
# PM Notebook

Summarizing Project Management Concepts for the PMP Exam

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Road to PMP

*No great man ever complains of want of opportunity.*
*Ralph Waldo Emerson*

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# CHAPTER 6 – SCHEDULE MANAGEMENT

## Key Terms

### Project Work vs. Project Manager Work

**Project Work –** The activities that will create the project scope.

**Project Manager Work / Level-of-Effort (LOE) –** The activities you have to do in order to manage the project. E.g. quality control, inspection, creation of reports, etc.

### Duration vs. Effort

**Activity Duration / Calendar Time / Expected Activity Duration (EAD)** – The total number of work periods required to complete a task.

**Effort/Person Hours –** Total number of labor units required to complete a task.

### Dependencies

**Mandatory Dependencies / Hard Logic –** Legally or contractually required order of activities. It is the natural order of activities.

**Discretionary Dependencies / Preferred/Preferential / Soft Logic** – A preferred order of activities defined by the team. Important when analyzing how to compress the schedule.

**External Dependencies –** Based on the needs or desires of a party outside the project. E.g. vendors, inspectors, and other projects that deliver required components.

**Internal Dependencies –** A type of **hard logic**. Based on the needs of the project and may be something the project team can control. E.g. waiting for team member who is taking a vacation, requiring a specific order because the management asked for that.

## Processes

### 1 – Plan Schedule Management (Planning)

- **Schedule Model** – The flow of your project activities in your activity list. It is a scaled down, less complex representation of the actual project.
- **Scheduling Methodology -** defines the rules and approaches for the scheduling process.
- Units of measurement (hours, days, weeks).
- Control thresholds.
- Rules for performance measurements.

### Inputs

1. **Project Management Plan**
   - **Scope Management Plan**
   - **Development Approach**
2. **Project Charter**
3. **OPAs**
4. **EEFs**

### Tools

1. **Expert Judgment**
2. **Data Analysis Techniques**
   - **Alternatives Analysis**
3. **Meetings**

### Outputs

1. **Schedule Management Plan**

## 2 – Define Activities (Planning)

- Activity list is a separate document.
- Involves taking the WBS work packages and decomposing them into activities.
- Basis for estimating, scheduling, and controlling work.

### Inputs

1. **Project Management Plan**
   - **Schedule Management Plan**
   - **Scope Baseline** – WBS, WBS Dictionary, Scope Statement
2. **OPAs**
3. **EEFs**

### Tools

1. **Decomposition** – Decomposing WBS to activities.
2. **Expert Judgment**
3. **Rolling Wave Planning –** Planning the project in waves as the project proceeds and details become clearer.
4. **Meetings**

### Outputs

1. **Activity List** – Lower-level than WBS. Contains activity identifier, activity name, and description.
2. **Activity Attributes –**
   - Unique activity identifier
   - WBS ID
   - Activity label

3. **Milestone List –** Significant events with the project schedule. A milestone has a duration of zero (0).
   - **Milestone Chart –** A way to visualize project milestone schedule. An up triangle means planned value. A down triangle means actual value. Line between the two shows how much variance.
4. **Change Requests**
5. **Project Management Plan Updates**

## 3 – Sequence Activities (Planning)

### Inputs

1. **Project Management Plan**
   - **Schedule Management Plan**
   - **Scope Baseline**
2. **Project Documents**
   - **Activity List**
   - **Activity Attributes**
   - **Assumptions Log**
   - **Milestone List**
3. **OPAs**
4. **EEFs**

### Tools

1. **Diagramming Models –**
   - **Precedence Diagramming Method (PDM) / Network Diagram / Activity-on-Node (AON) / Pure Logic Diagram –**
     1) Most common.
     2) Shows activities and relationships without a time scale.
   - **Arrow Diagramming Model (ADM) / Activity-on-Arrow (AOA) –**
     1) Uses finish-to-start representation only.
     2) Arrows are used to represent activities.
     3) May use dummy activities.
   - **Graphical Evaluation and Review Technique (GERT) –**
     1) Allows loops between activities (activities may be performed more than once.)
     2) Some activities may not be performed or performed only in part.
2. **Dependency Determination**
3. **Leads and Lags –**
   - **Lead/Accelerated/Negative Time –** When the **successor (S)** starts before **predecessor (P)** is done. Allows activities to overlap.
   - **Lag/Waiting/Positive Time –** When the **successor** starts after predecessor with some time.
4. **Project Management Information System (PMIS)**

