SWEN90016
Software Processes & Project Management

Formal Project Scheduling

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2020 – Semester 1
Lecture 4

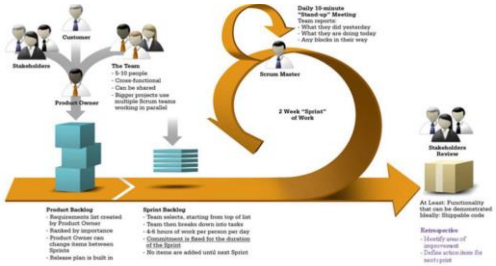
RECAP

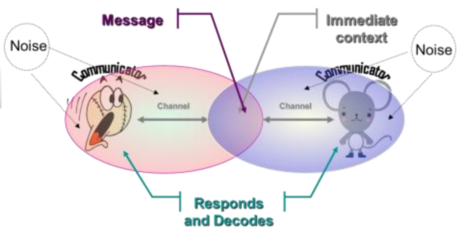
PROJECT

A temporary endeavour to create a unique product, service or outcome.

- Introduce **CHANGE** to the organization
- **TEMPORARY -** defined beginning and end
- **CROSS-FUNCTIONAL**
- Deals with the **UNKNOWN**
- **UNIQUE**
- They all vary in **SIZE**– 🚹 / 🚹 , $’s and 🕓

PROCESSES





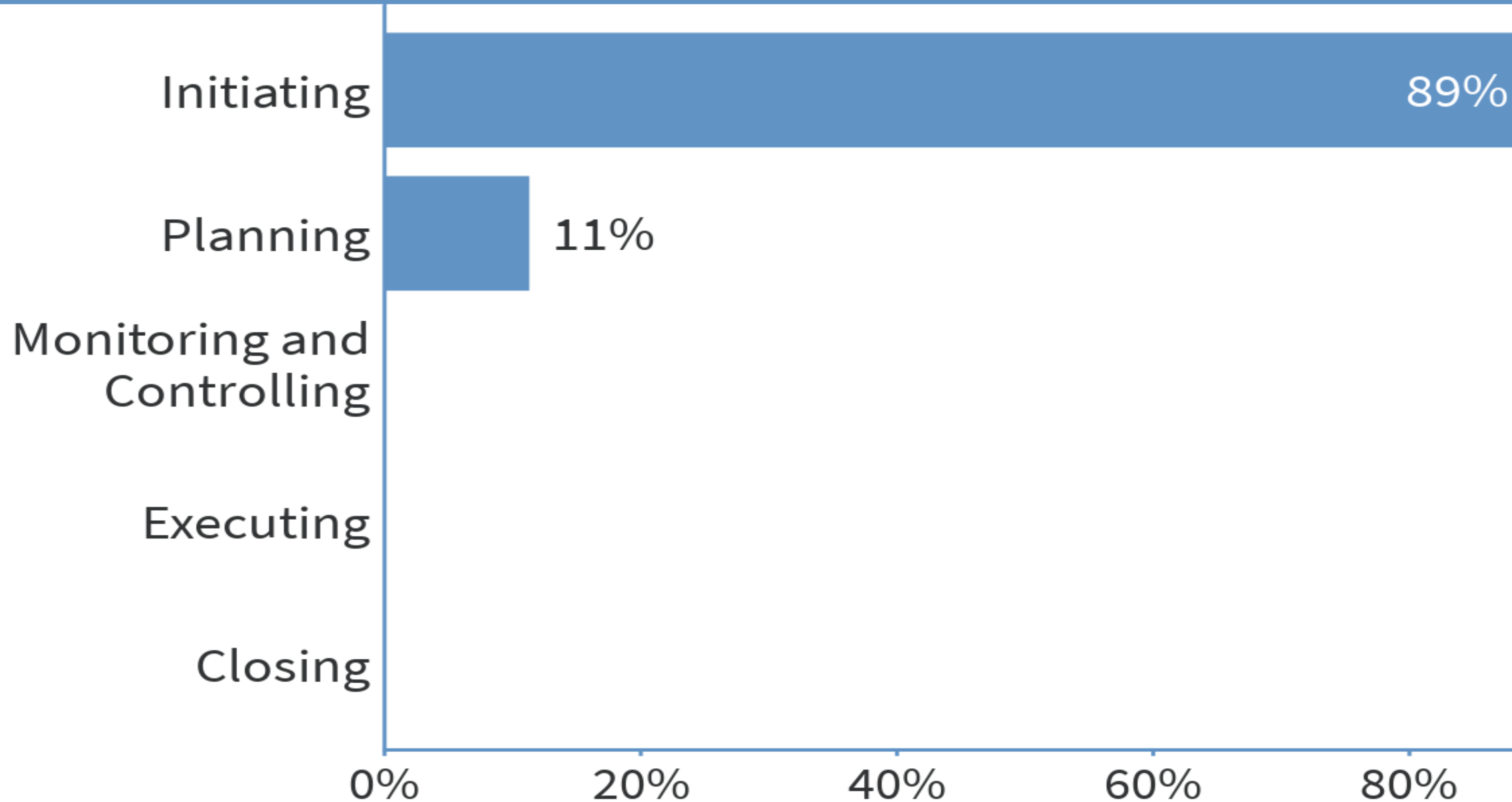
PEOPLE

- **Individuals**
- **Teams**
- **Communication**

What we are going to learn?

How to combine these ingredients: the project, the processes and the people to ***plan, execute***, ***monitor*** *and* ***control*** *a project*.

In what stage of the project management life cycle is the Project Charter developed?



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Project Statistics from Lecture 1

History tells us we have failed.

ALL IT PROJECTS					
	2011	**2012**	**2013**	**2014**	**2015**
Successful	29%	27%	31%	28%	29%
Challenged	49%	56%	50%	55%	52%
Failed	22%	17%	19%	17%	19%

- ***Successful:*** project is completed on-time and on-budget, with all features and functions as initially specified.
- ***Challenged:*** completed and operational but over-budget, over the time estimate or offers fewer features and functions than planned.
- ***Failed:*** project is cancelled at some point during the development cycle.

Standish Group Chaos Reports: Source: Standish Group 2015 Chaos Report www.projectsmart.co.uk/white-papers/chaos-report.pdf

Challenged Projects – why?

1. Lack of a Scope Document
   – Changing scope and requirements is one of the main reasons for project failure; making a detailed scope document that highlights all the stakeholders' requirements is imperative for successful project delivery

2. Inconsistent Communication
   – 57% of projects failed due to poor communication
   – Having a good communication plan up front is critical

3. Unrealistic Expectations and Deadlines
   – 60% of failed projects have a deadline of less than a year

4. Incompetent Project Manger and Team
   – 80% of successful projects are managed by certified project managers

Challenged projects – why?

5. Lack of cohesion between team members
   – Team members should have the same goals and must move towards these goals

6. Poor Monitoring and Risk Management
   – Many projects fail due to not paying enough emphasis on risk and managing them

7. Poor Planning
   – 40% of projects fail due to poor planning and lack of resources

   Every minute you spend in planning saves 10 minutes in execution; this gives you a 100% return on energy!

http://www.it-cortex.com/Stat_Failure_Cause.htm
https://blog.taskque.com/causes-project-failure/

