BAIT3153 Software and Project Management (SPM)

Chapter 2: Project Planning, Control and Process Models Selection

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Introduction

- Software project management begins with a set of activities that are collectively called project planning.
- Before the project can begin, the software team should estimate
  - ✓ the work to be done,
  - ✓ the resources that will be required, and
  - ✓ the time required from start to finish
- Once these activities are accomplished, the team should establish a project schedule that
  - ✓ Defines the software engineering tasks and milestones,
  - ✓ Identifies who is responsible for conducting each task, and
  - ✓ Specifies the inter-task dependencies

2.1 Project Planning and Estimation

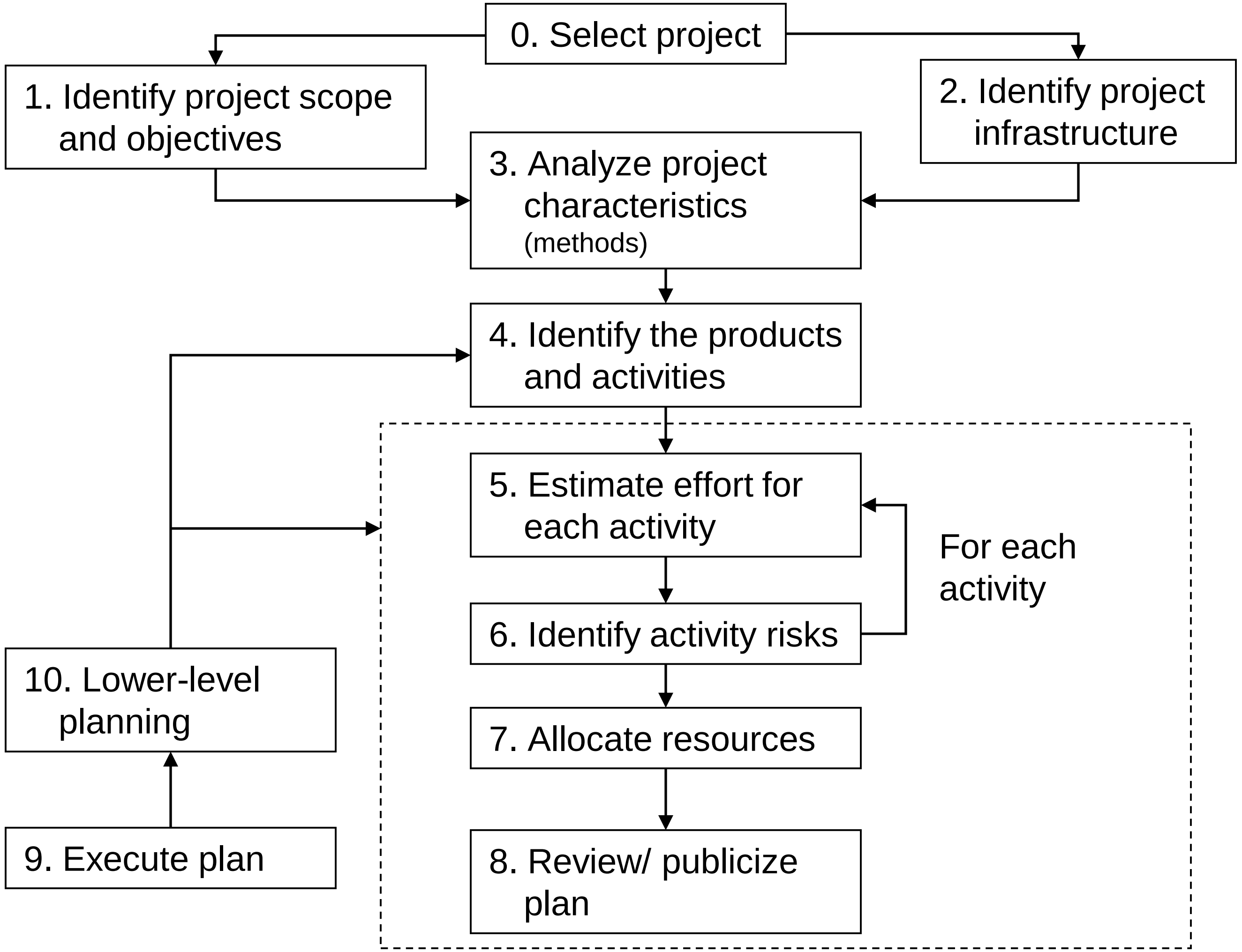
- Project Planning
- Estimations in Projects

Project Management Process Group and Knowledge Area Mapping

	Initiating	Planning	Executing	Monitoring & Control	Closing
Integration	Develop Project Charter	Develop PM Plan	Direct & Manage Project Work	• M&C Project Work • Perform Integrated Change Control	Close Project or Phase
Scope		• Plan Scope Management • Collect Requirements • Define Scope • Create WBS		• Validate Scope • Control Scope	
Time		• Plan Schedule Management • Define Activities • Sequence Activities • Estimate Activity Resources • Estimate Activity Durations • Develop Schedule		Control Schedule	
Cost		• Plan Cost Management • Estimate Costs • Determine Budget		Control Costs	
Quality		Plan Quality Management	Perform Quality Assurance	Control Quality	
HR		Plan HR Management	• Acquire Project Team • Develop Project Team • Manage Project Team		
Communications		Plan Communications Management	Manage Communications	Control Communications	
Risk		• Plan Risk Management • Identify Risks • Perform Qualitative Risk Analysis • Perform Quantitative Risk Analysis • Plan Risk Responses		Control risks	
Procurement		Plan Procurement Management	Conduct Procurements	Control Procurements	Close Procurements
Stakeholder	Identify Stakeholders	Plan Stakeholder Management	Manage Stakeholder Expectation	Control Stakeholder Engagement	

Project Planning

2.1 Project Planning and Estimation



0. Select project
1. Identify project scope and objectives
2. Identify project infrastructure
3. Analyze project characteristics (methods)
4. Identify the products and activities
5. Estimate effort for each activity
6. Identify activity risks
For each activity
7. Allocate resources
8. Review/ publicize plan
9. Execute plan
10. Lower-level planning

Steps in Project Planning

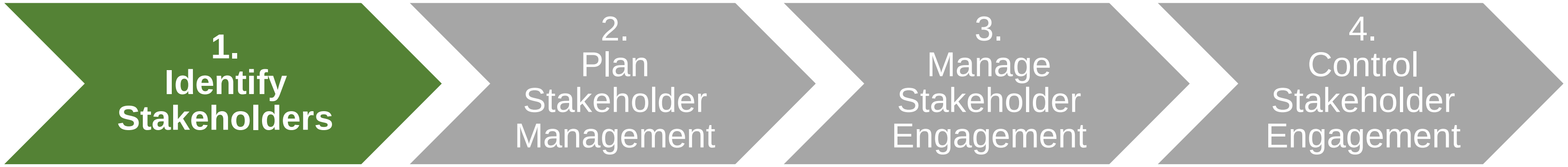
Project Plan Content

Project Planning

a. Introduction
b. Background: including reference to the business case
c. Project objectives
d. Constraints – these could be included with project objectives
e. Methods
f. Project products: both deliverable products that the client will receive and intermediate products
g. Activities to be carried out
h. Resources to be used
i. Risks to the project
j. Management of the project, including
   - Organizational responsibilities
   - Management of quality
   - Configuration management