### Outputs

1. **Project Schedule Network Diagram –** A **summary narrative** can accompany the schedule network diagram to describe the approach used to sequence the activities in the network.
2. **Project Document Updates**
   - **Activity List Updates**
   - **Activity Attributes Updates**
   - **Risk Register Updates**

## 4 – Estimate Activity Durations (Planning)

- Estimating should be done by the person doing the work whenever possible to improve accuracy.
- **Padding –** Extra time added to a schedule that you do not really think you need but that you add just to feel confident in the estimate. **Not acceptable** project management practice.

### Inputs

1. **Project Management Plan**
   - **Schedule Management Plan**
   - **Scope Baseline**
2. **Project Documents**
   - **Activity List**
   - **Activity Attributes**
   - **Assumptions Log**
   - **Milestone List**
   - **Resource Breakdown Structure (RBS)**
   - **Resource Calendars**
   - **Resource Requirements**
   - **Risk Register**
   - **Project Staff Assignments**
3. **EEFs**
4. **OPAs**

### Tools

1. **Expert Judgment**
2. **Estimating Techniques**
3. **Data Analysis Techniques**
   - **Alternatives Analysis**
   - **Reserve Analysis / Contingency Reserve/Buffer –** Adding extra time.
4. **Group Decision-Making Techniques**
5. **Meetings**

### Outputs

1. **Activity Duration Estimates**
2. **Basis of Estimates**
3. **Project Document Updates**

## 5 – Develop Schedule (Planning)

- Unrealistic schedule is project manager's fault.
- Calendar-based.
- Must be approved.

### Inputs

1. **Project Management Plan**
   - **Schedule Management Plan**
   - **Scope Baseline**
2. **Project Documents**
   - **Activity List**
   - **Activity Attributes**
   - **Assumptions Log**
   - **Milestone List**
   - **Resource Breakdown Structure (RBS)**
   - **Resource Calendars**
   - **Resource Requirements**
   - **Risk Register**
   - **Project Schedule Network Diagram**
   - **Activity Duration Estimates**
   - **Project Staff Assignments**
3. **Agreements**
4. **EEFs**
5. **OPAs**

### Tools

1. **Schedule Network Analysis**
2. **Critical Path Method (CPM)**
3. **Critical Chain Method (CCM)**
4. **Resource Optimization Techniques**
5. **Modeling Techniques –**
   - **What-if Analysis**
   - **Simulation –** Using a computer to model uncertainty.
     1) **Monte Carlo Simulation**
6. **Project Management Information System (PMIS)**
7. **Leads and Lags**
8. **Schedule Compression**
9. **Agile Release Planning**

### Outputs

1. **Project Schedule**
2. **Schedule Data –** Detailed information about activities, activity attributes, resource requirements, identified assumptions, alternate best-case and work-case schedules, and contingency reserves.
3. **Schedule Baseline**

4. **Project Calendars**
5. **Project Management Plan Updates**
6. **Project Document Updates**
   - **Activity List**
   - **Activity Attributes**
   - **Risk Register**

## 6 – Control Schedule (Monitoring & Controlling)

- **Measuring and assessing** work performance data against the schedule baseline.
- Involves **taking corrective and preventive** action over and over again.
- Involves **prioritizing the remaining work** and to properly allocate remaining resources based on their availability.
- If the project is running ahead of the schedule, Project Manager should evaluate **reducing staff for the project.** This could lead to savings for organization.
- Involves ensuring that the critical path does not change.

### Inputs

1. **Project Management Plan**
   - **Schedule Management Plan**
   - **Performance Measurement Baseline**
     1) **Schedule Baseline**
     2) **Scope Baseline**
2. **Project Documents**
   - **Project Calendars**
   - **Project Schedule**
   - **Resource Calendar**
   - **Schedule Data**
3. **Work Performance Data**
4. **OPAs**

### Tools

1. **Data Analysis Techniques**
   - **What-if Analysis**
2. **Project Management Information System (PMIS)**
3. **Performance Reviews –**
   - **Schedule Variance (SV) –** Indicates how much ahead (positive) or behind (negative) schedule the project is. **When a project finished SV will always be zero.**
   - **Schedule Performance Index (SPI) –** A measurement of schedule efficiency expressed as the ratio of earned value (EV) to planned value (PV.)
   - **Trend Analysis**
4. **Resource Optimization Techniques**
5. **Adjusting Leads and Lags**