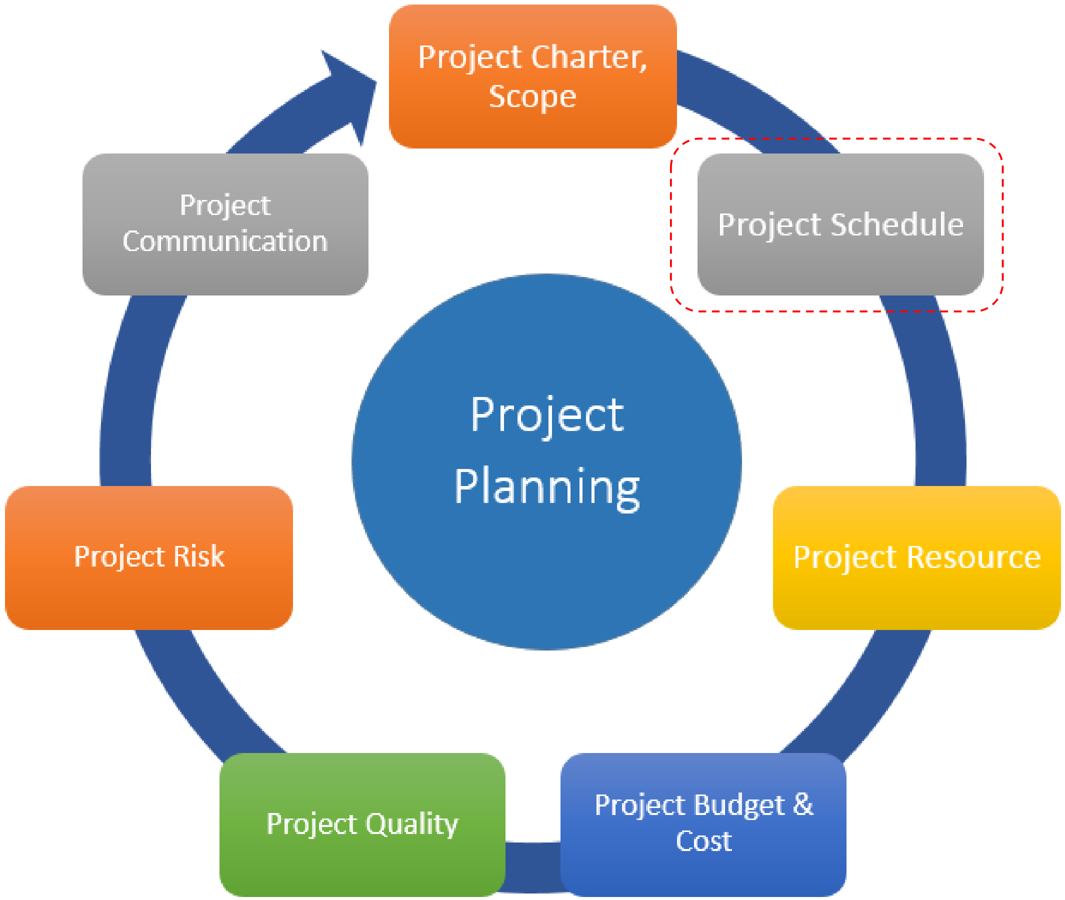
Project Planning

http://blog.zilicus.com/software-project-management-activities-roles/

Project Planning

- Project Management begins with a set of activities -collectively called *Project Planning*
  - Project Scheduling (Lecture 4)
  - Cost Estimation (Lecture 6)
  - Risk Management (Lecture 3)
  - Quality Management
  - Configuration Management (Change Management)
  - Resource Management
  - Communication Management(Lecture 5)

Project Planning



http://blog.zilicus.com/software-project-management-activities-roles/

Intended Learning Outcomes

1. Understand the role of a project schedule (Formal) (Module 8)

2. Understand how to develop a project schedule (Formal) (Module 8)

3. Understand how to use a project schedule to monitor and track project progress (Formal) (Module 8)

4. Understand **agile** planning principles(Module 9)

Intended Learning Outcomes

1. Understand the role of a project schedule

2. Understand how to develop a project schedule

3. Understand how to use a project schedule to monitor and track project progress

4. Understand agile planning principles

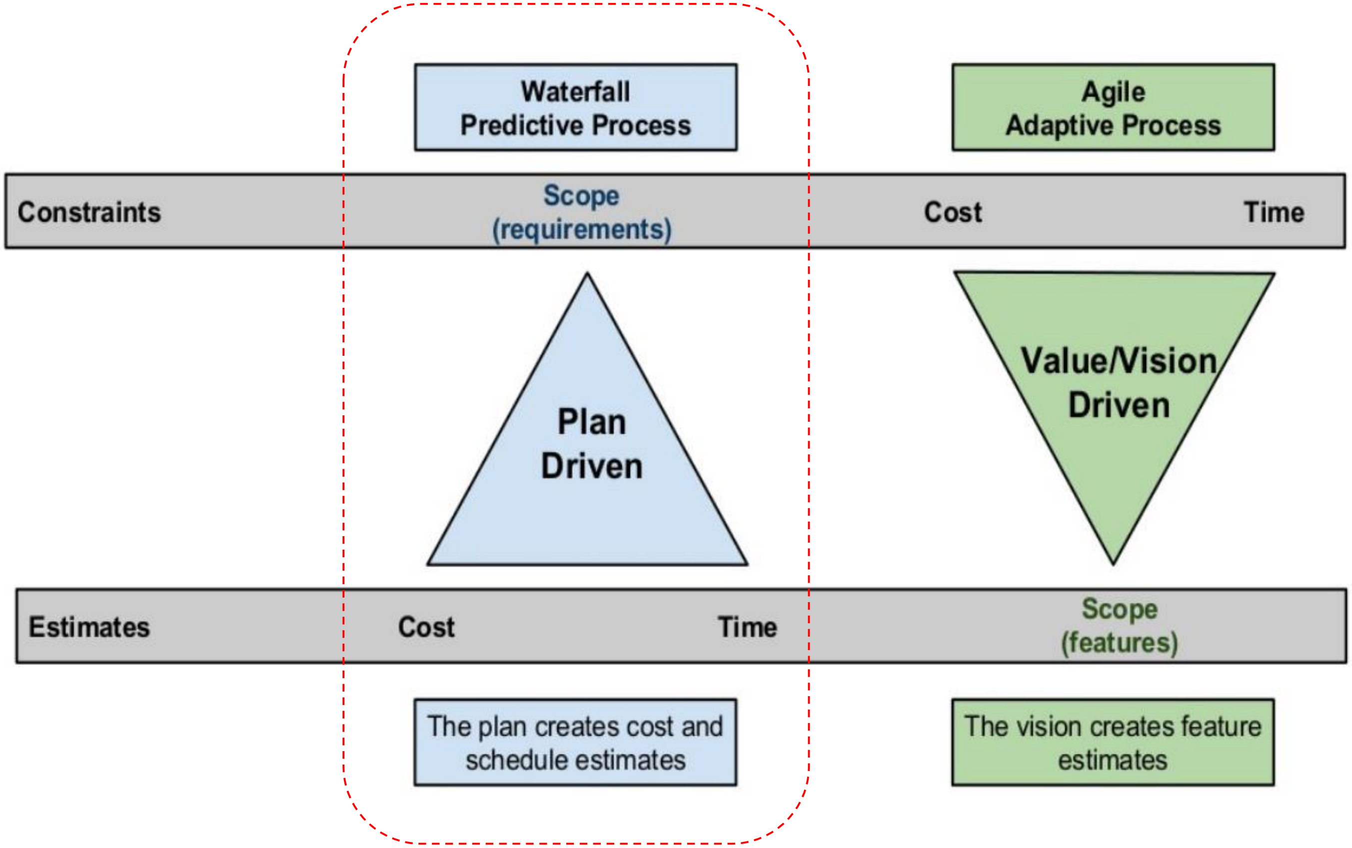
Project Schedule

- **Project Schedule:**
  - One of the important artefacts generated during the project planning phase
  - Is used and maintained throughout the project to monitor and track project progress - is a living document

- **What does the project schedule contain?**
  - Duration and dependencies for each task
  - People and physical resources required by each task
  - Milestones and deliverables
  - Project Timeline