Stakeholders

Project Planning

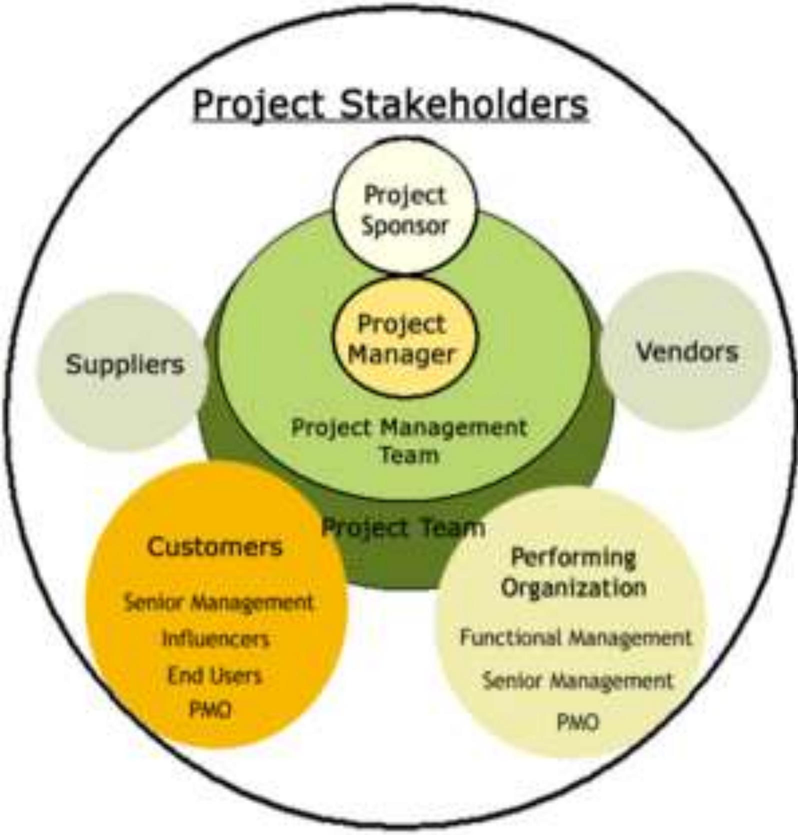

1. Identify Stakeholders

2. Plan Stakeholder Management

3. Manage Stakeholder Engagement

4. Control Stakeholder Engagement

- People who have a stake or interest in the project.
- Can be categorized as:
  - Internal to the project team – i.e., they will be under the direct managerial control of the project leader
  - External to the project team but within the same organization. E. the project leader might need the assistance of the users to carry out system testing
  - External to both the project team and the organization. E.g., customers (or users) who will benefit from the system that the project implements; contractors who will carry out work for the project.
- Different types of stakeholders may have different objectives. Thus, the project leader must recognize these different interests and to be able to reconcile them.



Setting Project Objectives

Project Planning

Appendix 2.1 Taxonomy of Project Definitions.pdf

Appendix 2.2 EVM Cheatsheet.pdf

- Among the stakeholders are those who actually own the project and control the financing of the project. Hence, they also set the objectives of the project.
- The objectives should define what the project team must achieve for project success.
- Objectives focus on the desired outcomes of the project rather than the tasks within it – they are the post-conditions of the project.

Goals are high-level, *general statements* about the aims of the project, while objectives are *detailed statements* about what the project should accomplish.

- In order to achieve the goal, we must achieve certain objectives first.
  - i.e., the objectives are steps on the way to achieve a goal.
- An effective objective for an individual must be something that is within the control of that individual.
  - e.g., an appropriate objective for software developers would be to keep development costs within a certain budget.

SMART

Project Planning

Goal : Improve Satisfaction level (Queuing System in Bank),
Objective: Reduce waiting time in the queue during peak hour.
System able to achieve above objective?

Well-defined objectives should be:

- Specific – effective objectives are concrete and well-defined. Objectives should be defined so that it is obvious to all whether the project has been successful.
- Measurable – there should be measures of effectiveness which tell us how successful the project has been.
- Achievable – it must be within the power of the individual or group (target) to achieve the objective.
- Relevant – the objective must be relevant to the true purpose of the project.
- Time constrained – there should be a defined point in time by which the objective should have been achieved.

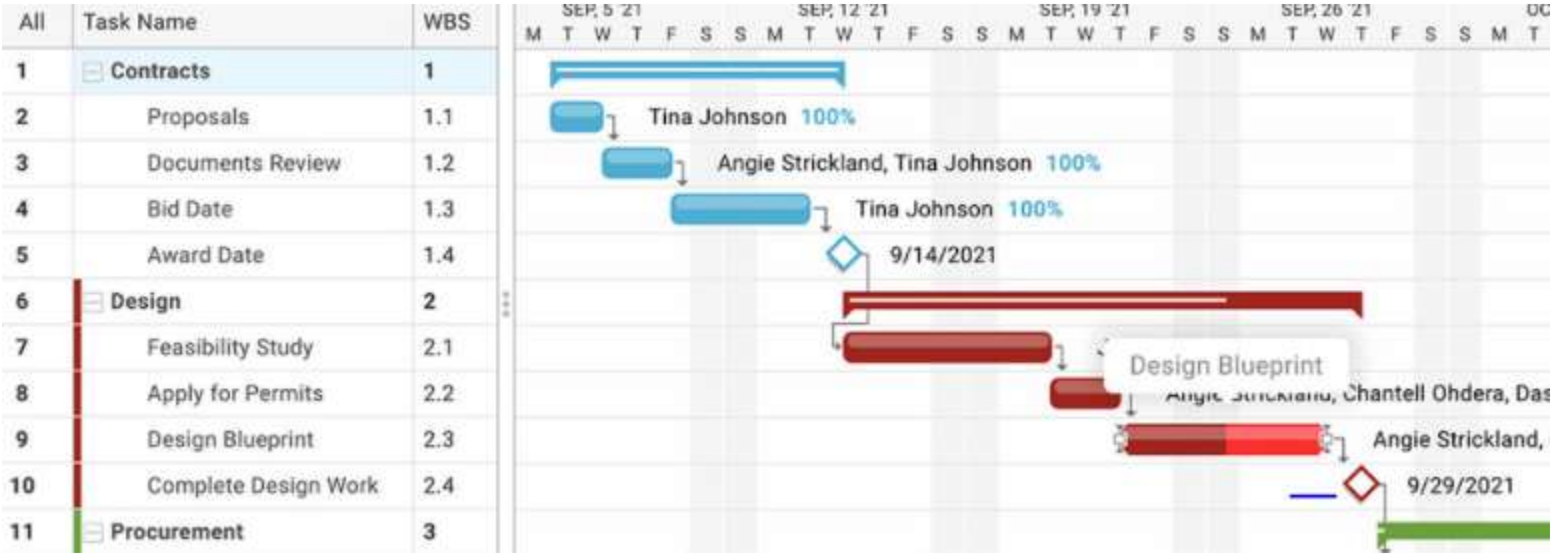
Gantt Chart

Project Planning

- A time-line chart where all project tasks are listed in the left-hand column and the horizontal bars indicate the duration of each task.
- When multiple bars occur at the same time on the calendar, task concurrency is implied.
- The diamonds indicate milestones.

