

# Project Schedule Management

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# Contents

- The Importance of Project Schedules
- Plan schedule management
- Define Activities
- Sequence Activities
- Estimate Activity Durations
- Develop Schedule
- Control Schedule
- Use Software to Assist PTM
- Other Scheduling Methods

**Time is easily  
measured and  
remembered**

**Time is a main  
cause of  
conflict?**

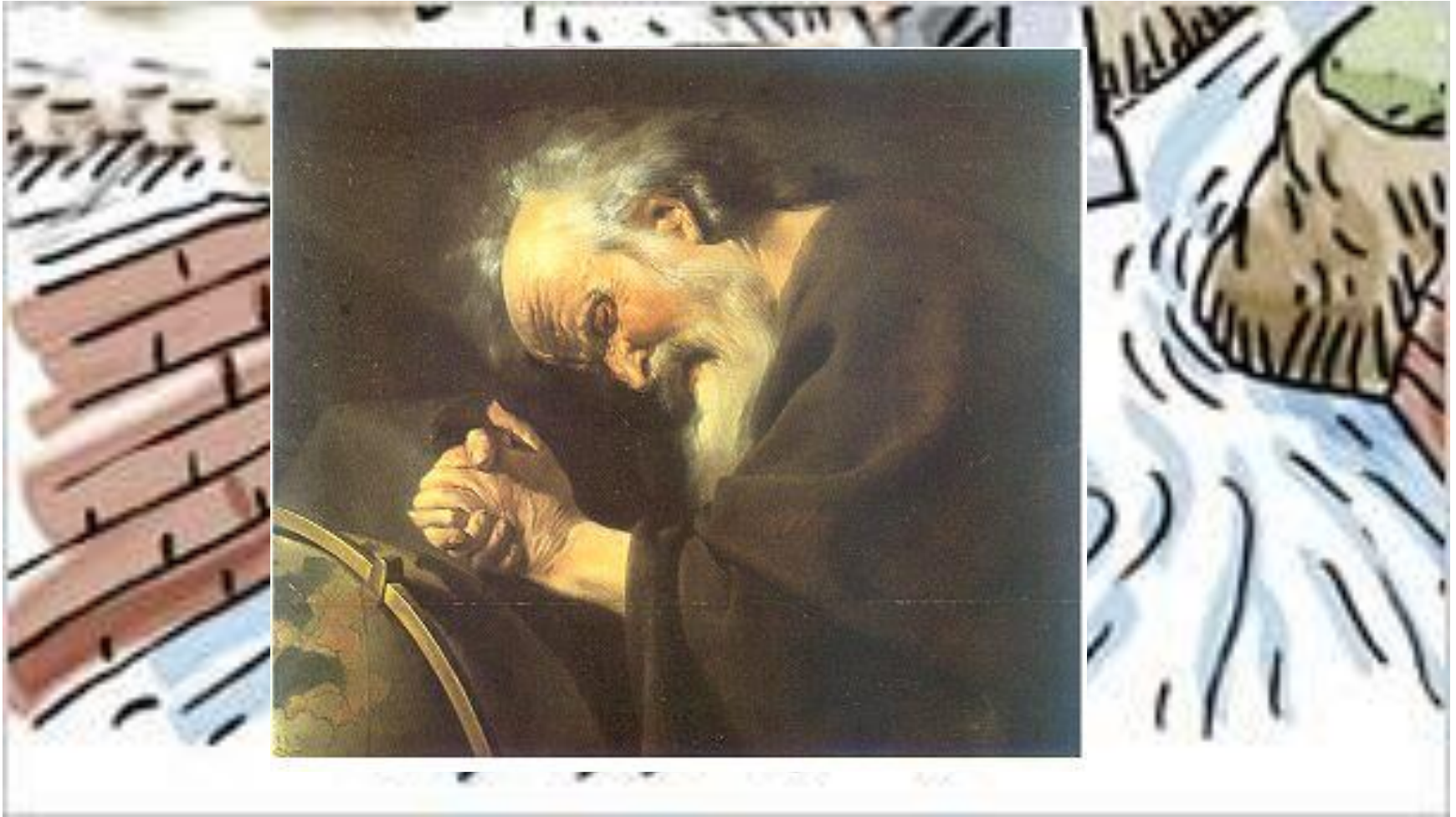
**People often compare planned and  
actual project completion times  
without taking into account the  
approved changes in the project**



# You Can Never Step Into The Same River Twice



# You Can Never Step Into The Same River Twice





# What Is Time?

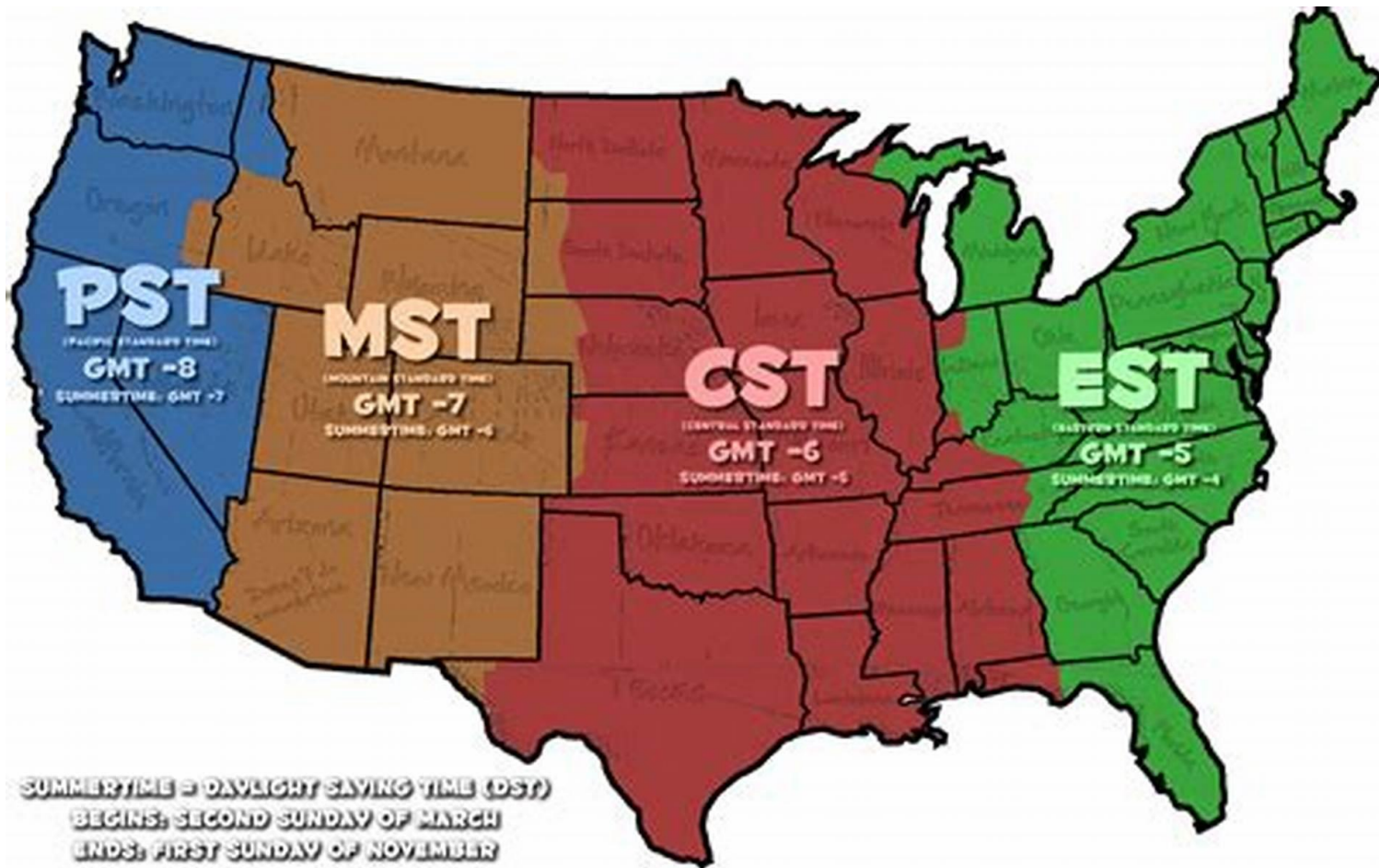


**Time is what clocks measure**

**Time is what keeps  
everything from happening  
at once**



# What Is Time?



# Time in Project

Time is a dimension in which

- events can be ordered from the past through the present into the future,
- and also the measure of durations of events and the intervals between them.

**What is the difference between Time and Scope/Cost?**





# Activity

An element of work normally found on the WBS that has expected duration, cost and resource requirements.

## Activity vs Work Package



# Schedule

- The start and end **dates** of the project and its **activities**.
- It is the approved version of a schedule model that can be changed only through formal change control procedures
- It is used as a basis for comparison to actual results.



# Schedule Conflicts

- Work style

Emphasize task completion, detailed schedules

vs.