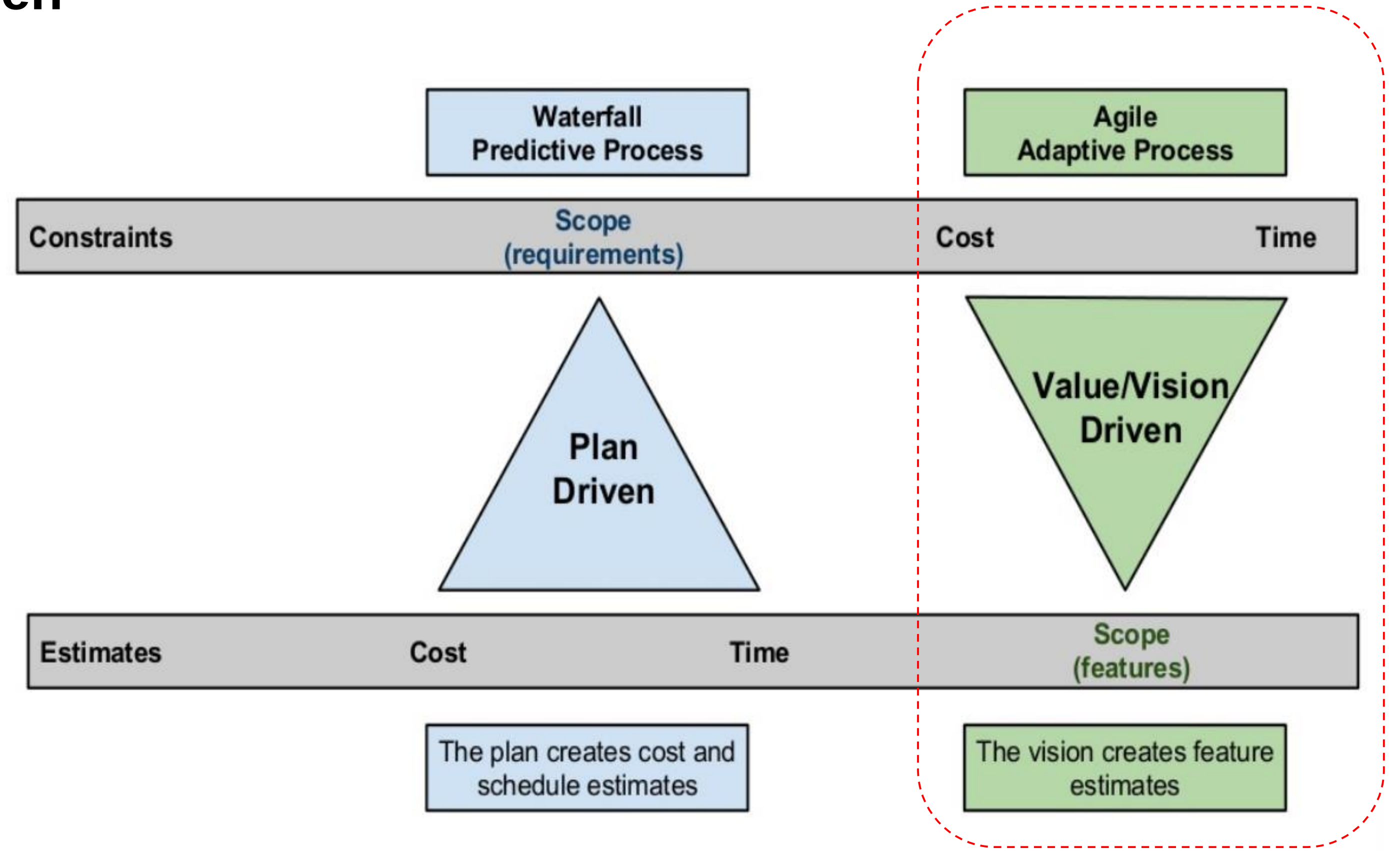
Project Schedule

Project planning and scheduling introduced in this topic apply to formal SDLC processes – Plan Driven



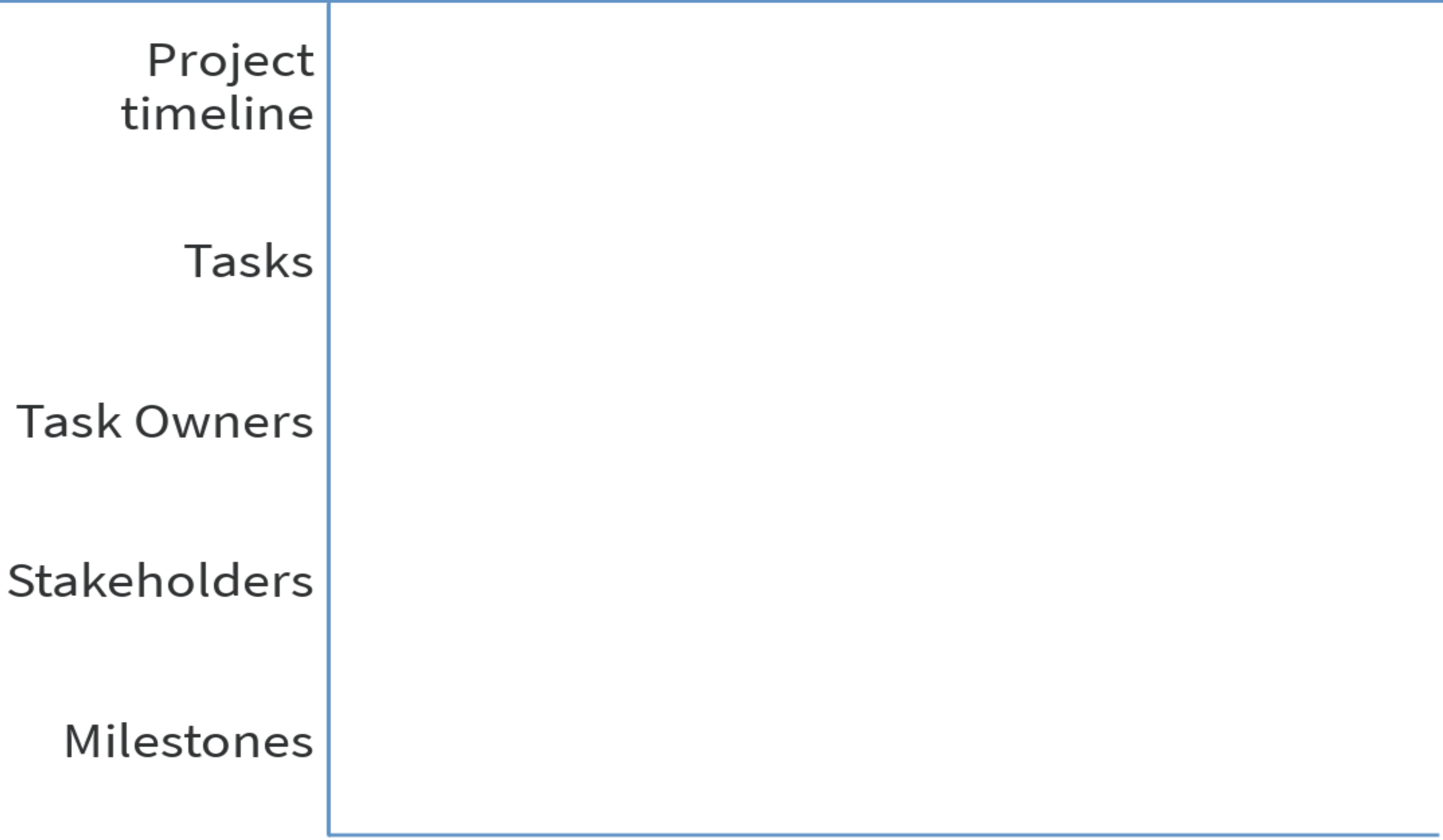
Project Schedule

Agile SDLC processes do not use a project schedule - Value/Vision Driven



Anecdotally organizations that use Agile practices also use project schedules for budgeting, contracting and reporting purposes.

Which of the following is not a part of the project schedule?



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Intended Learning Outcomes

1. Understand the role of a project schedule
2. Understand how to develop a project schedule
3. Understand how to use a project schedule to monitor and track project progress
4. Understand agile planning principles

Developing Project Schedule - Steps

1. Breakdown the task into small chunks you can deal with – Work Breakdown Structure (WBS)

2. Identify the interdependencies between the broken down tasks and develop a task network

3. Estimate the effort and the time allocation for each task

4. Allocate resources for tasks and validate effort

5. Develop the project schedule

Work Breakdown Structure – Step 1

- Planning and executing large tasks is challenging:
  - Estimating the time and resources
  - Identifying interim goals and deliverable
  - Progress monitoring

- Solution is to break the task down to manageable units:
  - Each task should have a specific outcome or a deliverable
  - Results in a Work Breakdown Structure (WBS)

Example - WBS

Redecorate Room

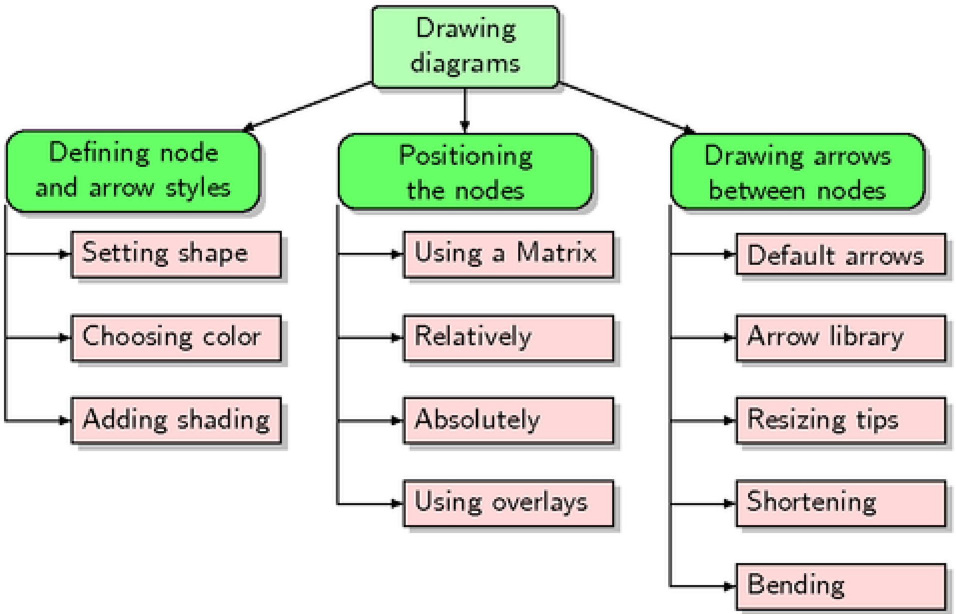
Prepare materials
- Buy paint
- Buy a ladder
- Buy brushes/rollers
- Buy wallpaper remover