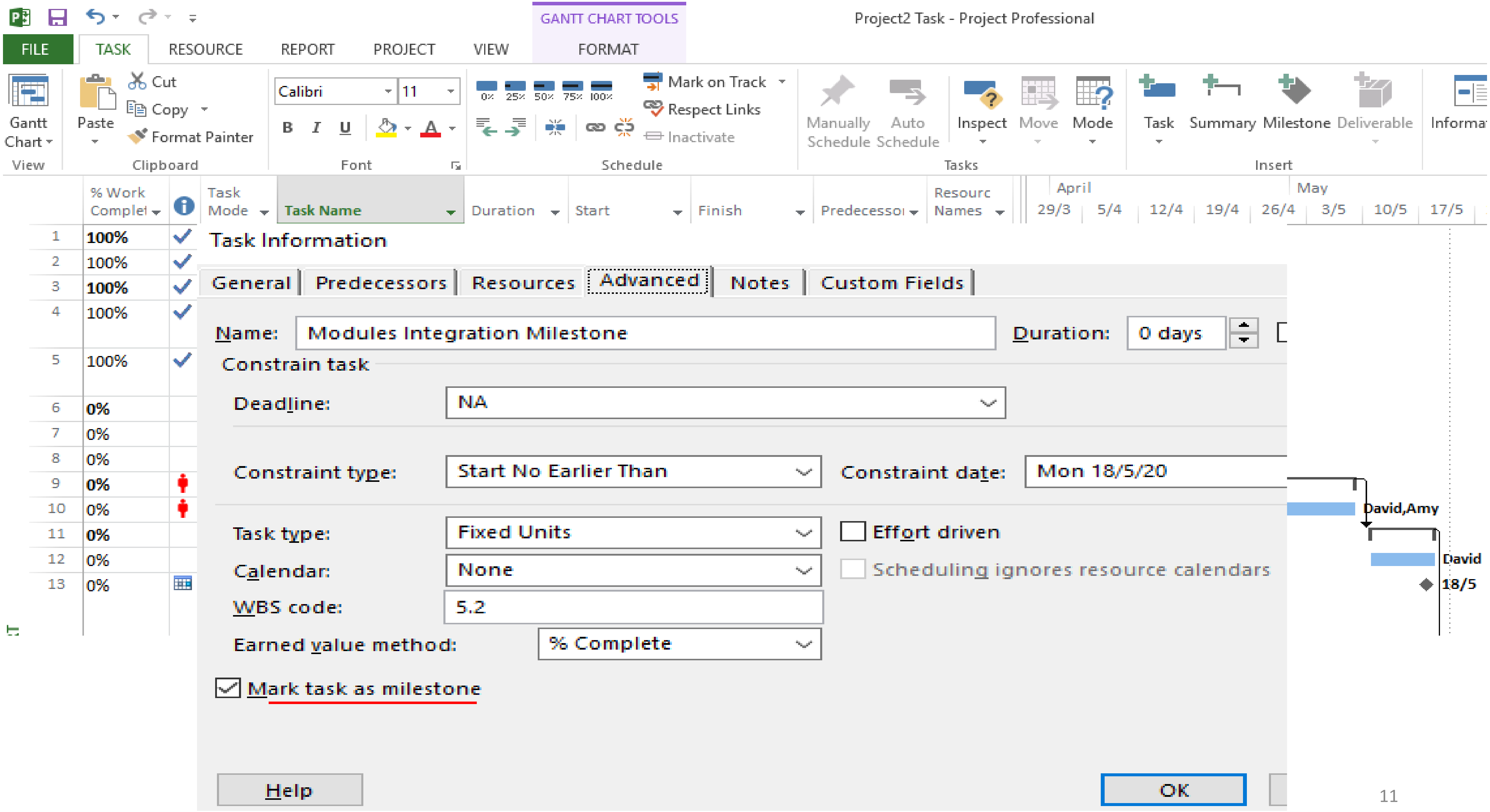
Project milestones : specific tasks that need to have done for the project within a specific amount of time

- Produces project tables (i.e. a tabular listing of all project tasks, their planned and actual start and end dates) which enable you to track progress.



All	Task Name	WBS
1	Contracts	1
2	Proposals	1.1
3	Documents Review	1.2
4	Bid Date	1.3
5	Award Date	1.4
6	Design	2
7	Feasibility Study	2.1
8	Apply for Permits	2.2
9	Design Blueprint	2.3
10	Complete Design Work	2.4
11	Procurement	3

SEP, 5 '21
SEP, 12 '21
SEP, 19 '21
SEP, 26 '21
OC
M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T
Tina Johnson 100%
Angie Strickland, Tina Johnson 100%
Tina Johnson 100%
9/14/2021
Design Blueprint
Angie Strickland, Chantell Ohdera, Das
Angie Strickland,
9/29/2021



	% Work Complete		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	100%	✓							
2	100%	✓							
3	100%	✓							
4	100%	✓							
5	100%	✓							
6	0%								
7	0%								
8	0%								
9	0%								
10	0%								
11	0%								
12	0%								
13	0%								