Open and flexible

- Culture difference

Siesta religious or secular holidays



# Three Important Tools

**Gantt Chart**

**Network Diagrams**

**Critical Path Analysis**



# Project Schedule Management

- Involves the processes required to ensure timely completion of a project.
- Six main processes are involved in project schedule management





Initiating

Planning

Executing

Monitoring &  
Controlling

Closing

- Plan schedule management
- Define activities
- Sequence activities
- Estimate activity durations
- Develop schedule

- Control schedule

- Activity 1
- Activity 2
- Activity 3
- Activity 4





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# Plan Schedule Management

The process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project charter</li><li>2. Project management plan</li><li>3. Enterprise environmental factors</li><li>4. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Expert judgment</li><li>2. Data analysis</li><li>3. Meetings</li></ol>	<ol style="list-style-type: none"><li>1. Schedule management plan</li></ol>

Key benefit: it provides guidance and direction on how the project schedule will be managed throughout the project



# Schedule Model

- Model contains activities with estimated durations, dependencies, and other information to produce a project schedule
- Represents a timeline with scheduled tasks and activities





# Output – Schedule Management Plan

- Project schedule model development
- Level of accuracy and units of measure (such as hours, days, or another unit)
- Control thresholds (percentage deviations)
- Rules of performance measurement (EVM)
- Reporting formats (formats and frequency)
- Process descriptions





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# Define Activities

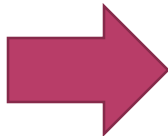
The process of identifying and documenting the specific actions to be performed to produce the project deliverables

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project management plan</li><li>2. Enterprise environmental factors</li><li>3. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Expert judgment</li><li>2. Decomposition</li><li>3. Rolling wave planning</li><li>4. Meetings</li></ol>	<ol style="list-style-type: none"><li>1. Activity list</li><li>2. Activity attributes</li><li>3. Milestone list</li><li>4. Change request</li><li>5. Project management plan updates</li></ol>



Survey development

Survey administration

Study report 

Draft report

Report edits

Final report

○ ○ ○ ○ ○ ○



# Defining Activities

- The goal of defining activities is to ensure that the project team completely understands all the work it must do as part of the project scope so they can start scheduling the work
- For example, “Produce users’ requirements report”





# Activity List and Attributes

- Activity list: activity name, activity identifier or number, a brief description of the activity
- Activity attributes: activity description, predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed date, and assumptions



# Concepts

## ACTIVITY ATTRIBUTES

Project Title: \_\_\_\_\_

Date Prepared: \_\_\_\_\_

ID: <i>From activity list</i>		Activity: <i>From activity list</i>			
Description of Work: <i>A description of the activity in enough detail so that the person(s) performing the work understands what is required to complete it.</i>					
Predecessors	Relationship	Lead or Lag	Successor	Relationship	Lead or Lag
<i>Any activities that must occur before the activity.</i>	<i>The nature of the relationship, such as start-to-start, finish-to-start, or finish-to-finish.</i>	<i>Any required delays between activities (lag) or accelerations (lead).</i>	<i>Any activities that must occur after the activity.</i>	<i>The nature of the relationship, such as start-to-start, finish-to-start, or finish-to-finish.</i>	<i>Any required delays between activities (lag) or accelerations (lead).</i>
Number and Type of Resources Required: <i>The number and roles of people needed to complete the work.</i>		Skill Requirements: <i>The level of skill necessary to complete the work (expert, average, novice or applicable job level).</i>		Other Required Resources: <i>Any equipment, supplies, or other types of resources needed to complete the work.</i>	
Type of Effort: <i>Indicate if the work is a fixed duration, fixed amount of effort, level of effort, apportioned effort or other type of work.</i>					
Location of Performance: <i>If the work is to be completed somewhere other than at the performing organizations site, indicate the location.</i>					
Imposed Dates or Other Constraints: <i>Indicate any fixed delivery dates, milestones or other constraints.</i>					
Assumptions: <i>List any assumptions about resource availability, skill sets, or other assumptions that impact the activity.</i>					

# Milestone

- Milestone - a significant point or event in a project
  - Zero duration
  - Not every deliverable or output created for a project is really a milestone
  - The most important and visible events



Flat Roadmap Horizontal Timelines for PowerPoint



# Tools

- **Expert Judgment**
- **Decomposition** is a technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts
- **Rolling wave planning** is an iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level
- **Meetings**





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# Sequence Activities

The process of identifying and documenting relationships among the project activities

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project management plan</li><li>2. Project documents</li><li>3. Enterprise environmental factors</li><li>4. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Precedence diagramming method</li><li>2. Dependency determination and integration</li><li>3. Leads and lags</li><li>4. Project management information system</li></ol>	<ol style="list-style-type: none"><li>1. Project schedule network diagrams</li><li>2. Project documents updates</li></ol>

key benefits: it defines the logical sequence of work to obtain the greatest efficiency given all project constraints



# Dependencies

- Mandatory dependencies – hard logic  
code → test
- Discretionary dependencies – defined by project team  
requirements → design
- External dependencies  
hardware procurement → OS installation
- Internal dependencies  
install DB → use DB



# Network Diagrams

A schematic display of the logical relationships among, or sequencing of, project activities

- Activity-on-arrow (AOA), or Arrow diagramming method (ADM):

A network diagramming technique in which activities are represented by arrows and connected at points called nodes to illustrate the sequence of activities.

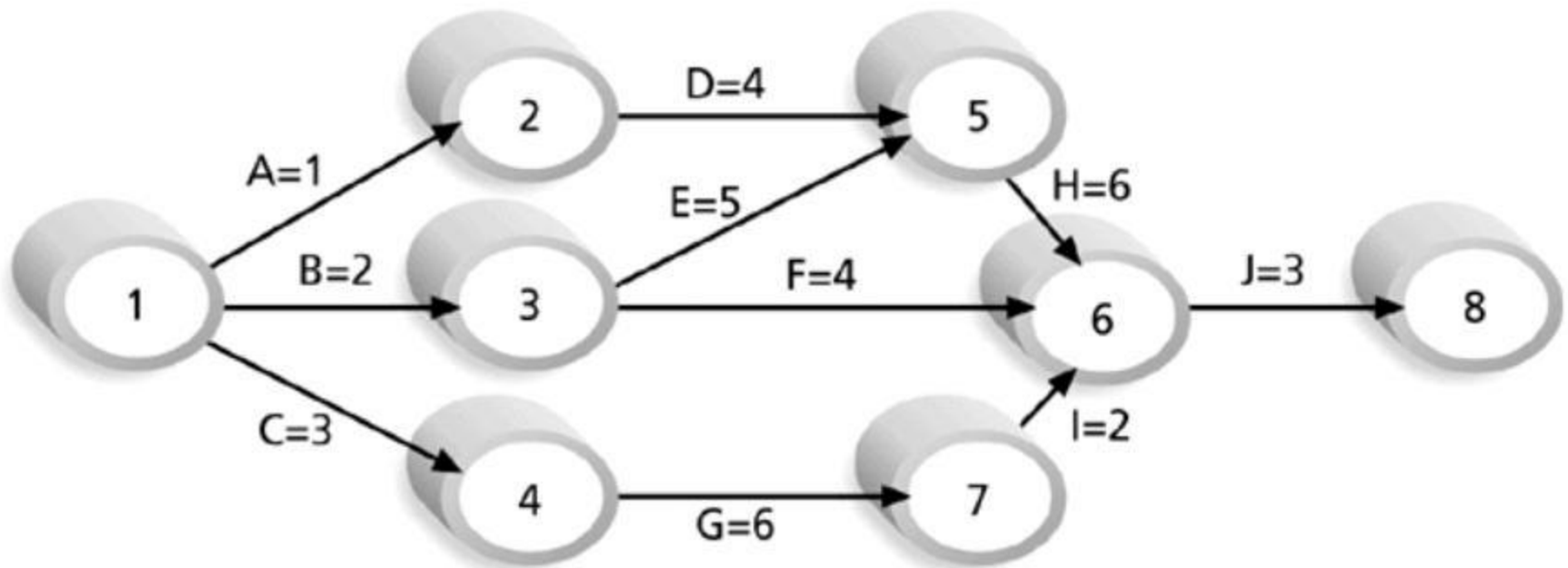
- Node: the starting and ending point of an activity.



# How to Draw AOA Diagram

- Left to right
- Burst
- Merge

**How to set C before H?**



Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

# WBS vs AOA

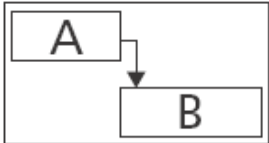
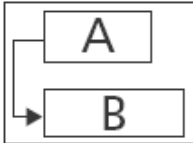
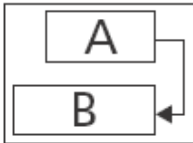
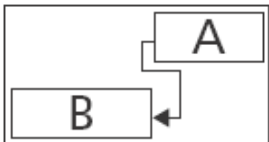


Not Like Dummy Activity?



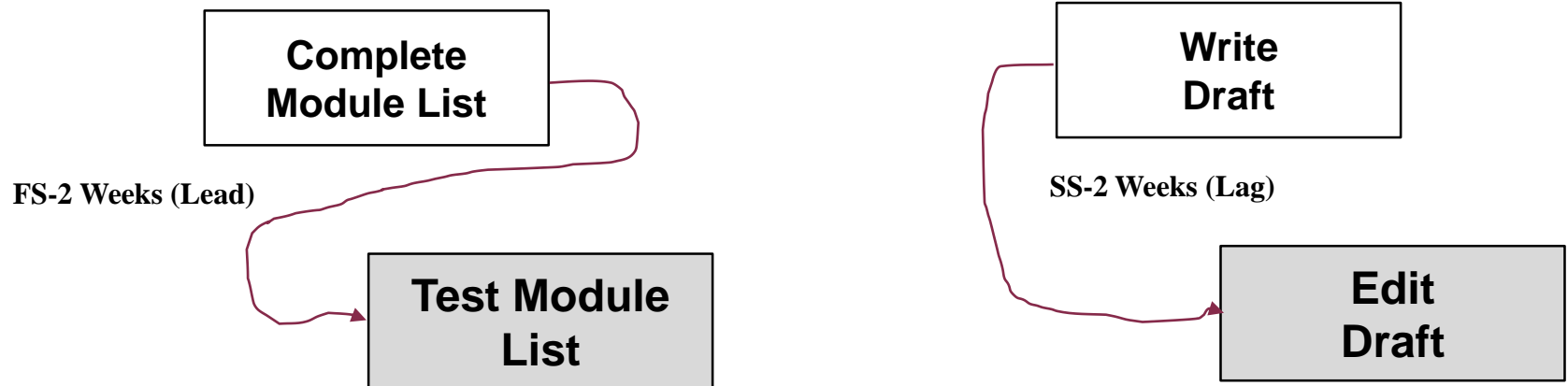
# Precedence Diagramming Method(PDM)

A network diagramming technique in which boxes represent activities.