Prepare room
- Remove old wallpaper
- Remove detachable decorations
- Cover floor with old newspapers
- Cover electrical outlets/switches with tape
- Cover furniture with sheets

Paint the room

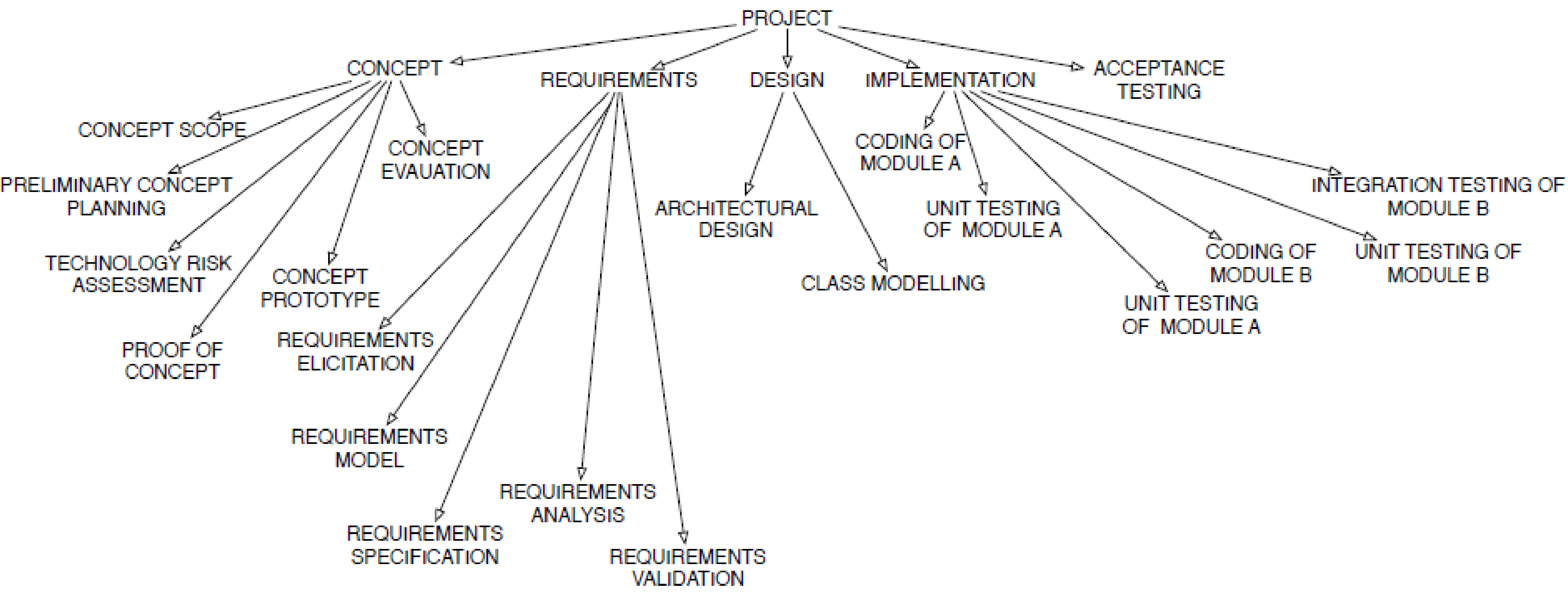
Clean up the room
- Dispose or store leftover paint
- Clean brushes/rollers
- Dispose of old newspapers
- Remove covers

http://slideplayer.com/slide/5384158/



http://texample.net/tikz/examples/work-breakdown-structure/

Example – WBS (Software Project)



Developing a Project Plan

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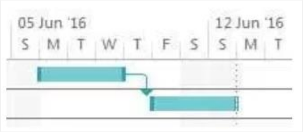
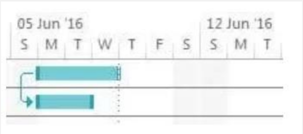
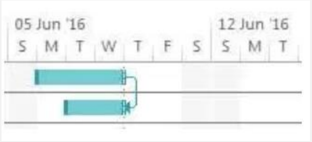
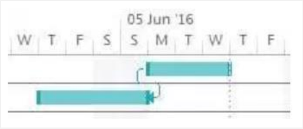
Identify Task Dependencies

- **Tasks can be:**
  - *Unconstrained:* the task can start at any time (buy paint, remove detachable decorations)
  - *Constrained:* depends on another task (cannot remove wall paper until decorations are removed)
    - If task **B** depends on task **A** (**A ->B)**
      - **B** is a Successor task (S)
      - **A** is a Predecessor task (P)
    - Remove Detachable Decorations (P) -> Remove wall paper (S)

- **Dependencies are caused by:**
  - a task needing a work product of another task
  - a task needing resources used by another task

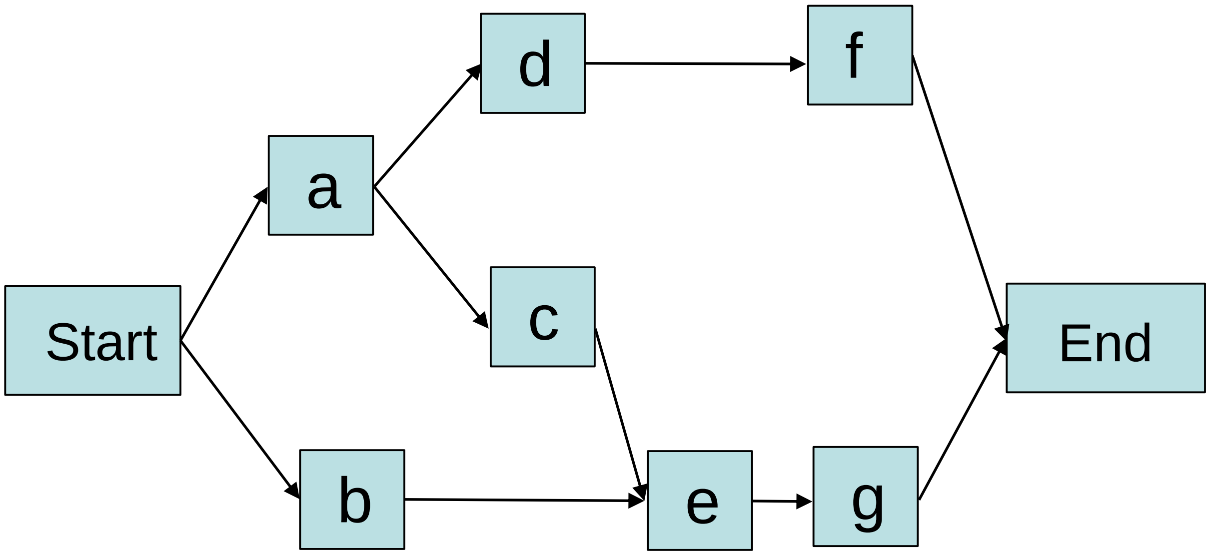
Types of Task Dependencies

Dependency	Description	Representation
Finish-to-Start	Predecessor must finish before Successor can start	
Start-to-Start	Predecessor must start before Successor can start	
Finish-to-Finish	Predecessor must finish before the Successor can Finish	
Start-to-Finish	Predecessor must start before the Successor can finish	