### Outputs

1. **Work Performance Information**
2. **Schedule Forecasts**
3. **Change Requests**
4. **OPAs Updates**
5. **Project Management Plan Updates**
6. **Project Document Updates**

## Activities

### Types

#### By Effort

| |
|---|
| **Level-of-Effort (LOE) –** Support activities. Like reporting and budgeting. |
| **Discrete Effort –** Activities required to complete project scope |
| **Apportioned Effort –** Project management work. Like quality assurance and communications. |

#### By Duration

| |
|---|
| **Effort-Driven Activities –** The more labor we put on the sooner the activity can get done. |
| **Fixed-Duration Activities –** Adding more labor will not make the activity finish faster. |

#### By Convergence

| |
|---|
| **Merge Activities / Path Converge/Convergence –** When two or more parallel activities are merged together. |
| **Burst Activities –** When one activity is split into multiple activities. |

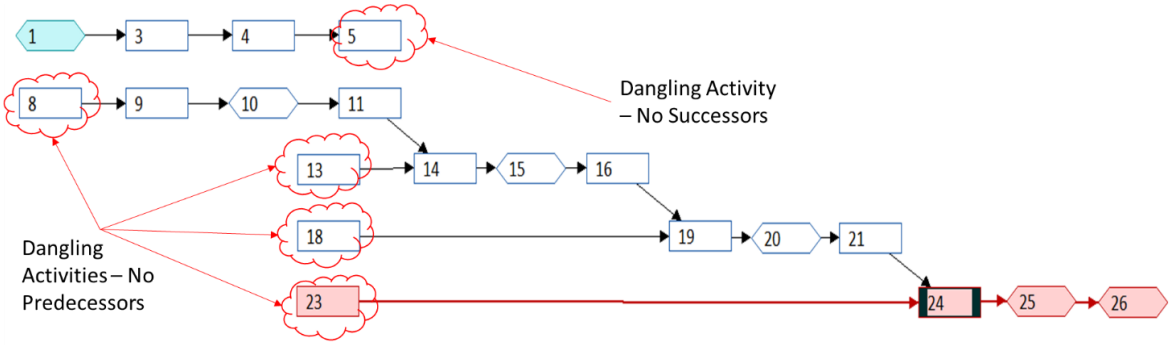
#### By Sequence

| |
|---|
| **Serial Activities –** Those that flow from one to the next, in sequence. |
| **Concurrent / Parallel –** When one or more activities are completed on the same time. |

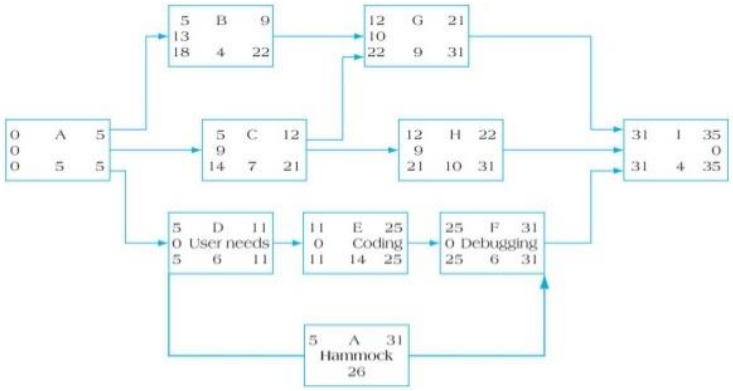
## Other Types

**Dangling Activities / Open-Ended Activities –** Any activity that is disconnected from either sides or connected from both sides with relations that do not govern the links.

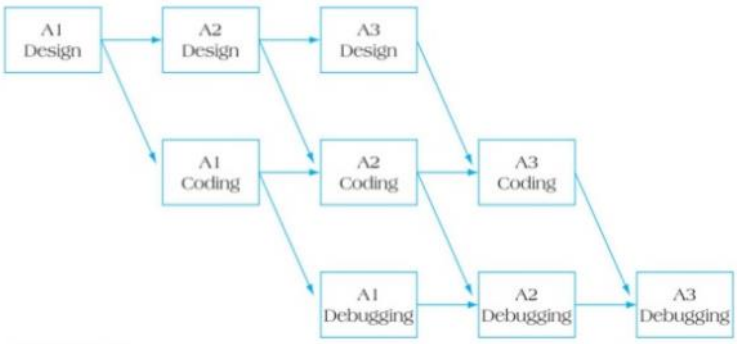
Dangling activities result in a schedule baseline that is not reliable due to the omission of substantial sequential constraints.