Task Information

General | Predecessors | Resources | Advanced | Notes | Custom Fields

Name: Modules Integration Milestone

Duration: 0 days

Constrain task

Deadline: NA

Constraint type: Start No Earlier Than

Constraint date: Mon 18/5/20

Task type: Fixed Units

□ Effort driven

Calendar: None

□ Scheduling ignores resource calendars

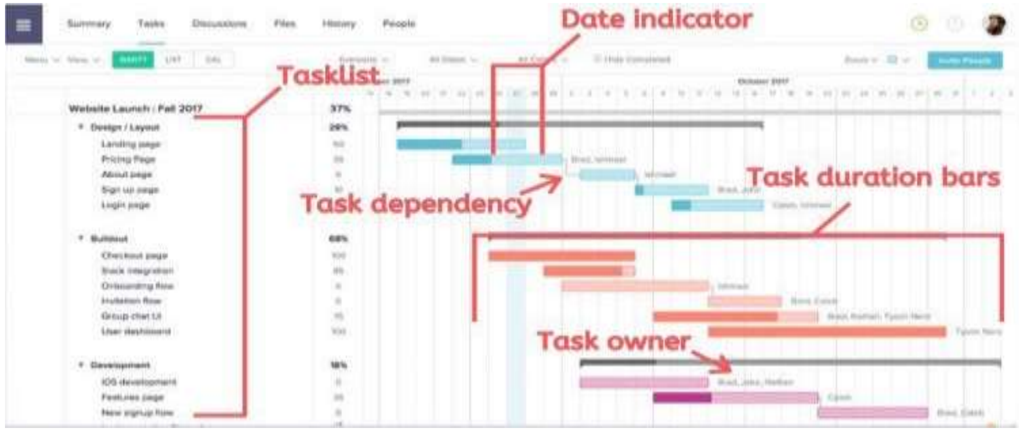
WBS code: 5.2

Earned value method: % Complete

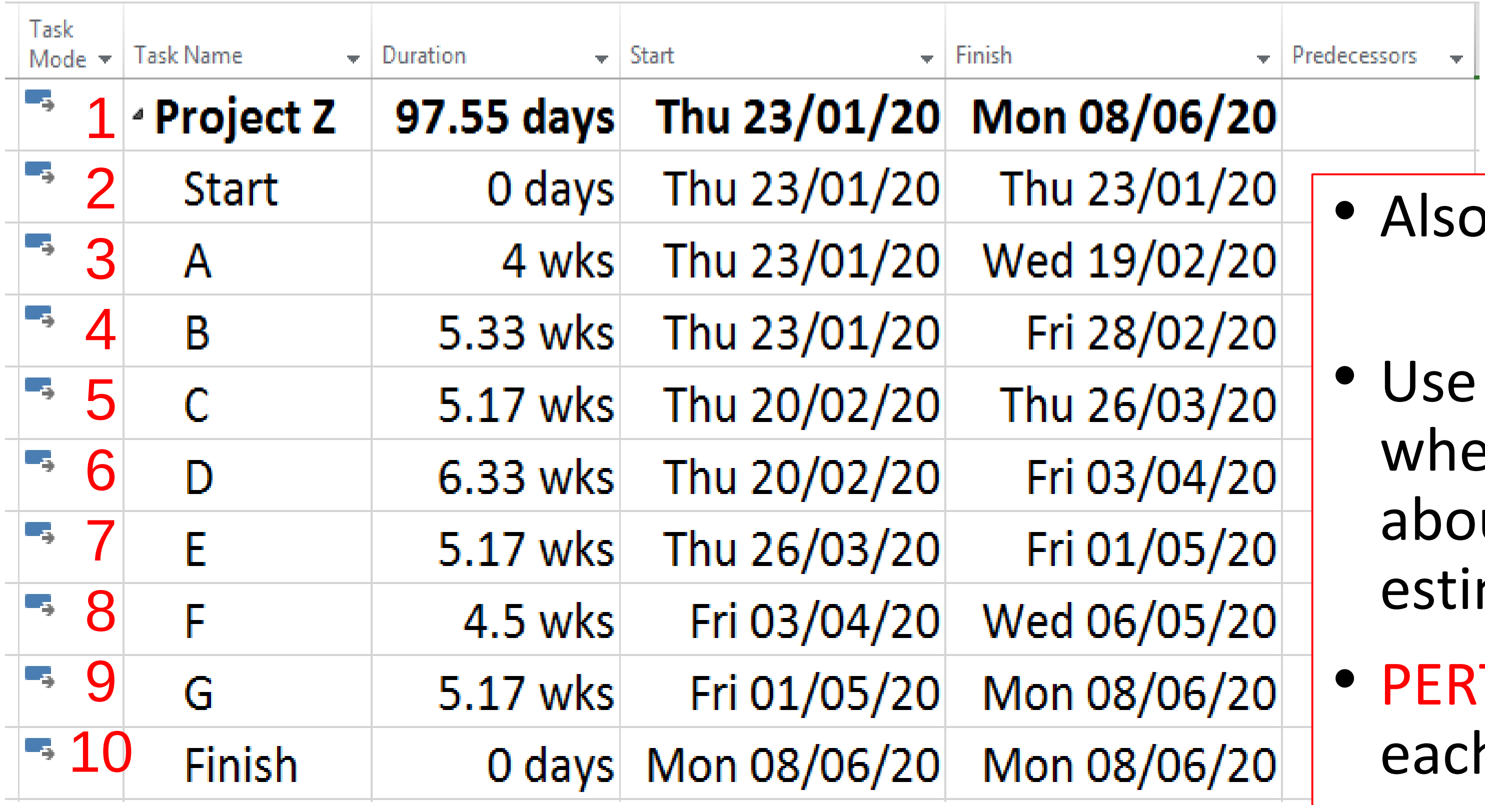
☑ Mark task as milestone

Gantt Chart

Project Planning



Project Table

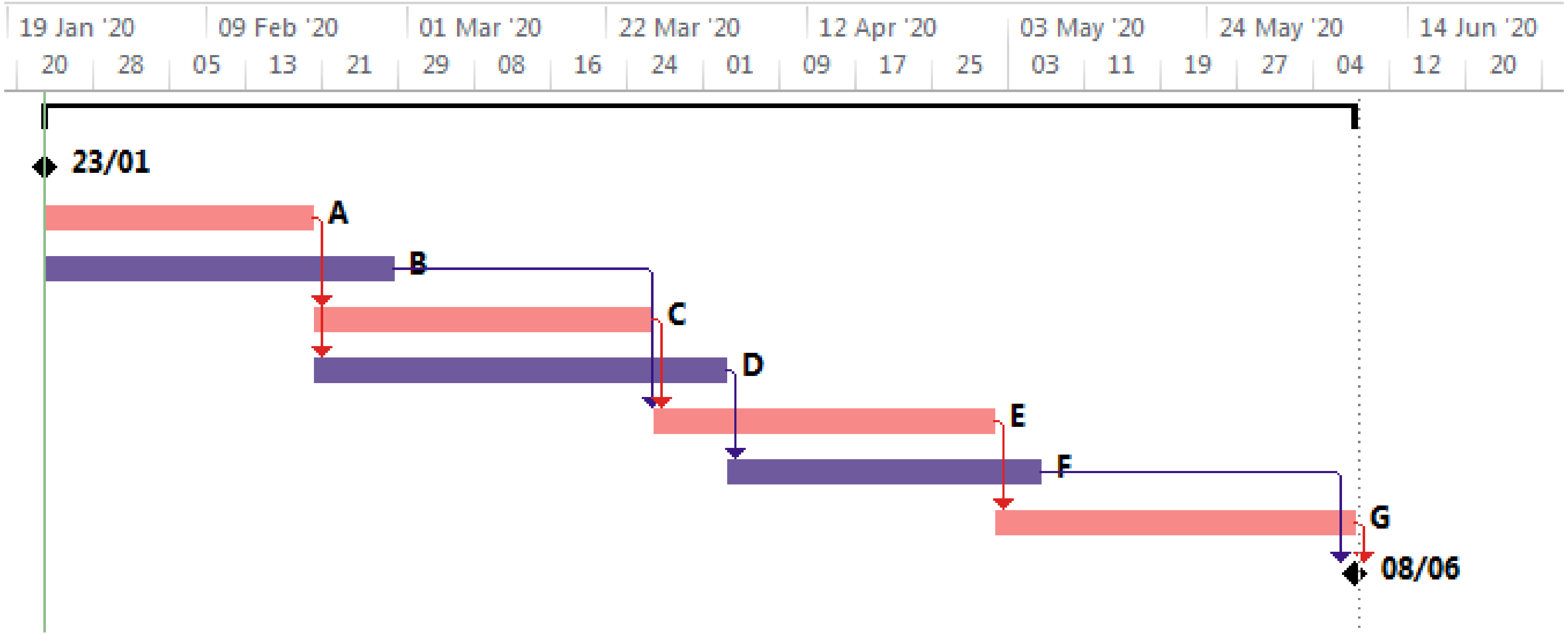


Task Mode	Task Name	Duration	Start	Finish	Predecessors
1	**Project Z**	**97.55 days**	**Thu 23/01/20**	**Mon 08/06/20**	
2	Start	0 days	Thu 23/01/20	Thu 23/01/20	
3	A	4 wks	Thu 23/01/20	Wed 19/02/20	
4	B	5.33 wks	Thu 23/01/20	Fri 28/02/20	
5	C	5.17 wks	Thu 20/02/20	Thu 26/03/20	
6	D	6.33 wks	Thu 20/02/20	Fri 03/04/20	
7	E	5.17 wks	Thu 26/03/20	Fri 01/05/20	
8	F	4.5 wks	Fri 03/04/20	Wed 06/05/20	
9	G	5.17 wks	Fri 01/05/20	Mon 08/06/20	
10	Finish	0 days	Mon 08/06/20	Mon 08/06/20	

- Also known as network diagram.
- Use PERT to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates
- PERT uses 3 estimates for the duration of each task instead of one!
  - **Optimistic time**
  - **Most likely time**
  - **Pessimistic time**

Gantt Chart

Project Planning

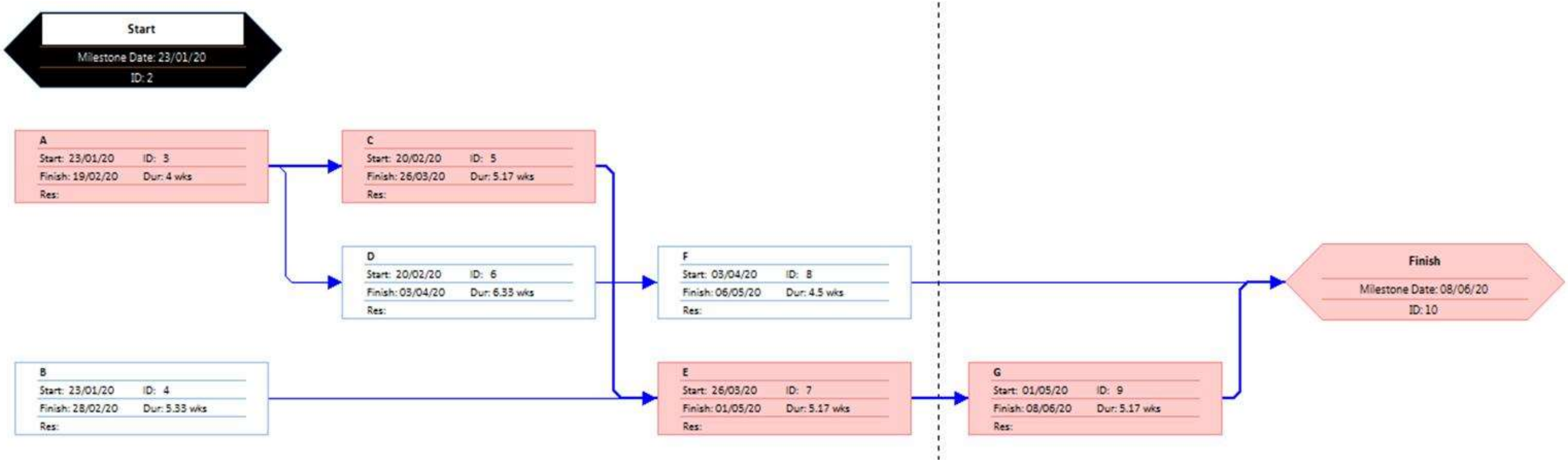


Milestone – a marker use to help in identifying group of activities, set schedule goals and monitor progress

Program Evaluation and Review Technique (PERT)

Project Planning

- Also known as network diagram.
- Developed to take account of the uncertainty surrounding estimates of task durations.