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

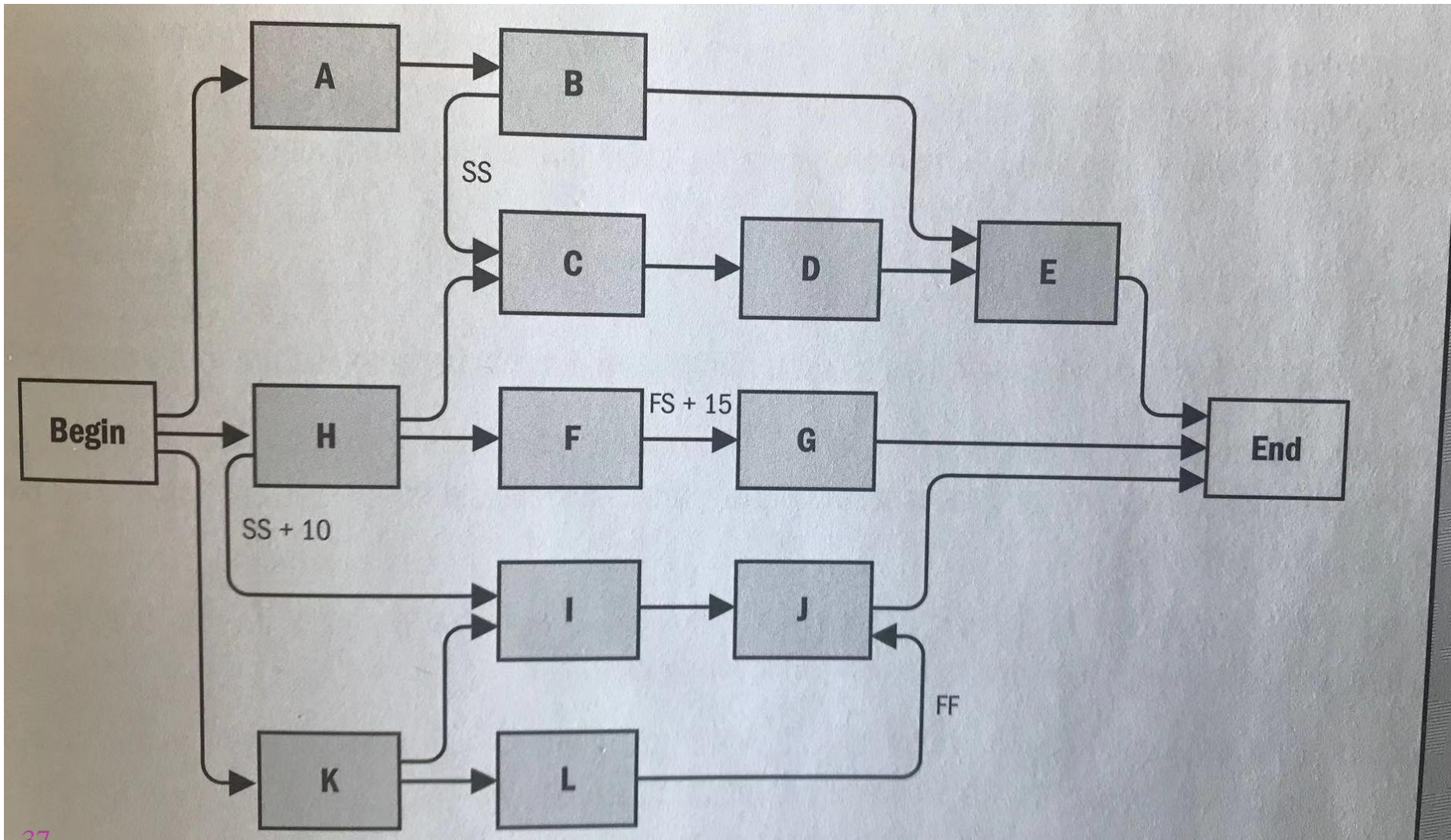


# Lead and Lag





# Project Schedule Network Diagram



# PDM vs AOA

- Most PMs use PDM
- PDM shows different dependencies among tasks, whereas AOA diagrams use only finish-to-start dependencies
- Dummy activity?





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# Estimate Activity Durations

The process of estimating the number of work periods needed to complete individual activities with estimated resources.

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project management plan</li><li>2. Project documents</li><li>3. Enterprise environmental factors</li><li>4. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Expert judgment</li><li>2. Analogous estimating</li><li>3. Parametric estimating</li><li>4. Three-point estimating</li><li>5. Bottom-up estimating</li><li>6. Data analysis</li><li>7. Decision making</li><li>8. Meetings</li></ol>	<ol style="list-style-type: none"><li>1. Duration estimates</li><li>2. Basis of estimates</li><li>3. Project documents updates</li></ol>

Key benefit: it provides the amount of time each activity will take to complete



What are related to the time of an activity?

Complexity

Resource



# Human Resource

- What specific skills do people need to do the work?
- What are the skill levels of the people assigned to the project?
- How many people are expected to be available to work on the project at one time?
- .....



# Duration and Effort

- Duration: includes the actual amount of time worked on an activity plus elapsed time
- Effort: the number of workdays or work hours required to complete a task



# Three-point Estimate

- Optimistic (tO): best-case scenario
- Pessimistic (tP): worst-case scenario
- Most likely (tM): expected scenario

$$\text{Triangular Distribution} = (tO + tP + tM) / 3$$





# Program Evaluation and Review Technique

- Estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates.

PERT weight average = (optimistic time + 4\*most likely time + pessimistic time)/6

## Beta Distribution



# Outputs

- Activity duration estimates
  - 2 weeks  $\pm$  2 days, which indicates that the activity will take at least eight days and not more than twelve (assuming a five-day workweek);
  - 15 % probability of exceeding three weeks, which indicates a high probability—85 %—that the activity will take three weeks or less
- Project document updates





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# Develop Schedule

The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create a schedule model.

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project management plan</li><li>2. Project documents</li><li>3. Agreements</li><li>4. Enterprise environmental factors</li><li>5. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Schedule network analysis</li><li>2. Critical path method</li><li>3. Resource optimization</li><li>4. Data analysis</li><li>5. Leads and lags</li><li>6. Schedule compression</li><li>7. Project management information system</li><li>8. Agile release planning</li></ol>	<ol style="list-style-type: none"><li>1. Schedule baseline</li><li>2. Project schedule</li><li>3. Schedule data</li><li>4. Project calendars</li><li>5. Change requests</li><li>6. Project management plan updates</li><li>7. Project documents updates</li></ol>



# Tools and Techniques

- Gantt Charts – displaying project schedule information
- Critical path analysis – developing and controlling project schedules without regard for any resource limitations
- Critical chain scheduling – limited resources
- PERT(Program Evaluation and Review Technology) – considering schedule risk



# Gantt Charts

- A standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in calendar form
- Gantt charts are sometimes referred to as bar charts because the activities' start and end dates are shown as horizontal bars