The most common type of dependency is the finish-to-start dependency

Task Network

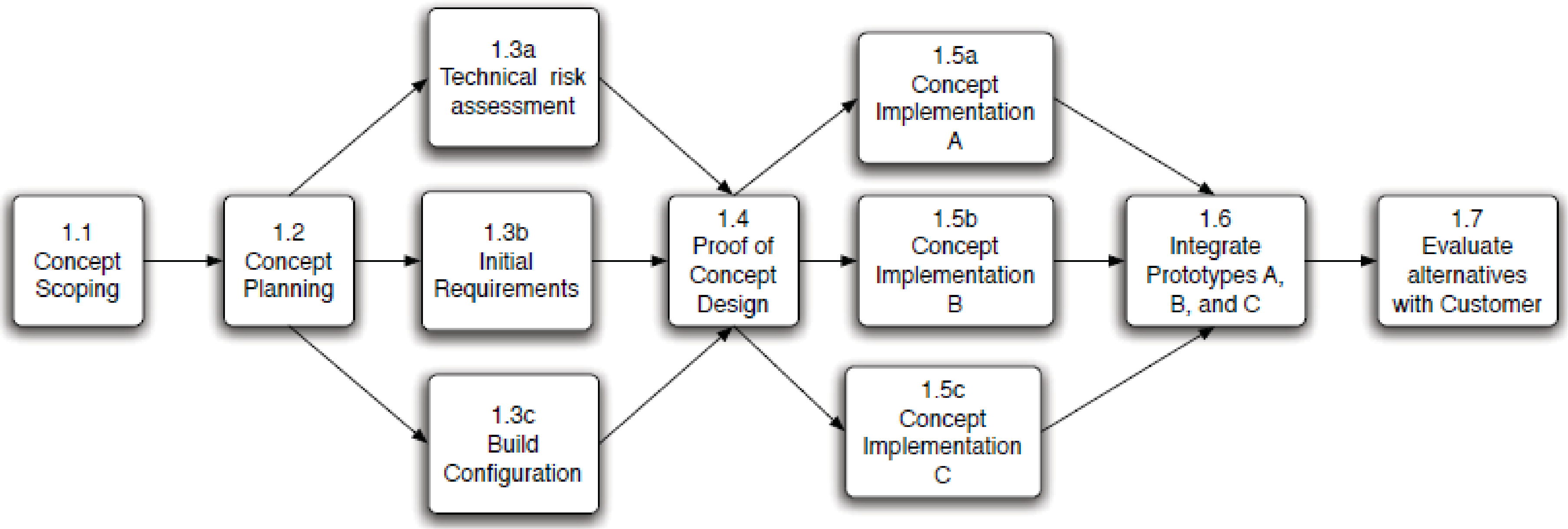
Activity	Predecessor
a	—
b	—
c	*a*
d	*a*
e	*b*, *c*
f	*d*
g	*e*



WBS – Software Project

1. Concept
   - 1.1 Concept Scope
   - 1.2 Preliminary Concept Planning
   - 1.3 Preliminary Analysis
     - 1.3a Technology Risk Assessment
     - 1.3b Initial Requirements
     - 1.3c Build Configuration
   - 1.4 Proof of Concept
   - 1.5 Concept Prototype
   - 1.6 Prototype Integration
   - 1.7 Concept Evaluation
2. Requirements
   - 2.1 Requirements Elicitation
   - 2.2 Requirements Prototype
   - 2.3 Requirements Analysis
   - 2.4 Requirements Specification
   - 2.5 Requirements Validation
3. Design
   - 3.1 Software Architecture Design
   - 3.2 Class Models
4. Implementation
   - 4.1 Coding the Client
   - 4.2 Testing the Client
   - 4.3 Coding the Server
   - 4.4 Testing the Server
   - 4.5 Integration Testing of Client with Server
5. Acceptance Testing

Task Network – Software Project



Which of the following is incorrect?

A task needing resources that another task uses creates a task dependency **A**

A task needing a work product created by another task creates a task dependency **B**

In a Start-to-Finish Successor must start before the Predecessor can finish **C**

If task B depends on task A, task B the successor and task A is the predecessor **D**

An unconstrained task can start at anytime **E**

Developing a Project Plan

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5. Develop a project schedule

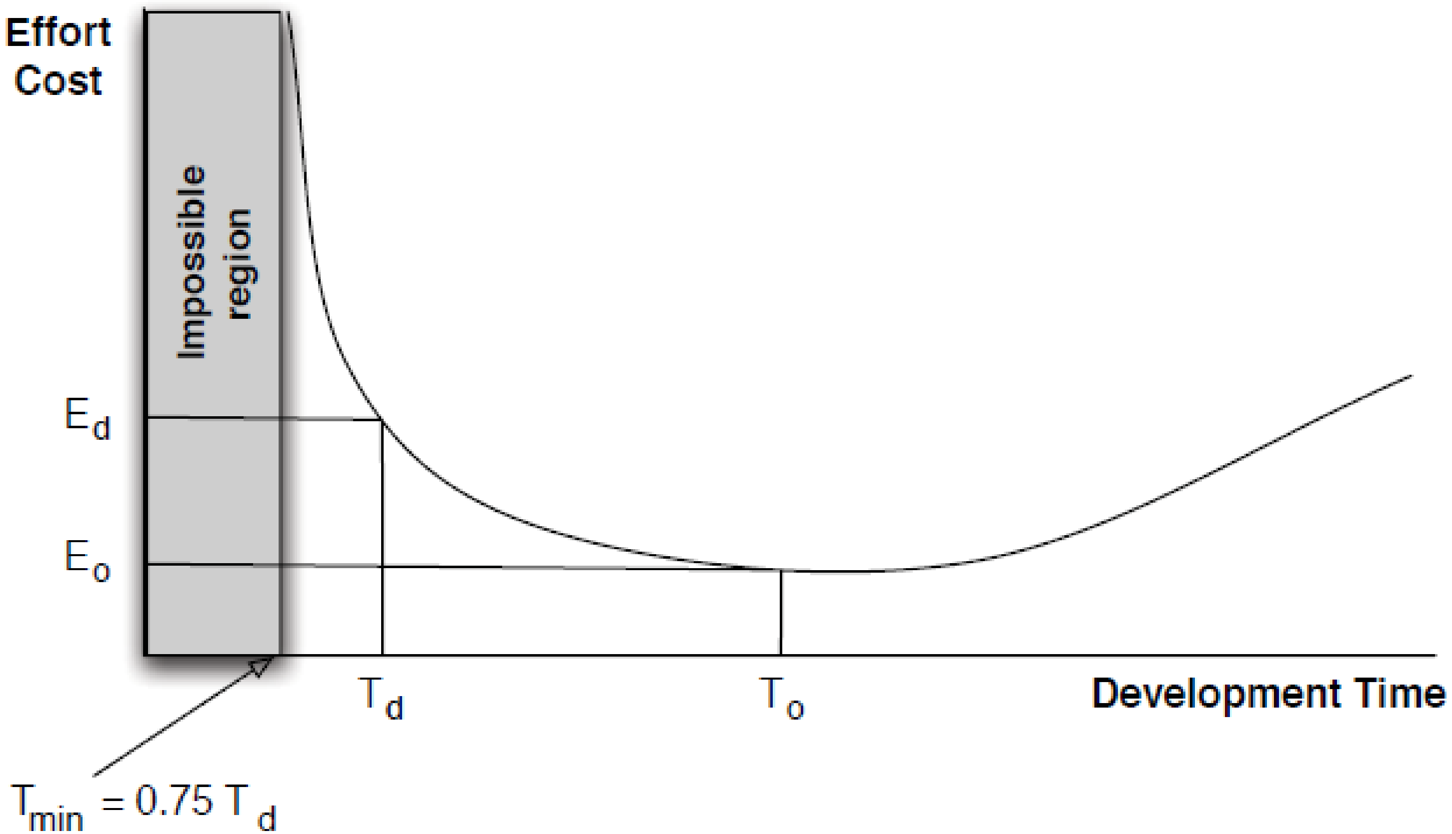
Effort-time Estimation

- **A common measure for estimating the effort for software is *man-months* (more generally *person-months*)**
  - Effort estimation will be covered in week 7

- **person-months:**
  - the time in months for a single person working full time to complete the task

- **The Mythical Man-Months [Brooks seminal paper]**
  - man-months is a misleading measure to estimate software
  - adding people to a project that is behind schedule could result in more damage than helping it

Effort vs Time



Putnam-Norden-Rayleigh curve

Time Estimation

- **Terminology**

  optimistic time - O

  pessimistic time - P

  most likely time - M

  expected time - T_E

$$T_E = (O + 4M + P)/6$$

Time Estimation

Activity	Predecessor	Time estimates			Expected time (T_E)
		Opt. (*O*)	Normal (*M*)	Pess. (*P*)	
a	—	2	4	6	4.00
b	—	3	5	9	5.33
c	*a*	4	5	7	5.17
d	*a*	4	6	10	6.33
e	*b*, *c*	4	5	7	5.17
f	*d*	3	4	8	4.50
g	*e*	3	5	8	5.17

Developing a Project Plan

1. Breakdown the task into small chunks you can deal with – Work Breakdown Structure (WBS)

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Resource Allocation

- If the effort (person-months) and the time are known, the number of personnel can be computed as:

$$N = \frac{Effort}{T}$$

- Assigning people to tasks
  - Although computing the number of personnel required for each task appears simple, resource allocation is complicated task
  - The project manager has to carefully consider the expertise of the people, and the availability of them for tasks, which might require validation and adjustment of the schedule

Developing a Project Plan

1. Breakdown the task into small chunks you can deal with – Work Breakdown Structure (WBS)
2. Identify the interdependencies between the broken down tasks and develop a task network
3. Estimate the effort and the time allocation for each task
4. Allocate resources for tasks and validate effort
5. Develop a project schedule

Project Schedule

- **Project Schedule will answer two important questions not answered so far:**
  - How long will the system take to develop?
  - How much will it cost?