Start
Milestone Date: 23/01/20
ID: 2

A
Start: 23/01/20 ID: 3
Finish: 19/02/20 Dur: 4 wks
Res:

C
Start: 20/02/20 ID: 5
Finish: 26/03/20 Dur: 5.17 wks
Res:

D
Start: 20/02/20 ID: 6
Finish: 03/04/20 Dur: 6.33 wks
Res:

F
Start: 03/04/20 ID: 8
Finish: 06/05/20 Dur: 4.5 wks
Res:

Finish
Milestone Date: 08/06/20
ID: 10

B
Start: 23/01/20 ID: 4
Finish: 28/02/20 Dur: 5.33 wks
Res:

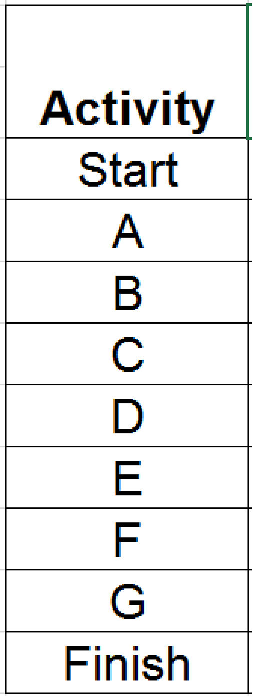
E
Start: 26/03/20 ID: 7
Finish: 01/05/20 Dur: 5.17 wks
Res:

G
Start: 01/05/20 ID: 9
Finish: 08/06/20 Dur: 5.17 wks
Res:

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 1: Identify specific activities and milestones

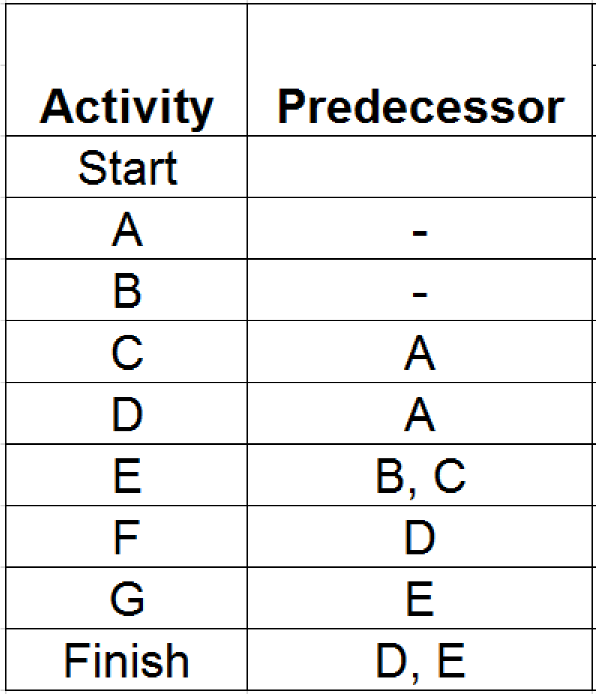


Activity
Start
A
B
C
D
E
F
G
Finish

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 2: Determine the sequence of activities



Activity	Predecessor
Start	
A	-
B	-
C	A
D	A
E	B, C
F	D
G	E
Finish	D, E

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 3: Estimate the time for each activity

- Typically uses the 3-time estimates:
  - Optimistic time (O): the shortest time in which the activity can be completed
  - Most likely time (ML): the completion time that has the highest probability
  - Pessimistic time (P): the longest time in which the activity can be completed.
- Then, calculate the expected time using the weighted average formula.

$$t_e = (O + 4ML + P) / 6$$

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 3: Estimate the time for each activity using **PERT** (cont'd)

		Activity Durations (Weeks)			
Activity	**Predecessor**	**O**	**ML**	**P**	**Expected (t_e)**
Start					
A	-	2	4	6	4
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	4.5
G	E	3	5	8	5.17
Finish	F, G				

Formula (O + 4*ML + P) / 6

(3 + 4*4 + 8) / 6 = 4.5

Can be completed in 3 days instead of 4

4 days is not possible! 8 days instead

For task/activity F:
Using PERT = 4.5 days

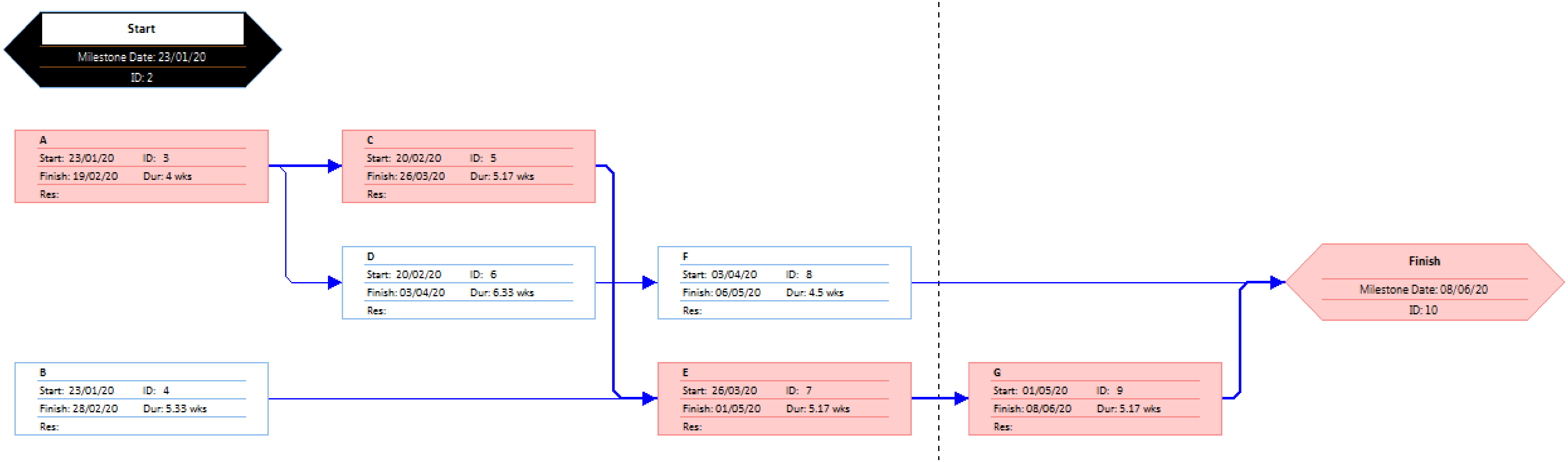
- ***Without*** *using PERT = __ days.*
*duration est. is based on **most likely(ML)**.*
- Does not take into account of any uncertainty that may occur.

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 4: Construct a network diagram

- You can represent both sequential and parallel activities in the diagram.
- Each activity represents a node; arrows to show relationships between activities.



Start
Milestone Date: 23/01/20
ID: 2

A
Start: 23/01/20 ID: 3
Finish: 19/02/20 Dur: 4 wks
Res:

B
Start: 23/01/20 ID: 4
Finish: 28/02/20 Dur: 5.33 wks
Res:

C
Start: 20/02/20 ID: 5
Finish: 26/03/20 Dur: 5.17 wks
Res:

D
Start: 20/02/20 ID: 6
Finish: 03/04/20 Dur: 6.33 wks
Res:

F
Start: 03/04/20 ID: 8
Finish: 06/05/20 Dur: 4.5 wks
Res:

E
Start: 26/03/20 ID: 7
Finish: 01/05/20 Dur: 5.17 wks
Res:

G
Start: 01/05/20 ID: 9
Finish: 08/06/20 Dur: 5.17 wks
Res:

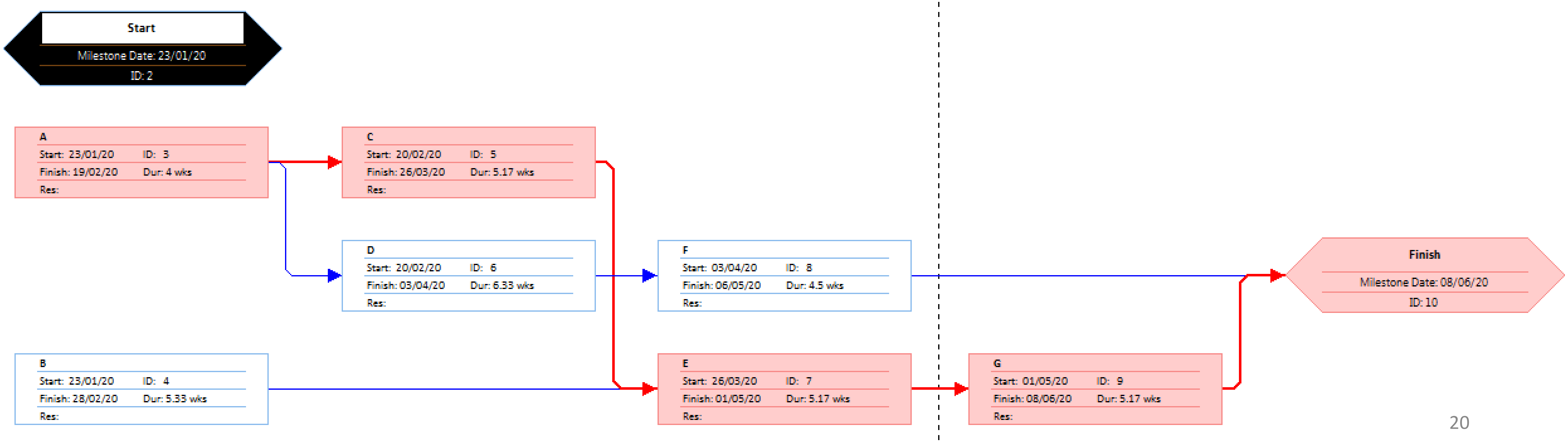
Finish
Milestone Date: 08/06/20
ID: 10

Program Evaluation and Review Technique (PERT)