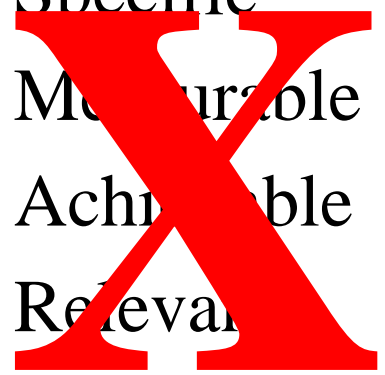
# Adding Milestones to Gantt Charts

## SMART Criteria

- Specific
- Measurable
- Assignable
- Realistic
- Time-framed

## Other definition

- Specific
- Measurable
- Achievable
- Relevant
- Time-oriented



**Finish a user requirement analysis report**



# Key Points of Using Milestones

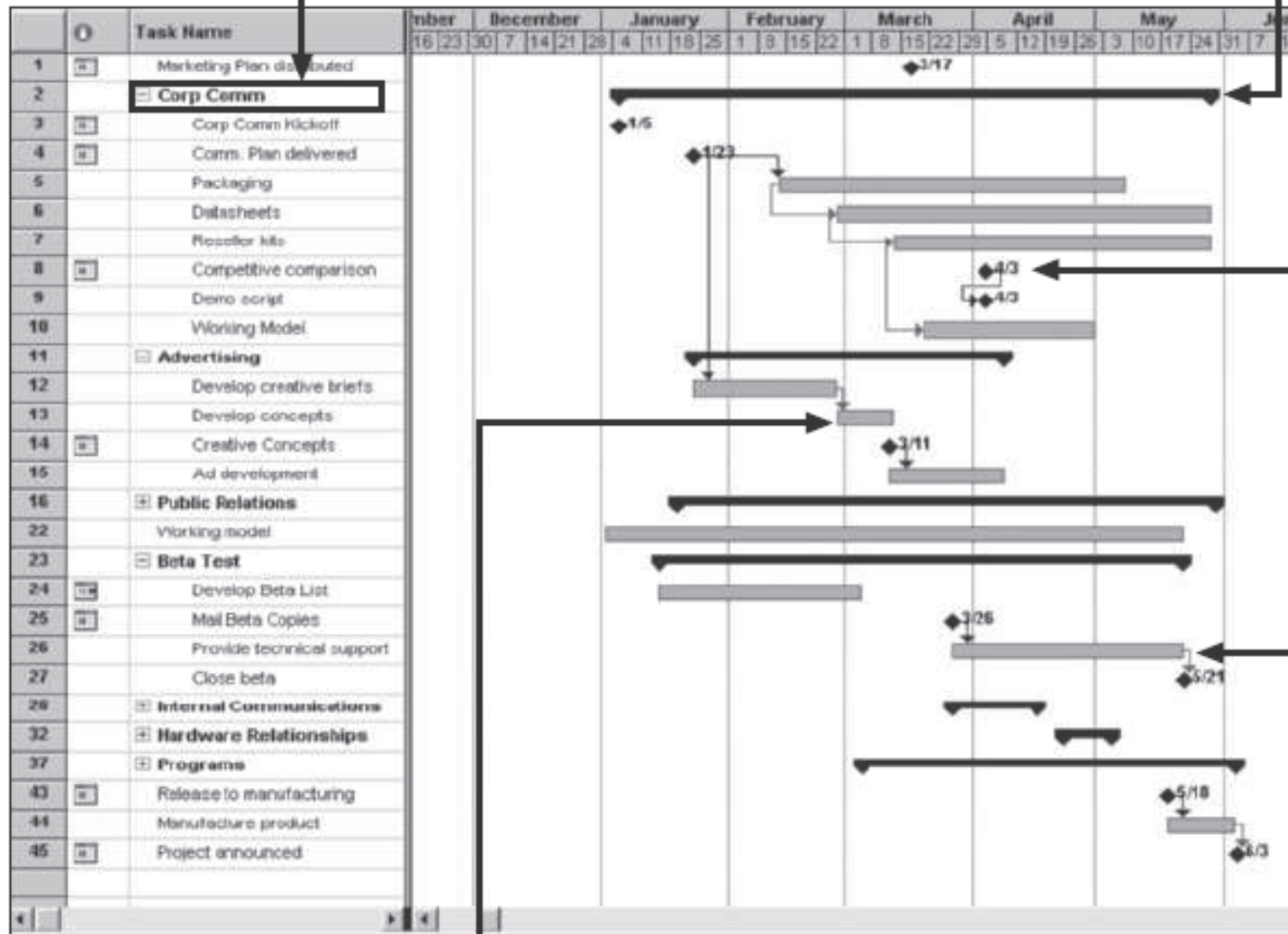
1. Define milestones early in the project and include them in the Gantt chart to provide a visual guide.
2. Keep milestones small and frequent.
3. Each milestone must be binary, meaning it is either complete or incomplete.
4. Carefully monitor the critical path.





WBS hierarchy shown by indentations

Summary task



Milestone

Individual task bar

Arrows show dependencies

# Tracking Gantt Chart

It is used to evaluate progress

- Baseline dates
- Scheduled baseline

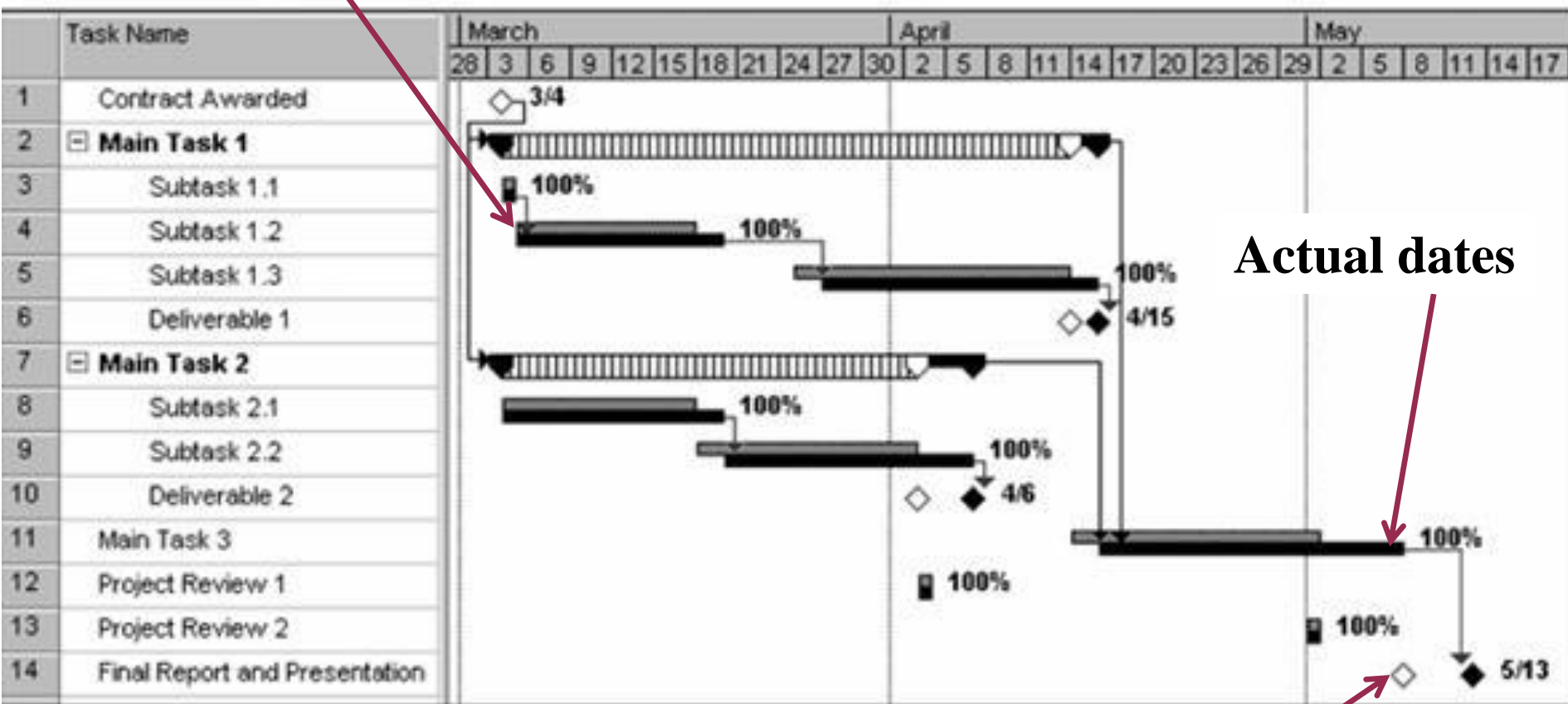
Symbols

- Two horizontal bars
- White diamond
- Percentages to the right of the horizontal bars

**Schedule baseline:** the entire approved planned schedule



Planned dates



Actual dates

Slipped Milestone



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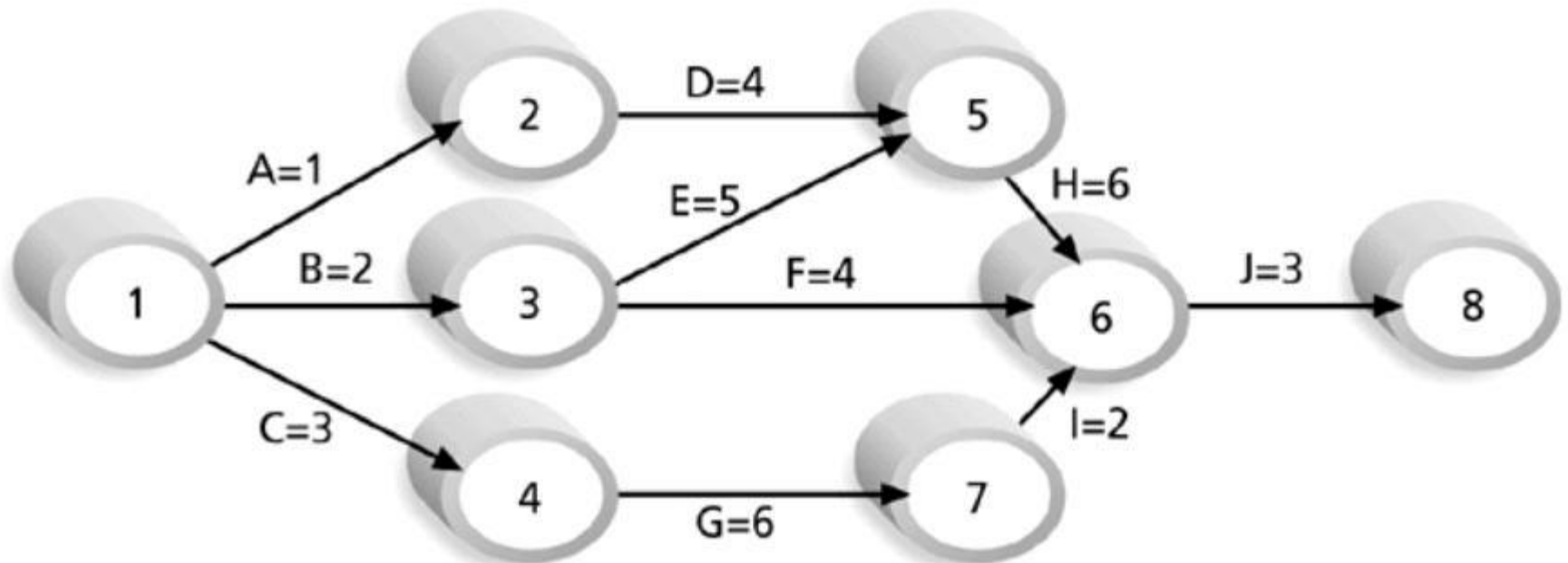
# Critical Path Method

A network diagramming technique used to predict total project duration

- A critical path is the series of activities that determine the earliest time by which the project can be completed



