. Adjusting leads and lags 7. Schedule compression 8. Scheduling tool	1. Work Performance measurements 2. Organizational process assets (updates) 3. Change Requests 4. Project Management Plan updates 5. Project Document Updates

68

Performance Reviews

➢ Performance reviews measure , compare, and analyze schedule performance such as actual start and finish dates , percent complete, and the remaining duration for the work in progress .

➢ If EVT is utilized the SV and the SPI are used to assess the magnitude of schedule variations

➢ An important part of schedule control is to decide if the schedule variations require corrective actions .

69

Performance measurement

➢ Poor performance may result in schedule changes.

➢ Performance measurements for schedule control include the schedule variance and schedule performance index. Both of these should be used to determine if corrective action is needed to get the schedule back on track.

➢ We will see about Schedule Performance Index in Cost Management.

Variance Analysis

➢ Variance analysis is a key factor in monitoring and controlling project time because this technique helps determine variances in schedule start and end dates.

➢ More details in cost

71

Project Management Software

➢ **Project Management Software for scheduling provides the ability to track planned dates vs. actual dates, and to forecast the effects of changes to the project schedule**

6.6 Control Schedule : Tools & Techniques

➢ Resource Leveling

➢ What-if scenario analysis

➢ Adjusting leads and lags

➢ Scheduling Tool

6.6 Control Schedule : Outputs

➢ The Schedule Control process has the following outputs:

1. Work Performance Measurements - Calculated Schedule Variance (SV) and Schedule Performance Index (SPI) are documented and communicated with stakeholders

2. Organizational process asset updates (lessons learned)

3. Change Requests – Approved schedule baselines shall be only updated through integrative change control. SV & SPI may result in change requests for baseline update.

4. Project Management Plan Update

5. Project Document updates – Schedule data

74

Q & A

➢ Can there be more than one critical path

➢ Is this advisable

➢ Why dummy activities are placed in schedule network

➢ Can critical path have dummy activity

➢ Can critical path change

➢ Do we need to follow change control for critical path change

➢ Will the network diagram changes if critical path changes

➢ How much float in critical activities

➢ What is the difference between project float and path float

➢ Can there be negative float

75

Q & A

- ➢ Is float & lead/lag same

- ➢ A project have too much float, what does that indicate

- ➢ Which is the longest path in a schedule

- ➢ What is the shortest period which you can complete a project

- ➢ What is the difference between schedule compression and resource leveling.

- ➢ Team prepares a schedule which will exceed milestone from client. What to do.

- ➢ Where the team shall look in first prior to start of estimation.