- **Two widely used graphical notations to represent the Project Schedule**
  - Gantt charts
    - A bar chart that shows the schedule against a calendar
  - PERT (Program Evaluation and Review Technique) charts
    - An activity network that shows the dependencies among tasks and the *critical path*

Project Scheduling - Definitions

Term	Description
Activity (Task)	Is part of a project that requires resources and time
Milestone	Is the completion of an activity that provides evidence of a deliverable completion or end of a phase – is an event that takes zero time
Free float (free slack)	Is the amount of time that a task can be delayed without causing a delay to subsequent tasks
Total float (total slack)	Is the amount of time that a task can be delayed without delaying project completion
Critical path	Is the longest possible continuous path taken from the initial event to the terminal event
Critical activity	Is an activity that has total float equal to zero

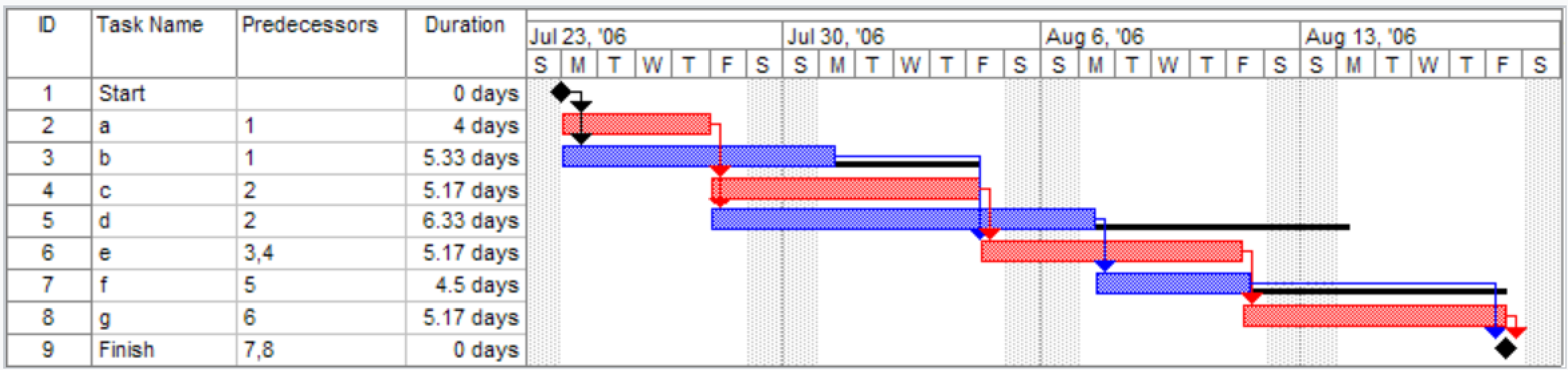
Milestones vs Deliverables

- **Milestones**
  - Mark specific points along a project timeline
  - These points may signal anchors such as:
    - a project start and end date
    - a need for external review
    - start and end of a phase
    - a completion of a deliverable
- **Deliverable**
  - Specific artefacts that are of interest
  - Examples of deliverables include:
    - Project documents such as the Project Management Plan, Requirements Specification, Design Document, Test Plan etc.
    - Prototypes
    - Final application

Gantt Chart

- Was introduced by Henry Gantt in 1910
- Gantt chart is a horizontal bar chart which shows tasks against a timeline – project schedule
- Can be used to view planned activities vs progress and therefore is a useful tool for monitoring project progress

Gantt Chart

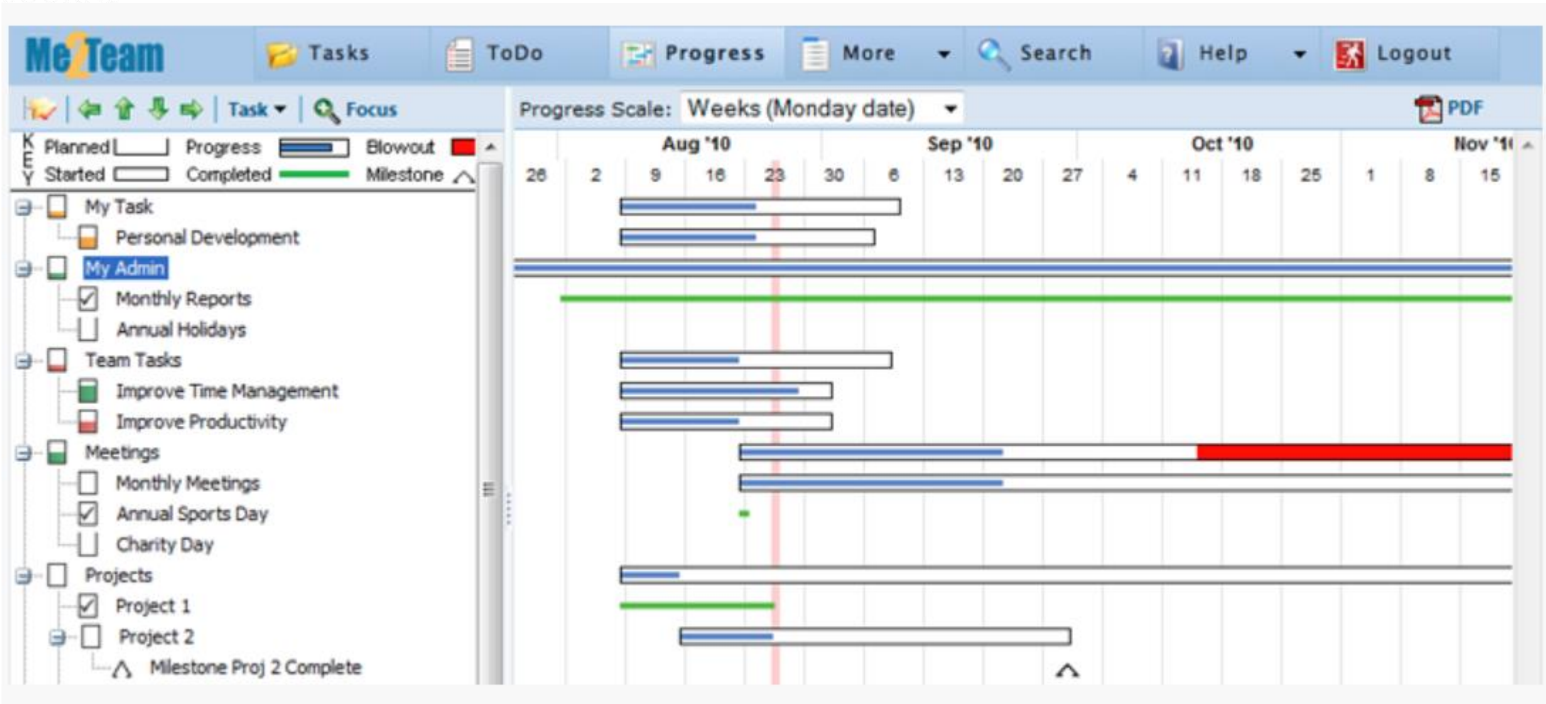


A Gantt chart created using Microsoft Project (MSP). Note (1) the critical path is in red, (2) the slack is the black lines connected to non-critical activities, (3) since Saturday and Sunday are not work days and are thus excluded from the schedule, some bars on the Gantt chart are longer if they cut through a weekend.