# Calculating the Critical Path



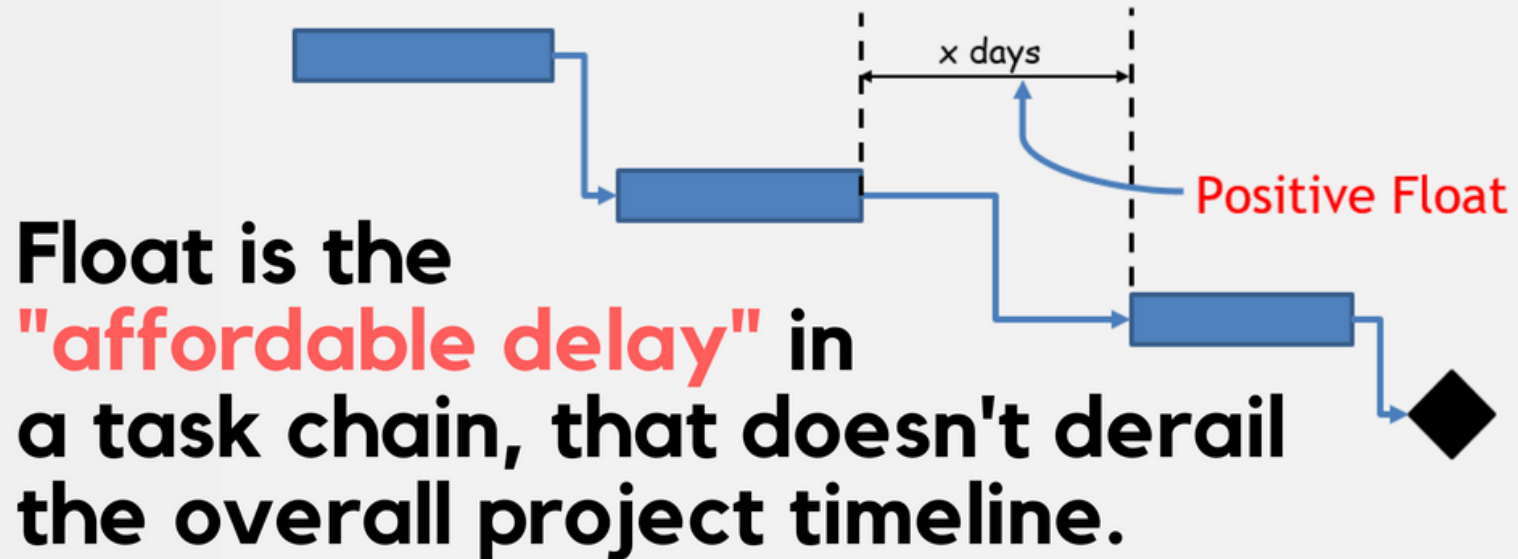
Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

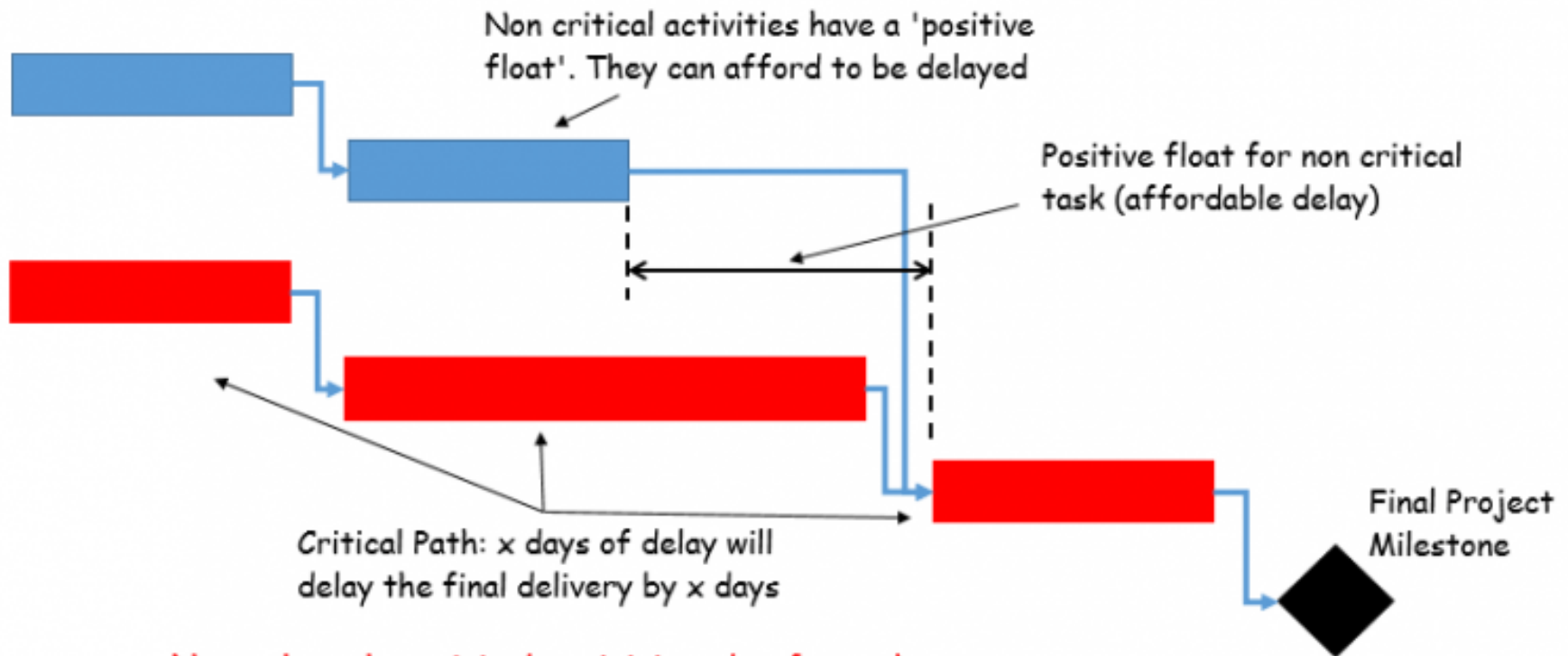


# Slack or float

The amount of time an activity may be delayed without delaying a succeeding activity or the project finish date

## Free Float / Slack in Project Schedule





Note that the critical activities also form the longest chain in terms of duration on Gantt chart

# Misunderstanding of Critical Path

- Critical path includes the most critical activities?
- The critical path is the shortest path through the network diagram?
- More than one critical path?
- Critical path ever changes?





# Shorten Project Schedule

**Crashing:** A technique used to shorten the schedule duration for the least incremental cost by adding resources

- Examples: approving overtime, bringing in additional resources, or paying expedite delivery to activities on the critical path
- Only works for activities ...?
- Increase project costs?

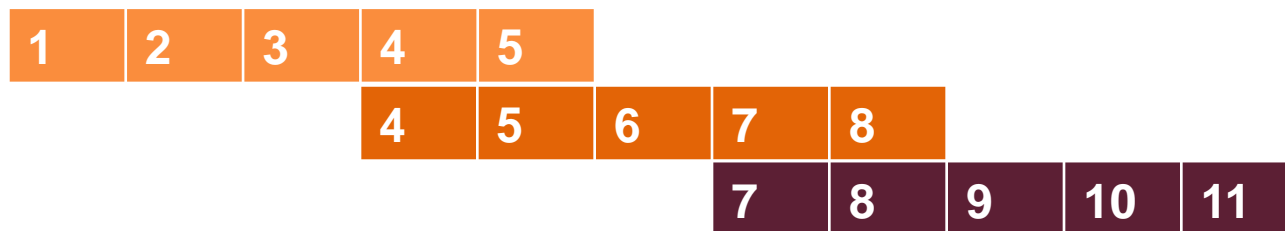


# Shorten Project Schedule

**Fast tracking:** A schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration.

- May result in rework and increased risk
- Only works when ...?
- Increase project costs?





# Shorten Project Schedule (more)

- Reduce the scope
- Degrade the quality
- ...



# Theory of Constraints

It is based on the metaphor of a chain and its weakest link:

“Any complex system at any point in time often has only one aspect or constraint that limits the ability to achieve more of the system’s goal”.