**Hammock Activity –** It is a type of activity that is used for grouping smaller activities that hang between two dates. The size of the hammock, or the duration of the hammock is calculated by the start date of the earliest task, and the finish date of the last task.




**Laddering Activities –** It is when work elements in an activity are progressively released to the next activity thus causing them to be overlapped during their execution.



## Relationships

Types of relationships between two dependencies A (first) and B (second) –

1. **Finish to Start (FS) –** $B(S) = A(F)\,[+1]$
2. **Start to Start (SS) –** $B(S) = A(S)$
3. **Finish to Finish (FF) –** $B(F) = A(F)$
4. **Start to Finish (SF) –** $B(F) = A(S)\,[-1]$

## Critical Path Method (CPM) / Logic-Driven Scheduling

**Critical Path Method** involves measuring the longest sequence of activities, it focuses on activity order.

- **Critical Path (CP) –** The string of activities that is longer than any other path. A delay in any one of the critical activities will delay the whole project.
- **Near-Critical Path –** The path that is close in duration to the critical path. Sometimes, the near-critical path becomes the critical.

Please note that following regarding critical path –

- Multiple critical paths increase project risk.
- Critical path has zero or negative float in case that there is a constraint set on the project finish date.

## Float / Slack

The amount of time that an activity can slip before it causes the project to be delayed.

| |
|---|
| **Total Float (Slack) –** The amount of time an activity can be delayed without delaying the project end date. It **cannot be aggregated**, and is **shared** across the path. |
| **Free Float –** The amount of time an activity can be delayed without delaying the early start date of its successor (S). |
| **Project Float –** The amount of time a project can be delayed without delaying the externally imposed project completion date required by the customer or management. |
| **Negative Float** – Means that estimated completion date is **after** the desired date. |

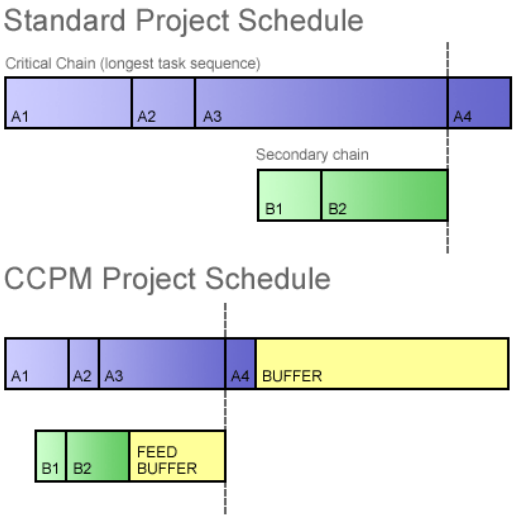
## Components

- **Early Start (ES) –** The earliest time that an activity can start.
- **Early Finish (EF) –** The earliest time that an activity can finish.
- **Late Start (LS) –** The latest time that an activity can start.
- **Late Finish (LF) –** The latest time that an activity can finish without delaying the project.
- **Forward Pass** – For early start and finish.
  $\text{ES} = \text{Maximum EF of all predecessors} + 1$
  $\text{EF} = \text{ES} + \text{Duration} - 1$
- **Backward Pass –** For late start and finish.
  $\text{LF} - \text{Minimum LS of all successors} - 1$
  $\text{LS} - \text{LF} - \text{Duration} + 1$
- **Float –**
  $\text{F} = \text{LF} - \text{EF or LS} - \text{ES}$

## Critical Chain Method (CCM)

**Critical Chain Method** involves the longest sequence of activities considering activity buffers and resource constraints.

- It focuses on **resources**.
- Focuses on managing the remaining buffer durations against the remaining duration of task chains.
- **Buffer** –
  - Protects the critical chain from slippage.
  - The size of each buffer accounts for the uncertainty in the duration of the chain of dependent tasks that lead up to the buffer.
  - Usually set to **50-percent** of the critical chain duration. While 50 percent sounds like a lot, it is often less than the total of hidden safety margins in individual tasks.