Project Planning

PERT Step 5: Identify the critical path

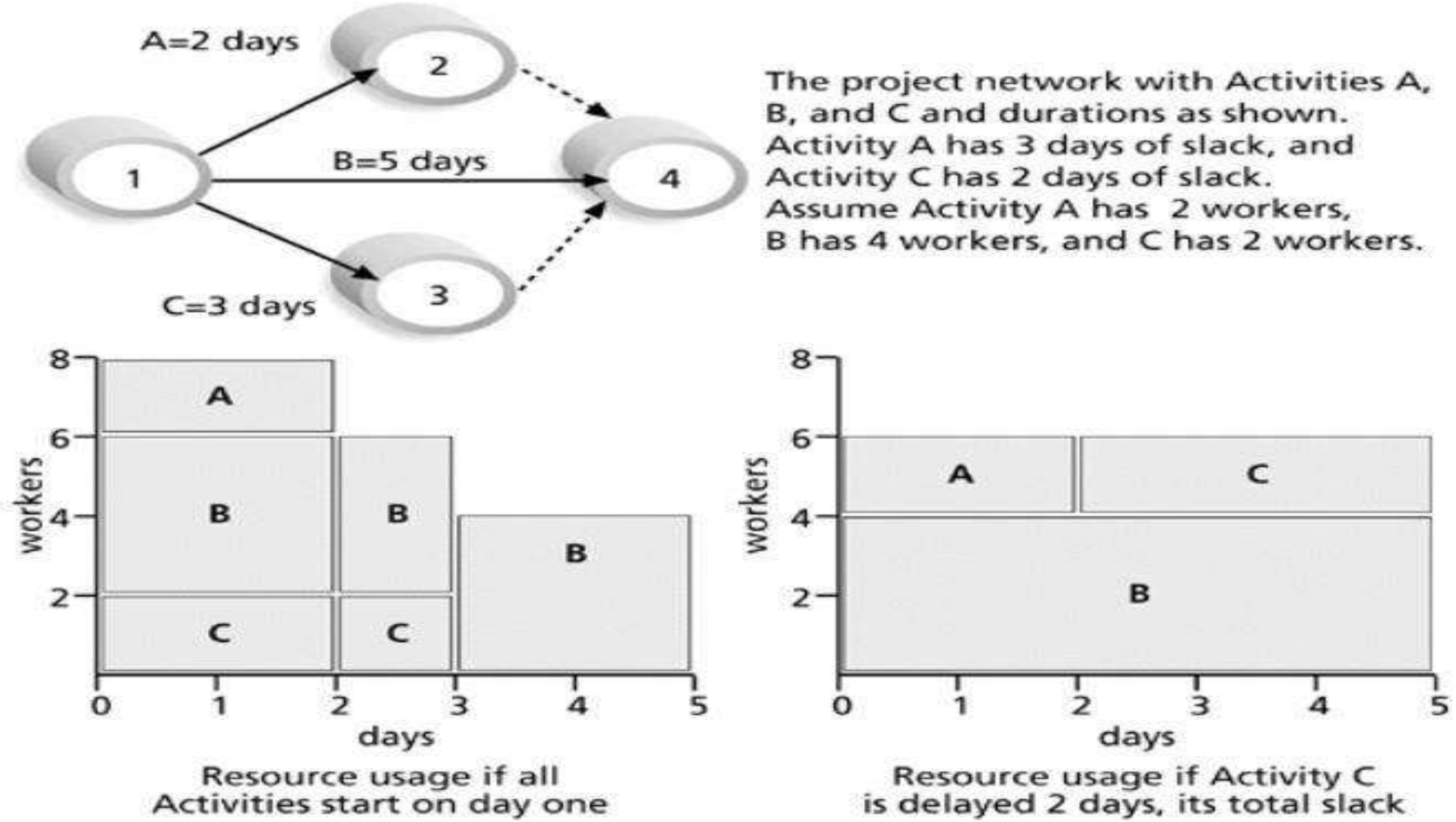
- The critical path includes the total amount of time necessary to complete the project (add the times for the activities and determining the longest path).
- The total project time does not change if activities outside the critical path speed up or slow down.



Program Evaluation and Review Technique (PERT)

Project Planning

A PERT chart illustrates a project as a network diagram



The project network with Activities A, B, and C and durations as shown. Activity A has 3 days of slack, and Activity C has 2 days of slack. Assume Activity A has 2 workers, B has 4 workers, and C has 2 workers.

Resource usage if all Activities start on day one

Resource usage if Activity C is delayed 2 days, its total slack

Estimations in Projects

Project Planning

- Estimation of resources, cost and schedule for a software project requires experience, access to good historical information (metrics), and quantitative predictions.
- Estimation carries inherent risks, and this risk leads to uncertainty.
- Factors that effect the uncertainty in planning include:
  - Project complexity
  - Project size
  - Degree of structural uncertainty (i.e. the degree to which requirements have been solidified, the ease with which functions can be compartmentalized, and the hierarchical nature of the information that must be processed)

Estimations in Projects

Project Planning

To achieve reliable cost and effort estimates:

- Delay estimation until late in the project
- Base estimates on similar projects that have already been completed
- Use relatively simple decomposition techniques to generate project cost and effort estimates
- Use one or more empirical models for software cost and effort estimation

Estimations in Projects

Project Planning

Three-point Estimates (Estimate time)

1. Simple Average
   - (P+O+ML)/3
   - Triangular distribution
2. Weighted Average
   - (P+O+4ML)/6
   - Beta distribution

Estimations in Projects

Project Planning

Activity	Optimistic	Pessimistic	Most Likely	Triangular Distribution	Beta Distribution
A	2	6	4	4	4
B	4	12	8	8	8
C	4	10	7	7	7
D	10	22	16	16	16
E	8	18	13	13	13
F	6	16	11	11	11
G	16	26	22	22	22
H	6	12	10	10	10

Always round UP

Ch2: Project Planning, Control & Process Models Selection

Review of prev lesson

2.1 Project Planning and Estimation	WBS → Estimate the Start date & End date for each task (duration) → set relationship between tasks → Project Schedule → Use 3-time estimate to develop a better time allocation for each task
	Network diagram → To identify critical path
	Resource usage → determine number of resources needed (e.g. for each day) (or when a particular task is delayed) → see *"A PERT chart illustrates a project as a network diagram"*

2.2 Project Monitoring and Control

→ Project control – Corrective Actions

2.3 Selection of Process Models

2.2 Project Monitoring and Control

- Tracking the Schedule
- Project Control - Corrective Actions
- Cost Monitoring
- Earned Value Analysis

Project Management Process Group and Knowledge Area Mapping

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Tracking the Schedule

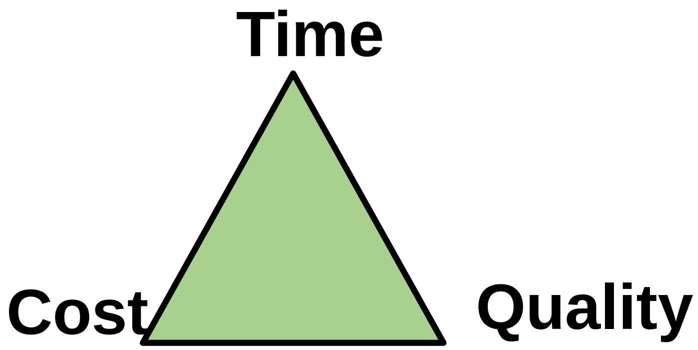
2.2 Project Monitoring and Control

- The project schedule becomes a road map that defines the tasks and milestones to be tracked and controlled as the project proceeds.