Linked Gantt charts

- contain lines indicating the dependencies between tasks

Gantt Chart



Progress Gantt charts

- tasks are shaded in proportion to the degree of their completion
- used for progress tracking – gives a visual representation of the progress

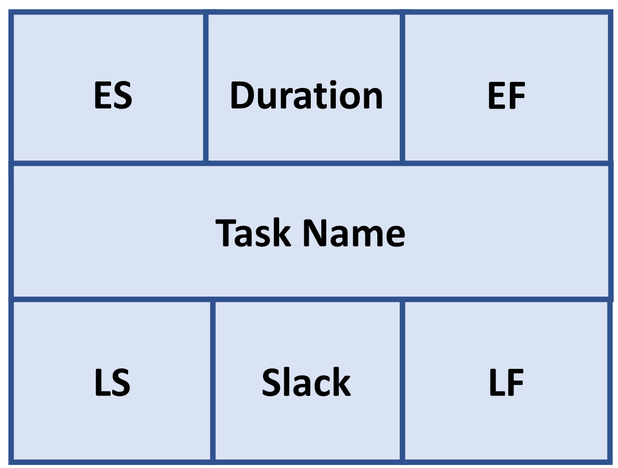
PERT Chart

- PERT (Program Evaluation and Review Technique) chart:
  - A task network which shows the dependencies along with time related information and the critical path

- PERT analysis helps:
  - understand the characteristics of the project that will let project managers do scheduling trade-offs
  - perform critical path analysis
  - monitor project progress and re-plan

PERT Chart

- Involves calculating the following estimates:
  - Earliest start time (ES)
  - Latest start time (LS)
  - Earliest finish time (EF)
  - Latest finish time (LF)
  - Slack time



PERT Chart – Example

Activity	Predecessor	Time estimates			Expected time (T_E)
		Opt. (*O*)	Normal (*M*)	Pess. (*P*)	
a	—	2	4	6	4.00
b	—	3	5	9	5.33
c	*a*	4	5	7	5.17
d	*a*	4	6	10	6.33
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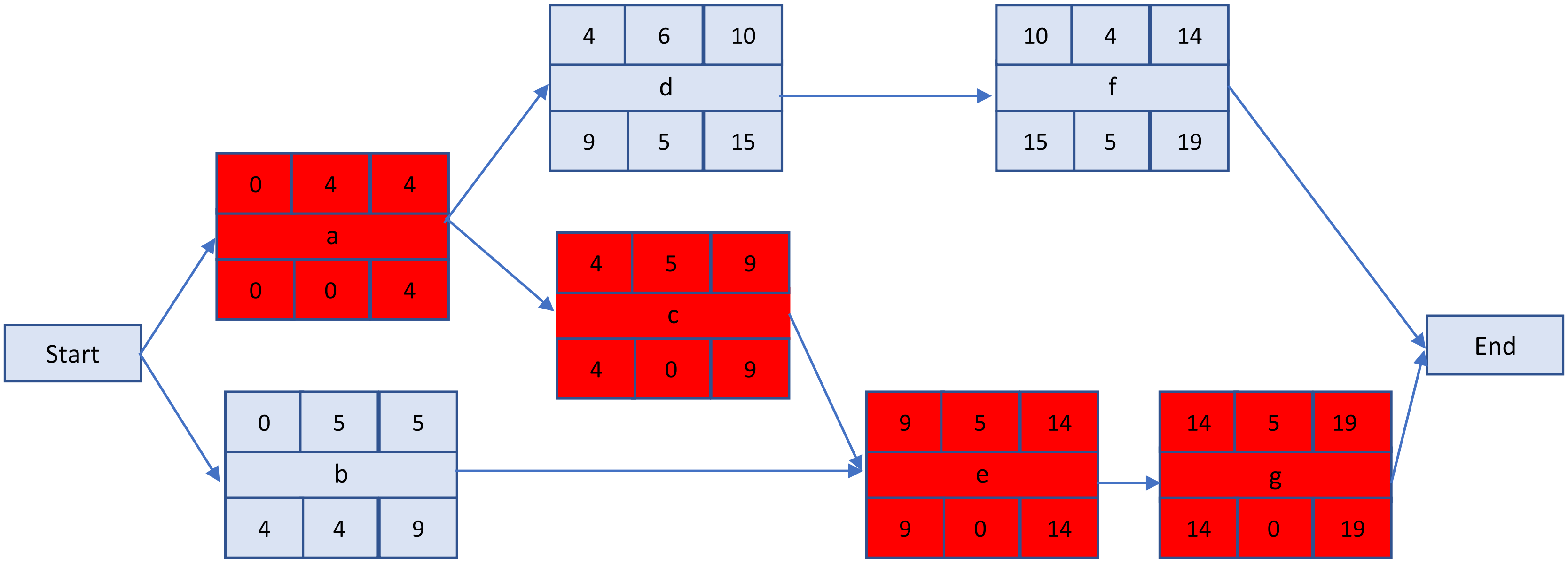
f	*d*	3	4	8	4.50
g	*e*	3	5	8	5.17

PERT Chart - Example



Critical Path: a, c, e, g
Duration: 19 days

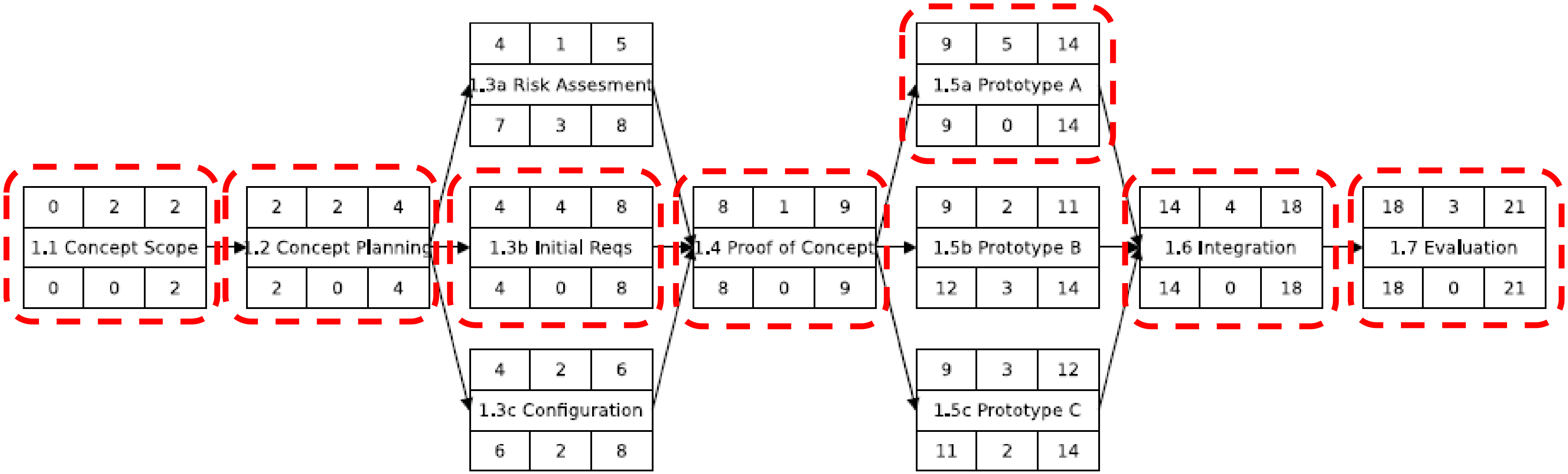
Notes:

- Critical path activities have a total free slack of 0
- Two parallel paths could be critical paths

PERT Chart Example

Task	Dependencies	Most Likely Time
1.1 Concept Scoping		2 days
1.2 Concept Planning	1.1	2 days
1.3a Technology Risk Assessment	1.2	1 day
13b Initial Requirements	1.2	4 days
13c Configuration	1.2	2 days
1.4 Proof of Concept	1.3a, 1.3b, 1.3c	1 day
1.5a Concept Prototype A	1.4	5 days
1.5a Concept Prototype B	1.4	2 days
1.5a Concept Prototype B	1.4	3 days
1.6 Prototype Integration	1.5a, 1.5b, 1.5c	4 days
1.7 Concept Evaluation	1.6	3 days

PERT Chart Example



Critical Path: 1.1, 1.2, 1.3b, 1.4, 1.5a, 1.6, 1.7

Duration: 21 days

Note: Critical path activities have a total free slack of 0

Critical Path Methods

- **Critical Path**
  - path with the longest duration
  - activities on the critical path have a total free slack of 0
  - a delay in any of the activities in the critical path will cause the project to delay

- **Crashing the project schedule**
  - shortening the total duration of the project by shortening the critical path
    - By removing the dependencies between activities in the critical path; or
    - Shortening the duration of activities in the critical path