## Schedule Compression

**Crashing –** Adding resources or moving them around to shorten it.

- Applies to **effort-driven** activities.
- **Adds cost.**
- While crashing equal activities, choose the **earlier** one.
- First step in crashing is **calculating the cost and time slope** for each **critical** activity that can be expedited.
- When crashing, start with the **lowest crashing cost**.
- **Slope –** The cost per day of crashing the project.

$$\frac{\boldsymbol{Crash\ Cost\ (CC) - Normal\ Cost\ (NC)}}{\boldsymbol{Normal\ Duration\ (ND) - Crash\ Duration\ (CD)}}$$

- **Law of Diminishing Returns –** Refers to a point at which the level of profits or benefits gained is less than the amount of money or energy invested (ROI). At this point, adding more input will not produce a proportional increase in productivity.

**Fast-tracking –** Performing phases or activities in parallel or partially parallel. **Adds risk.**

## Resource Optimization Techniques

To adjust the use of resources.

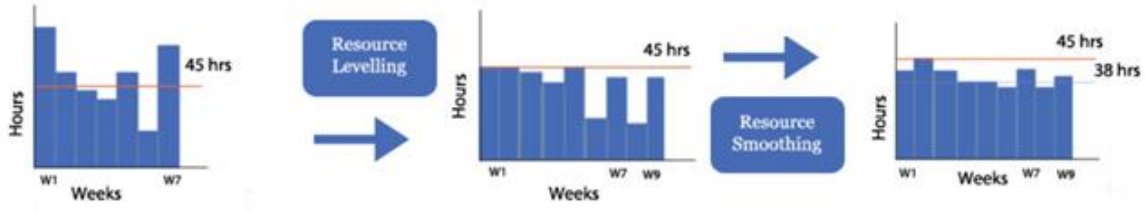
**Resource Leveling –** Adjusting **start and finish dates** based on resource constraints for balancing demand of resources with the available supply.

- Used when individual bars of resource histogram extend beyond the maximum allowed hours (i.e. **over-allocation**.)
- Used to produce a **resource-limited** schedule.
- May **lengthen the schedule** and **increase cost**.
- Include **adding more resources** or **modifying the schedule.**

**Resource Smoothing –** Adjusting activities so that requirements for resources do not exceed certain predefined resource limits.

- Used when **time constraint** takes priority**.**
- Usually **applied after leveling**.
- **May not optimize all resources**.

**Resource Reallocation –** Moving activities from and to critical path.



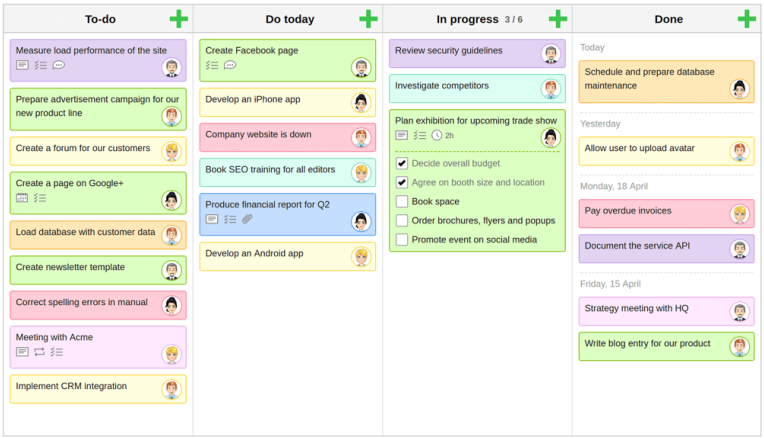
## Additional Terms

**Control Threshold –** A predetermined range of acceptable variances, such as +/–10 percent off schedule.

**Fragnet/Subnet** – A representation of a project network diagram that is often used for outsourced portions of a project, repetitive work within a project, or a subproject.

**Kanban Board** – is a work and workflow visualization tool that enables you to optimize the flow of your work.

- **Kanban for Work-in-Progress (WIP) –** To visualize work in progress.




**Lean Management –** an approach to running an organization that supports the concept of continuous improvement, a long-term approach to work that systematically seeks to achieve small, incremental changes in processes in order to improve efficiency and quality.

- Uses a product **backlog.**

**Sub-networks / Fragment Networks –** Several identical or nearly identical series of activities that are repeated throughout the project.