Tracking the Schedule

2.2 Project Monitoring and Control

- The project schedule becomes a road map that defines the tasks and milestones to be tracked and controlled as the project proceeds.
- Tracking can be accomplished in a number of different ways:
  - Conducting periodic project status meetings in which each team member reports progress and problems
  - Evaluating the results of all reviews conducted throughout the software engineering process
  - Determining whether formal project milestones have been accomplished by the scheduled date
  - Comparing the actual start date to the planned start date for each project task listed in the project table
  - Meeting informally with practitioners to obtain their subjective assessment of progress to date and problems on the horizon
  - Using earned value analysis to assess progress quantitatively



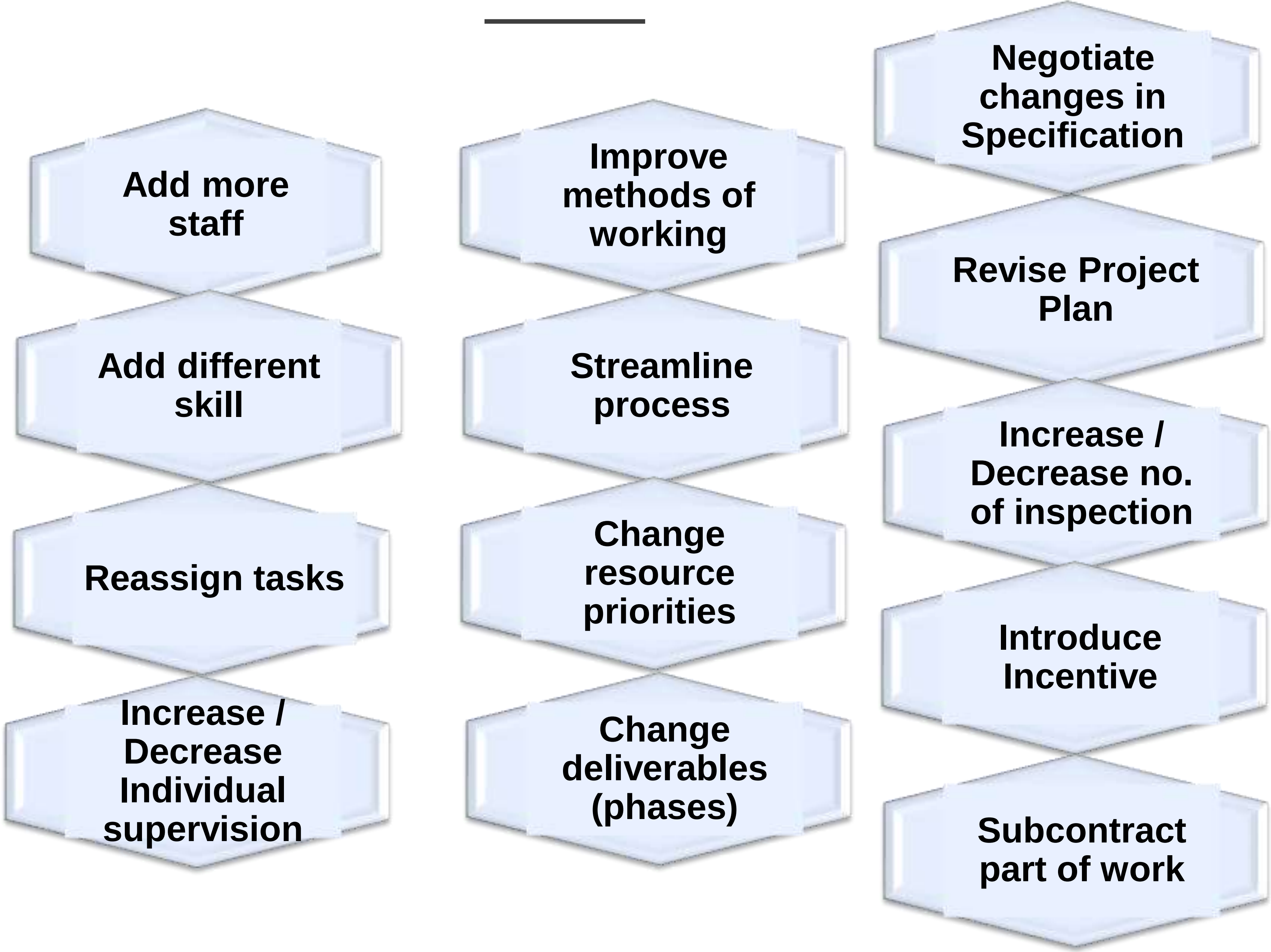
Project Control - Corrective Actions

2.2 Project Monitoring and Control

- Project manager needs to **monitor** the progress of the projects in terms of the time, cost and quality (triple constraints)
- **Control** is more than monitoring and finding out problems, needs **corrective actions** whenever and wherever needed.

Project Control - Corrective Actions

2.2 Project Monitoring and Control



Add more staff

Add different skill

Reassign tasks

Increase / Decrease Individual supervision

Improve methods of working

Streamline process

Change resource priorities

Change deliverables (phases)

Negotiate changes in Specification

Revise Project Plan

Increase / Decrease no. of inspection

Introduce Incentive

Subcontract part of work

a. Adding more staff-schedule
b. Adding different skills-lack knowledge
c. Reassigning tasks: specialize
d. Increasing/decreasing individual supervision :experienced
e. Improving methods of working :suitability of methods for the tasks
f. Streamlining the process : redundant
g. Change resource priorities: important
h. Negotiating changes in the specification :main functions first.
i. Re-planning the project
j. Changing the phasing of deliverables :parallel tasks
k. Increasing/decreasing the number of inspection (assessment)
l. Encouraging the team :low productivity
m. Introducing incentives
n. Subcontracting part of the work

Project Control - Corrective Actions

2.2 Project Monitoring and Control

a. Adding more staff

One of the possibilities when behind schedule

- **Will work if a task can be partitioned**

  (E.g. Interviewing **users** to gather requirements)

- **Drawback**

  - Need to consider **communication, learning curve, time to get-up to speed & etc. –** may affects overall productivity *(this means adding additional staff may further delay the task)*

  - ***Will incur additional cost***

Project Control - Corrective Actions

2.2 Project Monitoring and Control

b. Adding different skills

- An alternative to adding more staff, consider adding people with different or greater skills

- When problems need skill/knowledge or staff lack experience
  - **Adding experienced or skilled staff to a team may yield results. Eg:** Adding a person who is skillful in UI design

Project Control - Corrective Actions

2.2 Project Monitoring and Control

c. Reassigning Task

- Without needing to add staff or skills
- May get better productivity or better quality work by switching tasks around as each has different strength
- Some are creative, some are thorough, while some are analytical
- Can make use of the knowledge of characteristics of the team members to assign tasks that will make use of their strength

Project Control - Corrective Actions

2.2 Project Monitoring and Control

d. Increasing individual supervision

- Problems with the work of members are known only when they deliver products
- Partitioning tasks and creating smaller deliverables to exercise quality control more frequently
- Enable inexperienced/ less confident staff to obtain guidance

Project Control - Corrective Actions

2.2 Project Monitoring and Control

e. Decreasing individual supervision

- Opposite when dealing with experienced staff who may resent too frequent check up
- May affect personal interest and affect the work quality
- Giving individual responsibility and increase job interest and motivation for larger deliverables
- Reduces work of supervision and re-channel resourceful focus

Project Control - Corrective Actions

2.2 Project Monitoring and Control

f. Improving methods of working

- Besides the work itself, need to consider the suitability of methods for the tasks
- E.g. using Joint Application Development (JAD) approach to reconcile what seemed to be mutually exclusive requirements between different users, staging workshop where all users can come together to thrash out the differences during analysis stage
- Using 4th GL to obtain users interface requirements

Project Control - Corrective Actions

2.2 Project Monitoring and Control

g. Streamlining the process

- Some tasks like quality control may be bureaucratic and time-consuming
- Will be aggravated if the procedures or processes are vague
- Streamline them by removing unnecessary activities and using standardized forms and process