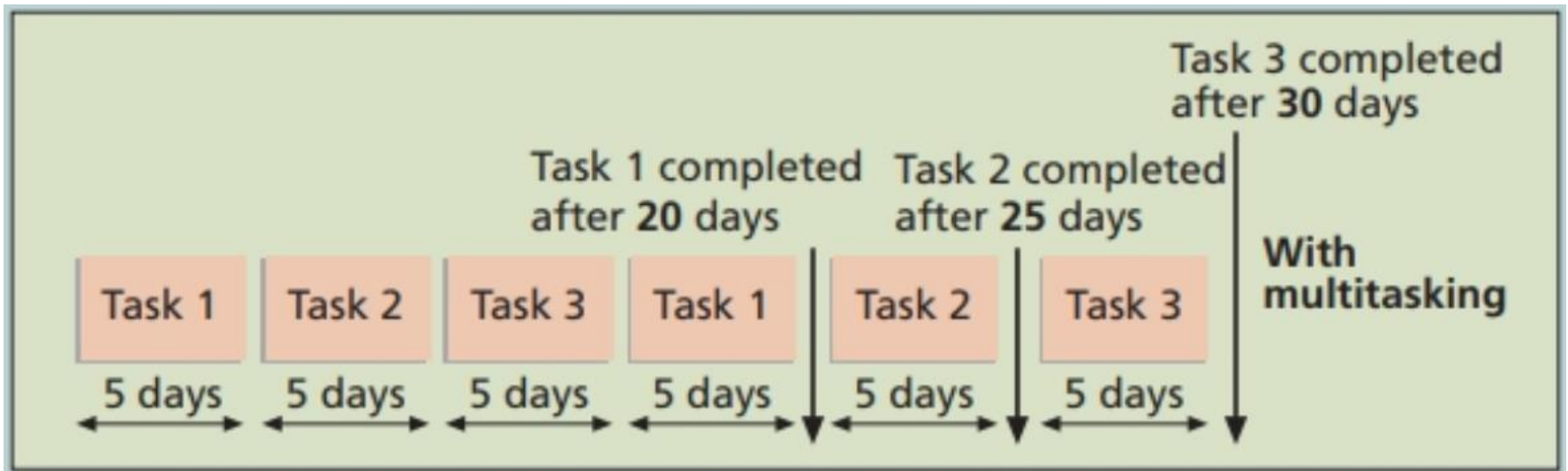
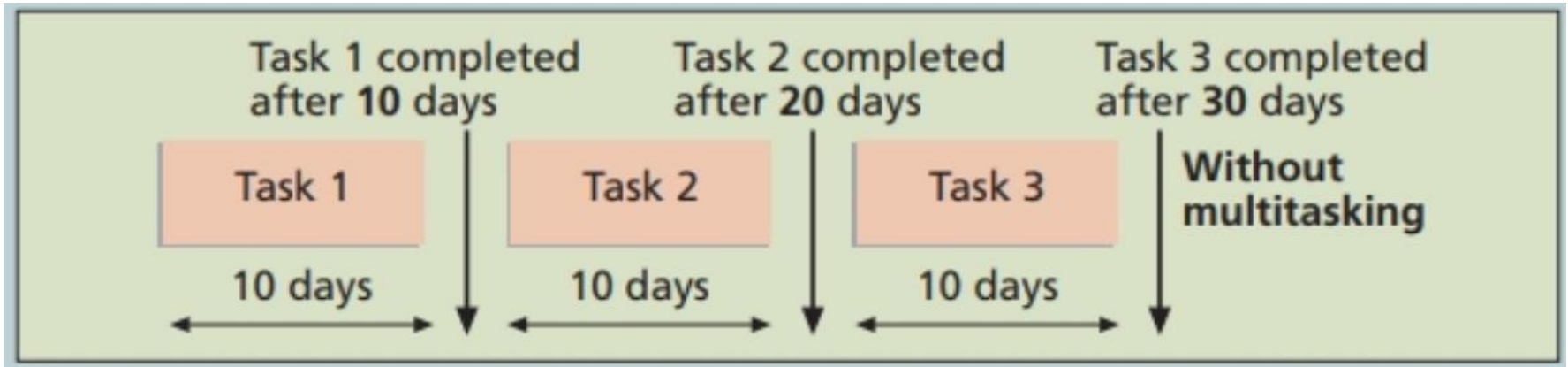


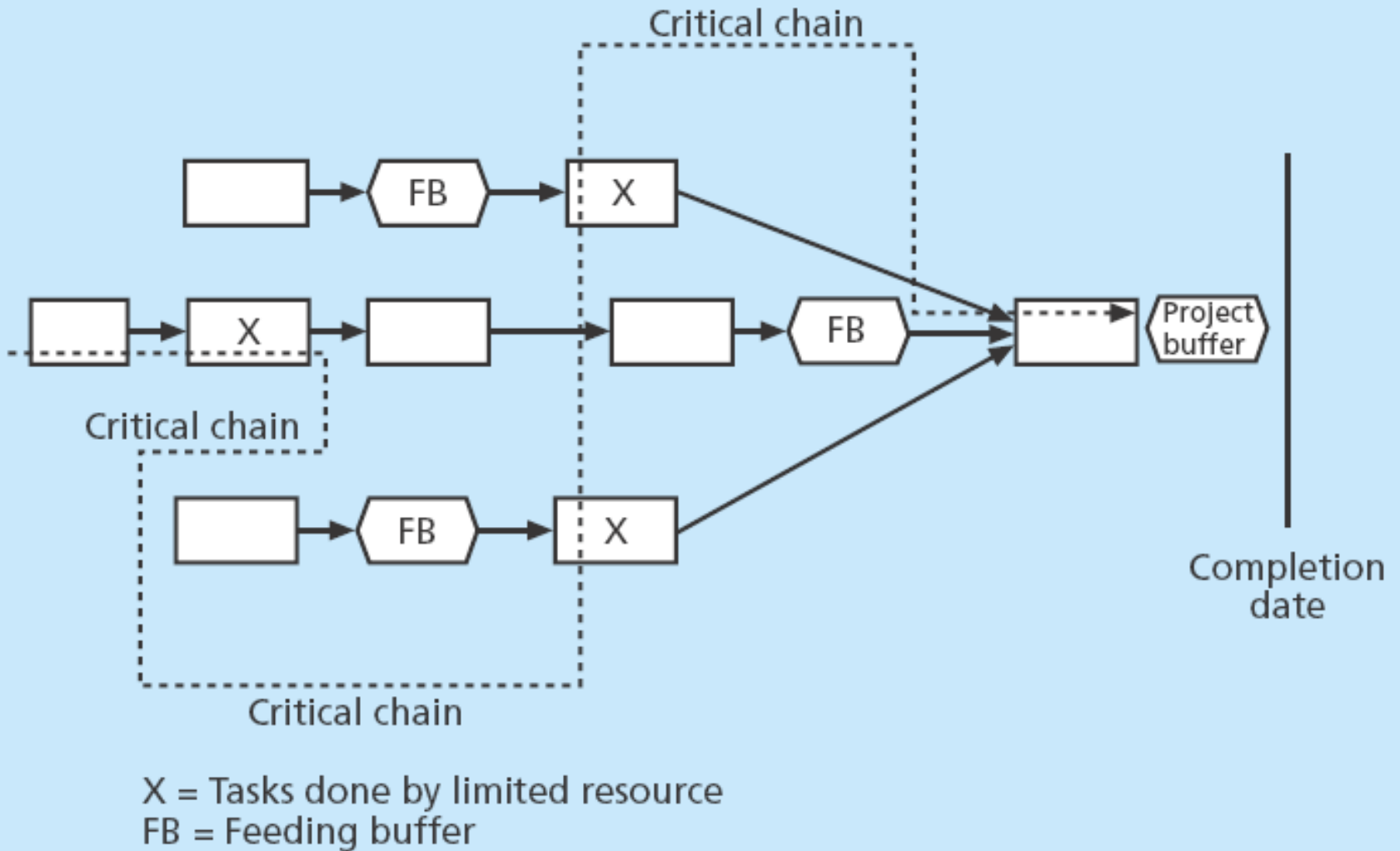
# Critical Chain Scheduling

- A method of scheduling that considers limited resources when creating a project schedule and includes buffers to protect the project completion date
- Availability of scarce resources
- Assumption: **Resources do not multitask or at least minimize multitasking**