Tools

Product	Rating	Price	Platforms	Deployments	Business Size	
Smartsheet	★★★★☆ (395)	$$$$$			S M L	Visit Website
Mavenlink	★★★★☆ (224)	$$$$$			S M L	Visit Website
Workzone	★★★★☆ (38)	$$$$$			S M L	Visit Website
inMotion	★★★★☆ (32)	$$$$$			S M L	Visit Website
Accelo	★★★★½ (3)	$$$$$			S M L	Visit Website
monday.com (formerly dapulse)	★★★★★ (606)	$$$$$			S M L	Visit Website
Workfront	★★★★☆ (425)	$$$$$			S M L	Visit Website
Freshservice	★★★★½ (341)	$$$$$			S M L	Visit Website
Wrike	★★★★☆ (745)	$$$$$			S M L	Visit Website
Airtable	★★★★★ (162)	$$$$$			S M L	Visit Website

https://www.workzone.com/blog/gantt-chart-software/

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Intended Learning Outcomes

- Understand the role the project schedule
- Understand how to develop a project schedule
- Understand how to use a project schedule to monitor and track project progress
- Understand agile planning principles

Project Tracking and Control

- **How do software projects fall behind schedule?**

  One day at a time

  – Fred Brooks, the well-known author of the seminal article Mythical Man-Months

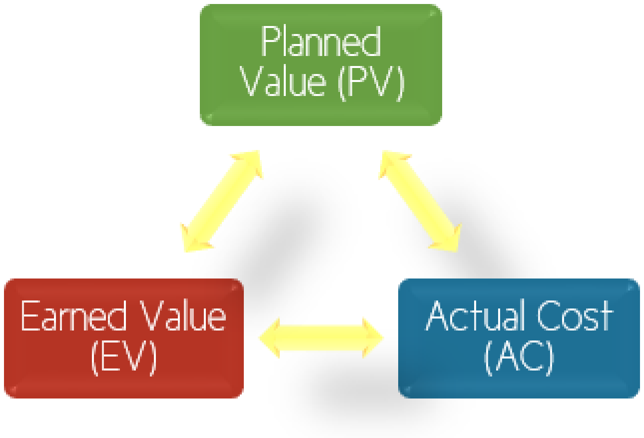
- **Project scheduling is important, but *tracking and controlling* are even more important!**

Project Tracking and Control

- How to track and control project progress?
  - Periodic meetings where team members report progress
  - Evaluating the results of reviews and audits conducted as part of the software engineering process
  - Tracking formal project milestones
  - Comparing actual start dates with scheduled start dates
  - Meeting engineers and having informal discussions
  - Using a formal method like *earned value analysis*

Earned Value Analysis (EVA)

- EVA can be used to:
  - report current/past project performance
  - predict future project performance based on current/past performance
- Results can be expressed in dollars and/or percentage



Computing EVA

- Planned Value (PV)
  - that portion of the approved cost estimate planned to be spent on the given activity during a given period
- The Earned Value (EV)
  - the value of the work actually completed
- Actual Cost (AC)
  - the total of the costs incurred in accomplishing work on the activity in a given period

EVA - Example

- Consider the following scenario:

You are assigned to manage a project that is planned to finish in 12 months, estimated to cost $100,000. At the end of the third month, based on the project Gantt chart, 20% of the work had been reported as completed. The finance department has reported the cost of the project to date as $35,000.

What is the PV?

What is the EV?

What is the AC?

EVA - Example

- Consider the following scenario:

You are assigned to manage a project that is planned to finish in 12 months, estimated to cost $100,000. At the end of the third month, based on the project Gantt chart, 20% of the work had been reported as completed. The finance department has reported the cost of the project to date as $35,000.

PV = $100,000*3/12 = $25,000 (assuming equal work distribution over the period, which may not be the case always)

EV = $100,000*20/100 = $20,000

AC = $35,000

EVA – Schedule Variance

- **Schedule Variance Analysis**
  - Uses EV and PV to calculate a variance to the project schedule

- **Schedule Variance: expressed in dollars**

$$SV = EV - PV$$
$$= 20{,}000 - 25{,}000$$
$$= (5000)$$

- **Schedule Performance Index: expressed as a fraction**

$$SPI = EV/PV$$
$$= 20{,}000/25{,}000$$
$$= 0.8$$

EVA – Cost Variance

- **Cost Variance Analysis**
  - Uses EV and AC to calculate a variance to the project schedule

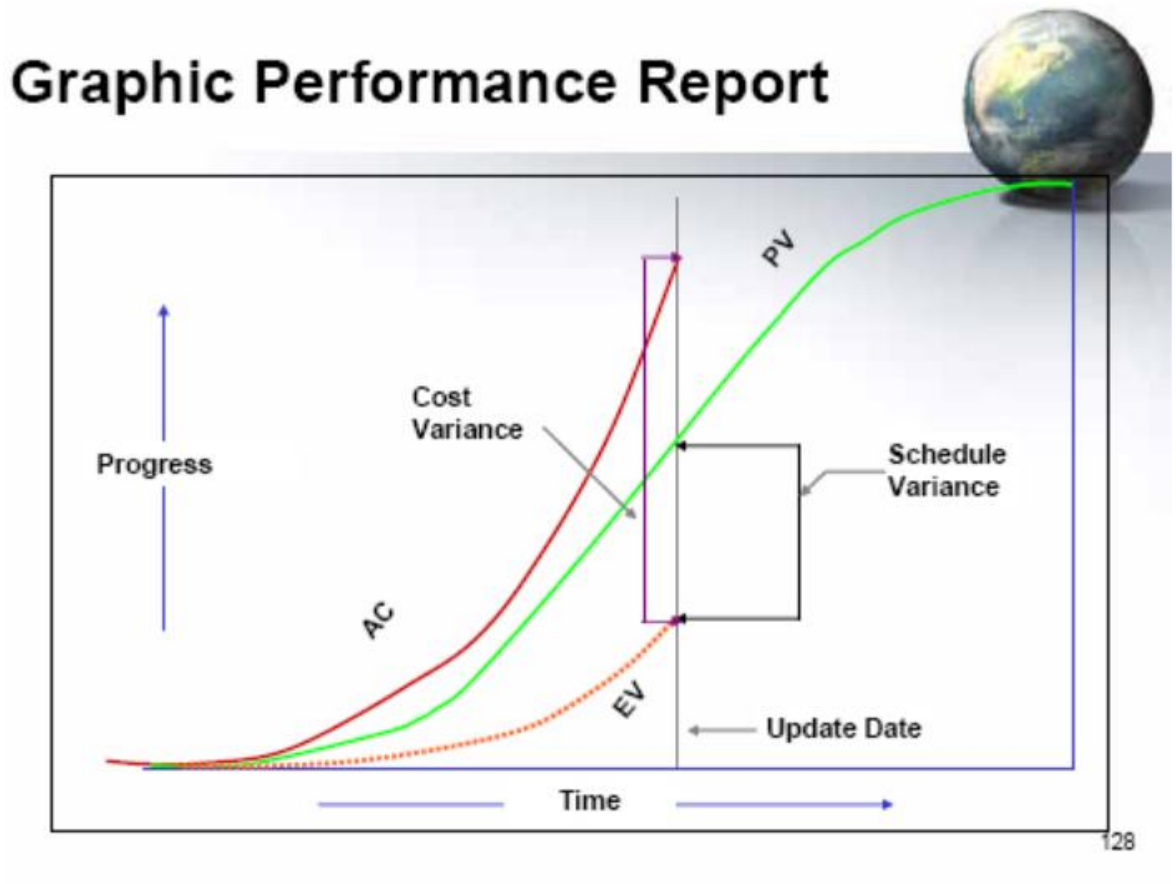
- **Cost Variance: expressed in dollars**

$$CV = EV - AC$$
$$= 20,000 - 35,000$$
$$= (15,000)$$

- **Cost Performance Index: expressed as a fraction**

$$CPI = EV/AC$$
$$= 20,000/35,000$$
$$= 0.57$$

EVA – Graphical Representation



https://www.pmi.org/learning/library/earned-value-management-systems-analysis-8026

A project planned to finish in 12 months is estimated to cost $100,000. At the end of the third month, the Project Manager computes the following: Planned Value = 15,000; Earned Value = 20,000; Actual Costs = 35,000. Which of the following is correct?

Schedule Variance is 5000 dollars

Schedule Variance is 20,000 dollars

Cost Variance is 15,000 dollars

Cost Variance is 20,000 dollars

Cost Variance is -20,000 dollars

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Intended Learning Outcomes

1. Understand the role of a project schedule

2. Understand how to develop a project schedule

3. Understand how to use a project schedule to monitor and track project progress

4. Understand agile planning principles

References

1. F. P. Brooks. The mythical man-month. In Essays on software engineering. Addison-Wesley, 1995.

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3. Kenneth S. Rubin. Essential Scrum – A Practical Guide to the Most Popular Agile Process. Addison-Wesley, 2013.