## Multitask, bad or good?







Source: Eliyahu Goldratt, *Critical Chain*





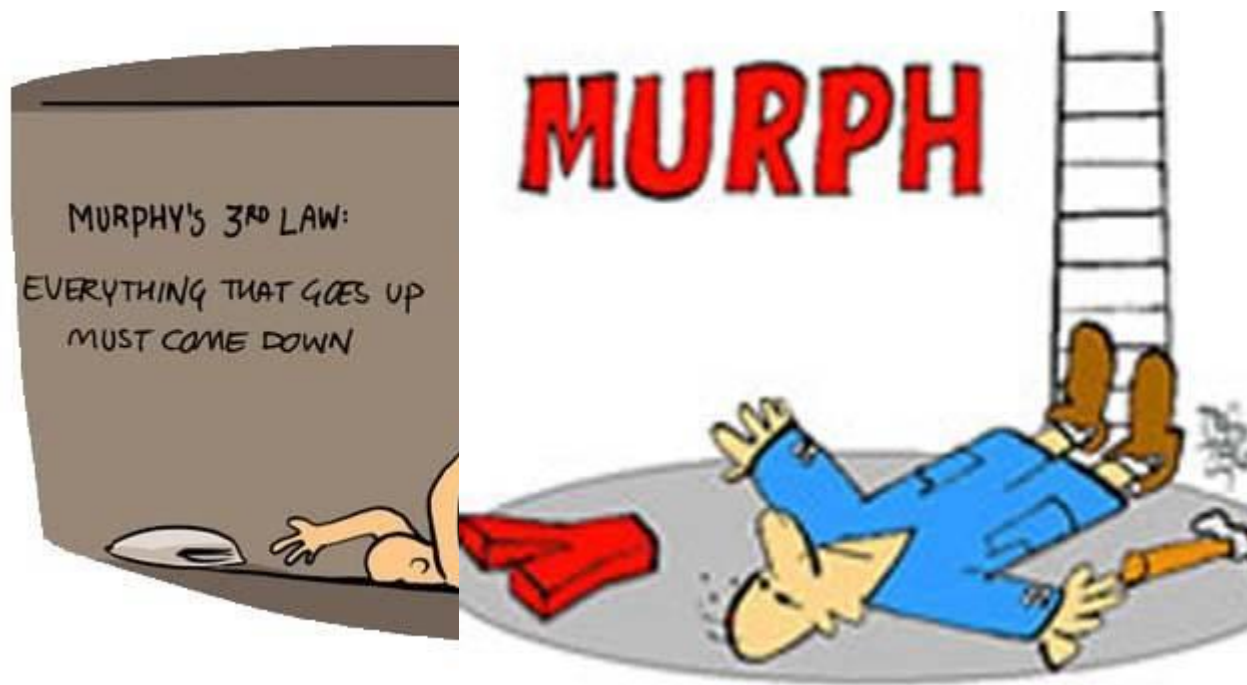
# Murphy's Law

- If something can go wrong, it will



# Murphy's Law

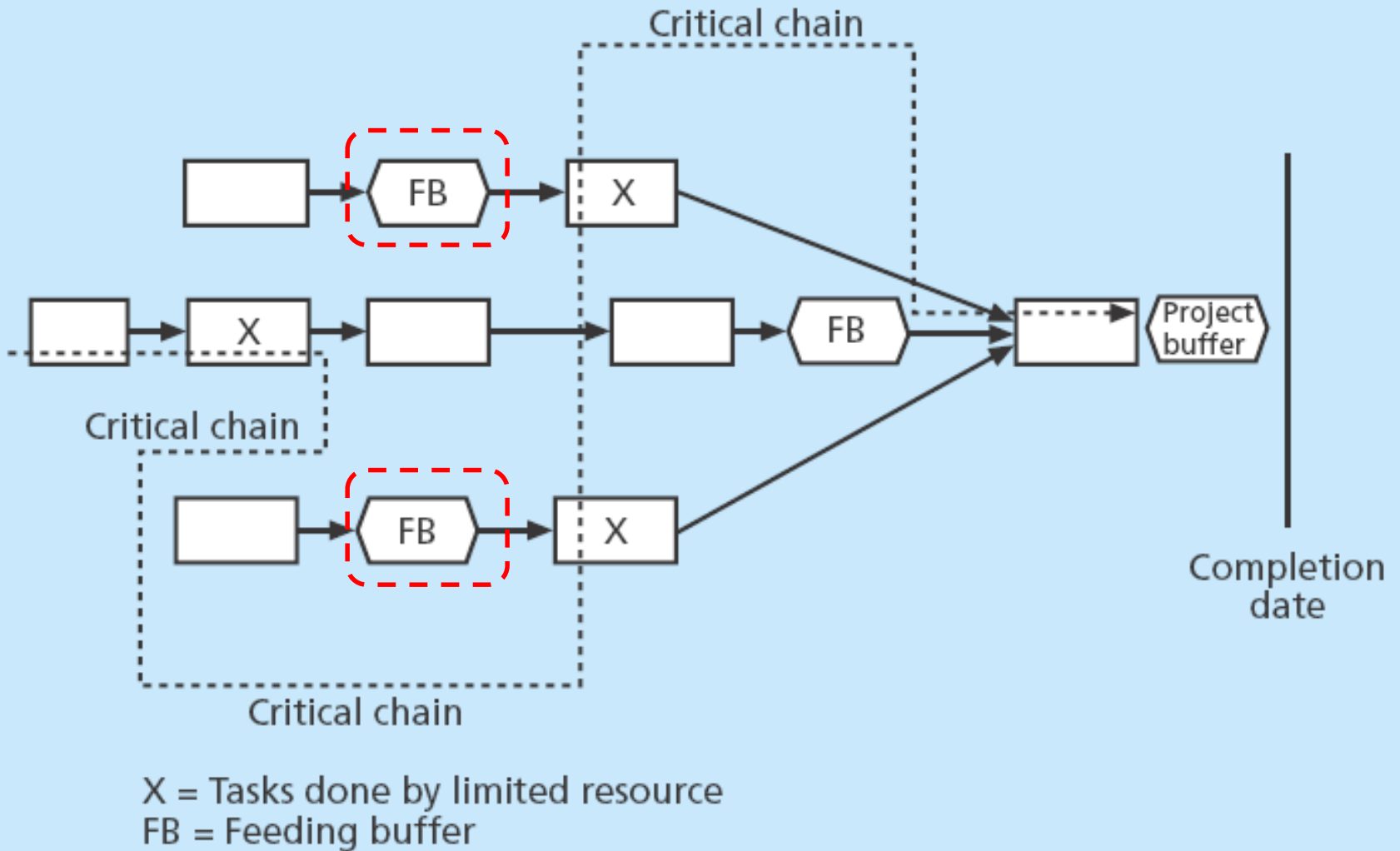
- If something can go wrong, it will



# Murphy's Law

- If something can go wrong, it will





Source: Eliyahu Goldratt, *Critical Chain*



# Parkinson's Law

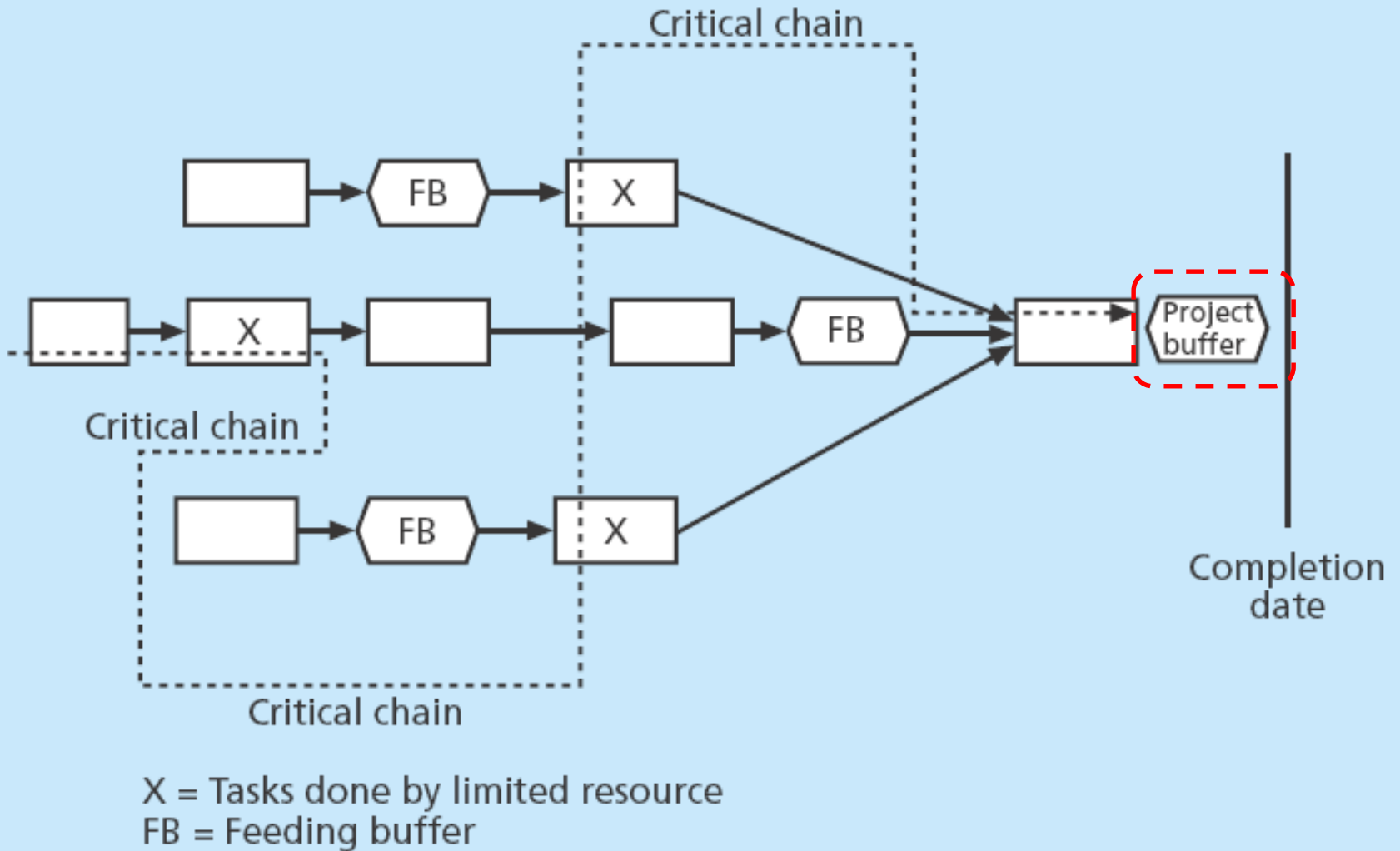
Work expands so as to fill the time available for its completion.



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Tsinghua University



Source: Eliyahu Goldratt, *Critical Chain*



# Output

- Project schedule
- A schedule baseline
- Schedule data
- Project calendars
- Project management plan updates
- Project documents updates





# Milestone Schedule

Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1.MB	Begin New Product Z	0	◆				
1.1.1.M1	Complete Component 1	0			◆		
1.1.2.M1	Complete Component 2	0			◆		
1.1.3.M1	Complete Integration of Components 1 & 2	0					◆
1.1.3.MF	Finish New Product Z	0					◆

← Data Date





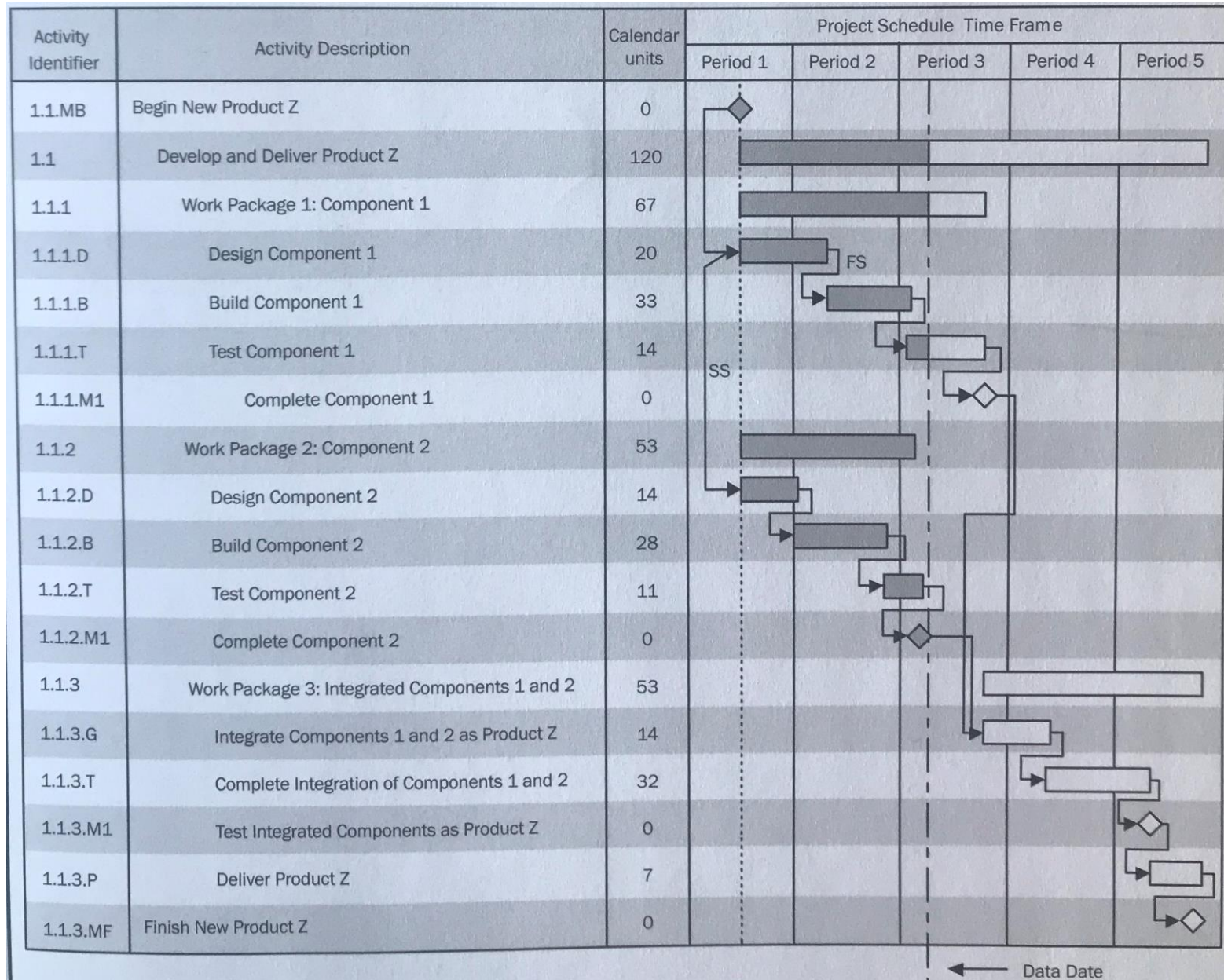
# Summary Schedule

Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1	Develop and Deliver New Product Z	120					
1.1.1	Work Package 1: Component 1	67					
1.1.2	Work Package 2: Component 2	53					
1.1.3	Work Package 3: Integrated Components 1 and 2	53					

← Data Date



# Detailed Schedule



# Agile and Time Management

Two values of agile software development:

- “customer collaboration over contract negotiation” and
- “responding to change over following a plan.”

The emphasis was on completing some useful work for the customer in short time increments versus trying to define all the work required first and then scheduling when it could be done





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# Control Schedule

The process of monitoring the status of project to update the project schedule and manage changes to the schedule baseline.

Inputs	Tools & Techniques	Outputs
<ol style="list-style-type: none"><li>1. Project management plan</li><li>2. Project documents</li><li>3. Work performance data</li><li>4. Organizational process assets</li></ol>	<ol style="list-style-type: none"><li>1. Data analysis</li><li>2. Critical path method</li><li>3. Project management information system</li><li>4. Resource optimization</li><li>5. Leads and lags</li><li>6. Schedule compression</li></ol>	<ol style="list-style-type: none"><li>1. Work performance information</li><li>2. Schedule forecasts</li><li>3. Change requests</li><li>4. Project management plan</li><li>5. Project documents updates</li></ol>

Key benefit: the schedule baseline is maintained throughout the project



# Concerns

- Determining the current status of the project schedule
- Influencing the factors that create schedule changes
- Reconsidering necessary schedule reserves
- Determining if the project schedule has changed
- Managing the actual changes as they occur





# Tools and Technologies

- Performance reviews, where progress reports are often provided
- A schedule change control system
- A scheduling tool and/or project management software
- Variance analysis, such as analyzing float or slack and using earned value
- What-if scenario analysis, which can be done manually or with the aid of software
- Adjusting leads and lags
- Schedule compression, such as crashing and fast tracking
- Resource optimization techniques, such as resource leveling



# Reality Check

- Review the draft schedule, prepared a more detailed schedule and get stakeholders' approval
- Progress meetings with stakeholders
- Discipline: setting firm date

**Work is completed as planned or changes are reported as needed**

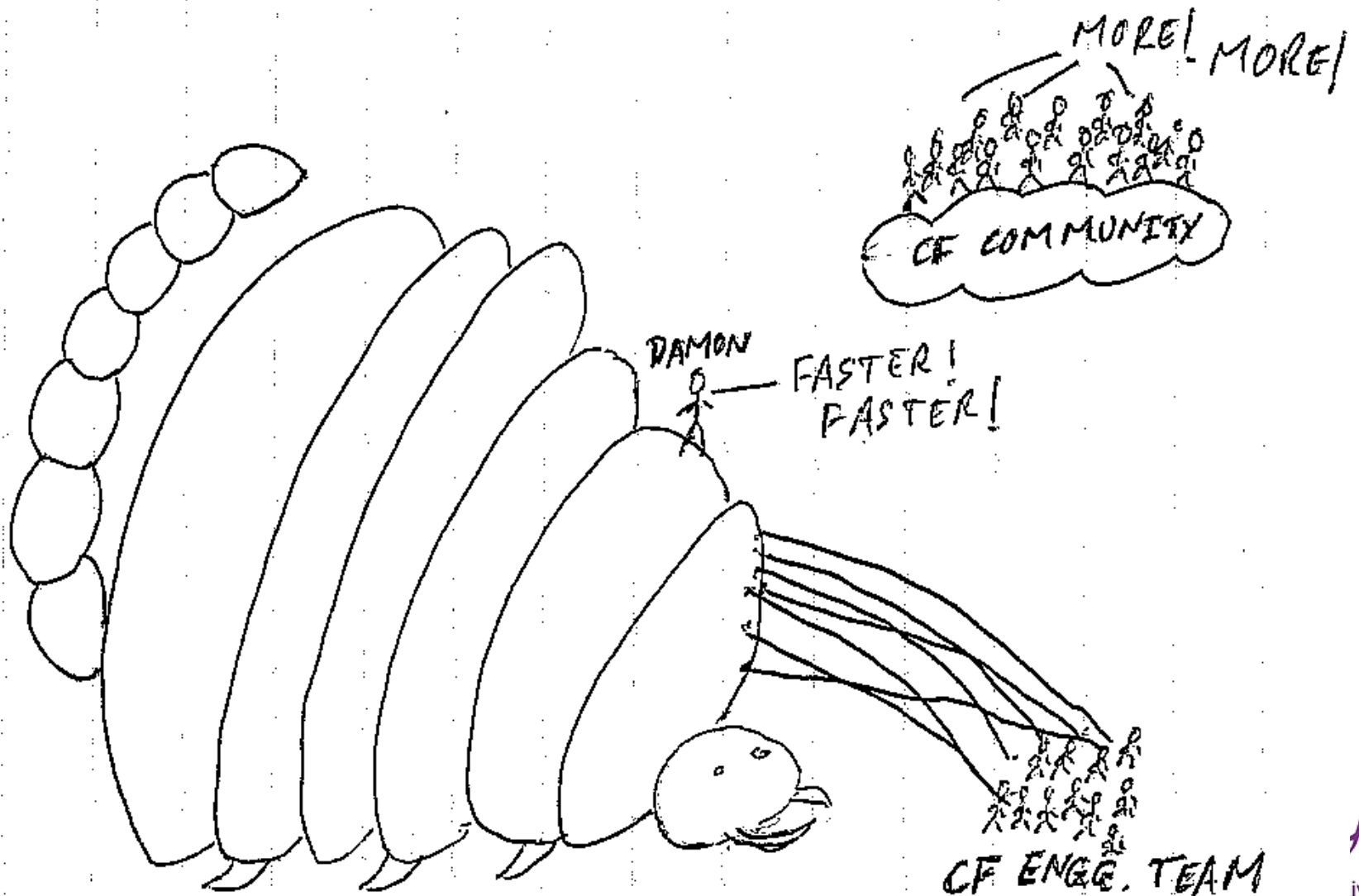




# Death March



# Death March



# Death March



**Go south by driving the chariot north**



# Death March



**“This is a major project of utmost importance, but it has no budget, no guidelines, no support staff, and it’s due in 15 minutes. At last, here’s your chance to really impress everyone!”**



# Chaos Theory

No single resource is utilized more than 75 percent

75%



# Control Schedule in Agile Approach

- Determining the current status of the project
- Conducting retrospectives for correcting processes and improving, if required
- Reprioritizing the remaining work plan (backlog)
- Determining the rate at which the deliverables are produced, validated, and accepted in the given time per iteration
- Determining that the project schedule has changed
- Managing the actual changes as they occur





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# Microsoft Project

- Draw network diagram
- Determine the critical path
- Create Gantt charts
- Report, view, and filter specific project time management information





# Words of Caution

- Establish dependencies instead of reentering all of the dates
- Set a baseline instead of spending one day every week copying and pasting information from Project into a spreadsheet and using complicated “IF” statements to figure out what activities were behind schedule
- Rely too much on templates and ignore unique concerns for their particular projects





# Contents

- The Importance of Project Schedules
- Plan schedule management
- Define Activities
- Sequence Activities
- Estimate Activity Durations
- Develop Schedule
- Control Schedule
- Use Software to Assist PTM
- Other Scheduling Methods

# Iterative Scheduling with A Backlog

- Rolling wave planning based on adaptive life cycles such as the agile approach for product development
- Used
  - deliver incremental value to the customer
  - multiple teams can concurrently develop a large number of features that have few interconnected dependencies
- Benefit: it welcomes changes throughout the development lifecycle



Does the critical path matter?



# On-demand Scheduling

- Based on the theory-of-constraints and pull-based scheduling concepts
- Balance demand against the team's delivery throughput
- Do not rely on a schedule that was developed previously
- Pull work from a backlog or intermediate queue of work to be done immediately as resources become available
- Tasks may be made relatively similar in size and scope or can be bundled by size and scope





# Thanks!



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