Project Control - Corrective Actions

2.2 Project Monitoring and Control

h. Changing resource priorities

- Access to some important resources may be limited and created bottlenecks
- Need to negotiate for better access or find alternative environment/facilities in which work can proceed
- Examine project critical path to relocate the priorities of access

Project Control - Corrective Actions

2.2 Project Monitoring and Control

i. Re-planning the project

- Problems evaluation may show some fundamental flaws in the way project has been planned
- Although embarrassing, it is critical, project manager has to rework the plan
- Some tasks dependencies become clear after the work has started
- Need to note while new plans remove problems of old plan may introduce new risks
- A re-appraisal of the risks should be part of the re-planning process

Project Control - Corrective Actions

2.2 Project Monitoring and Control

j. Changing the phasing of deliverables

- Short of a complete revision of plan, it may prove effective by changing the phasing of the deliverables
- Planning may show as one end-product but analysis may reveal that the product can be partitioned into several discrete elements
- Some discrete elements may have higher priorities and may be possible to consider phased delivery to concentrate on more urgent requirements
- May also consider parallel working e.g. design overlap with analysis
- May introduce new risks and proper appraisal is needed

Project Control - Corrective Actions

2.2 Project Monitoring and Control

k. Decreasing the number of inspections

- Only if inspections (assessment) are uncovering an acceptably low no. of defects
- Else problems will arise later and doesn’t result in any positive effects

Project Control - Corrective Actions

2.2 Project Monitoring and Control

I. Increasing the number of inspections

- For critical systems and if intermediate deliverables are less satisfactory
- Or there is a high level of defects on completed deliverables
- To ensure errors are discovered earlier and rectified more quickly
- May delay the project when no. of inspections increases

Project Control - Corrective Actions

2.2 Project Monitoring and Control

m. Encouraging the team

- Project fatigue may arise = lower productivity, increased absenteeism, resignations, complaints, etc.
- Actions may include:
  - refocusing on team’s achievements to rekindle enthusiasm
  - organizing social events in company time to engender a sense of team spirit
  - redistribution of work to provide development opportunities
  - a team building exercise of some sort
  - reducing the size of deliverables (at the end may be larger!)

Project Control - Corrective Actions

2.2 Project Monitoring and Control

n. Introducing incentives

- Depending on the organization, the project manager may or may not be able to offer financial incentives
- But incentives may be in other form, e.g. time off, recognition, etc.
- For multiple team, inter-team competition may be considered but practiced with care

Project Control - Corrective Actions

2.2 Project Monitoring and Control

o. Subcontracting part of the work

- Despite all the tools and techniques, project may still not on schedule
- Project manager may consider sub-contracting out the tasks to those with special skills/ facilities
- But responsibility will still be with the PM
- Must make sure the contractors work to the required standards

Project Control - Corrective Actions

2.2 Project Monitoring and Control

p. Negotiating changes in the specification

- When all else fail, may negotiate to change the specification. It may be original objective is too ambitious for the time or money
- Alternatively may resort to phased delivery with major functions being delivered first.
- Not usually well received but better than to fail the project totally

E.g., *Implement a new online ticketing system by 1-FEB-2023 to achieve ticket response time of no more than 1 hour.*

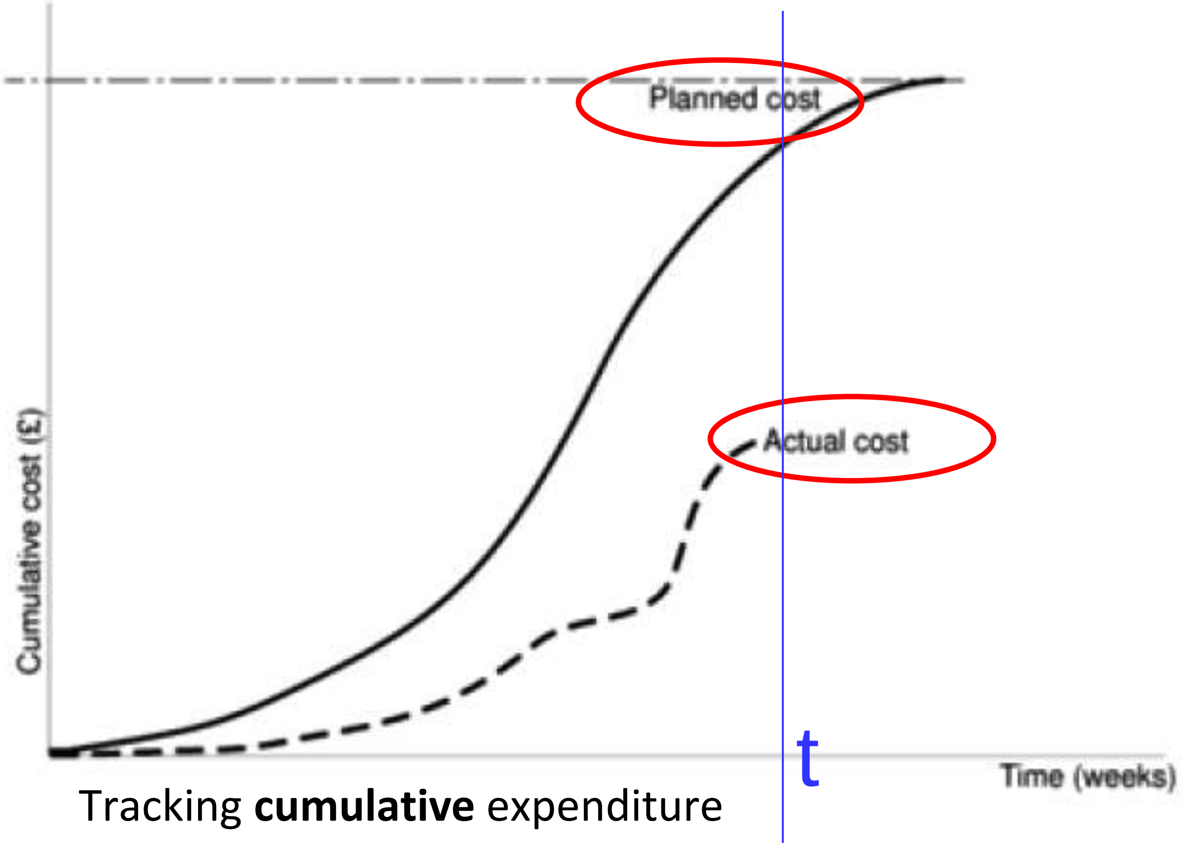
Cost Monitoring

2.2 Project Monitoring and Control

- Cost/expenditure monitoring provides an indication of the effort that has gone into (or at least been charged to) a project.
- A project might be on time but only because more money has been spent on activities than original budgeted.
- A cumulative expenditure chart provides a simple method of comparing actual and planned cost.
  - By itself it is not particularly meaningful, e.g. the expenditure chart could illustrate a project that is running late or one that is on time but has shown substantial cost savings.
  - Thus, we need to take into account the current status of the project activities before attempting to interpret the meaning of recorded expenditure.

Monitoring Cost

2.2 Project Monitoring and Control



Tracking **cumulative** expenditure

Compare planned cost against actual cost

Diagram shows there is substantial **costs savings** (i.e. at time t, actual amount of money spent < planned amount

Before making any conclusion, Find out the status of current project activities

Use Earned Value Analysis (EVA) to draw conclusion

Earned Value (EV) Analysis

- **EV analysis** is a refinement of cost monitoring.
  (takes into account the project progress and schedule)
- After doing **EV analysis** you will be able to check whether:
  1 a project cost has exceeded its budget
  2. a project is behind schedule, ahead of schedule/on time

- **EV analysis** is based on assigning a "*value*" to each task (as identified in the WBS) based on the original expenditure forecasts.
  - i.e., it is **equivalent** to the price agreed upon by a contractor to do the unit of work.
- This assigned value is called *planned value (**PV**)*.
- A task that has not started, the earn value (***EV) = 0***, and when it has been completed (& hence the project), EV = PV
- *EV = the actual value of work completed (*EV = PV when a task has been completed*).*

Earned Value (EV) Analysis

2.2 Project Monitoring and Control

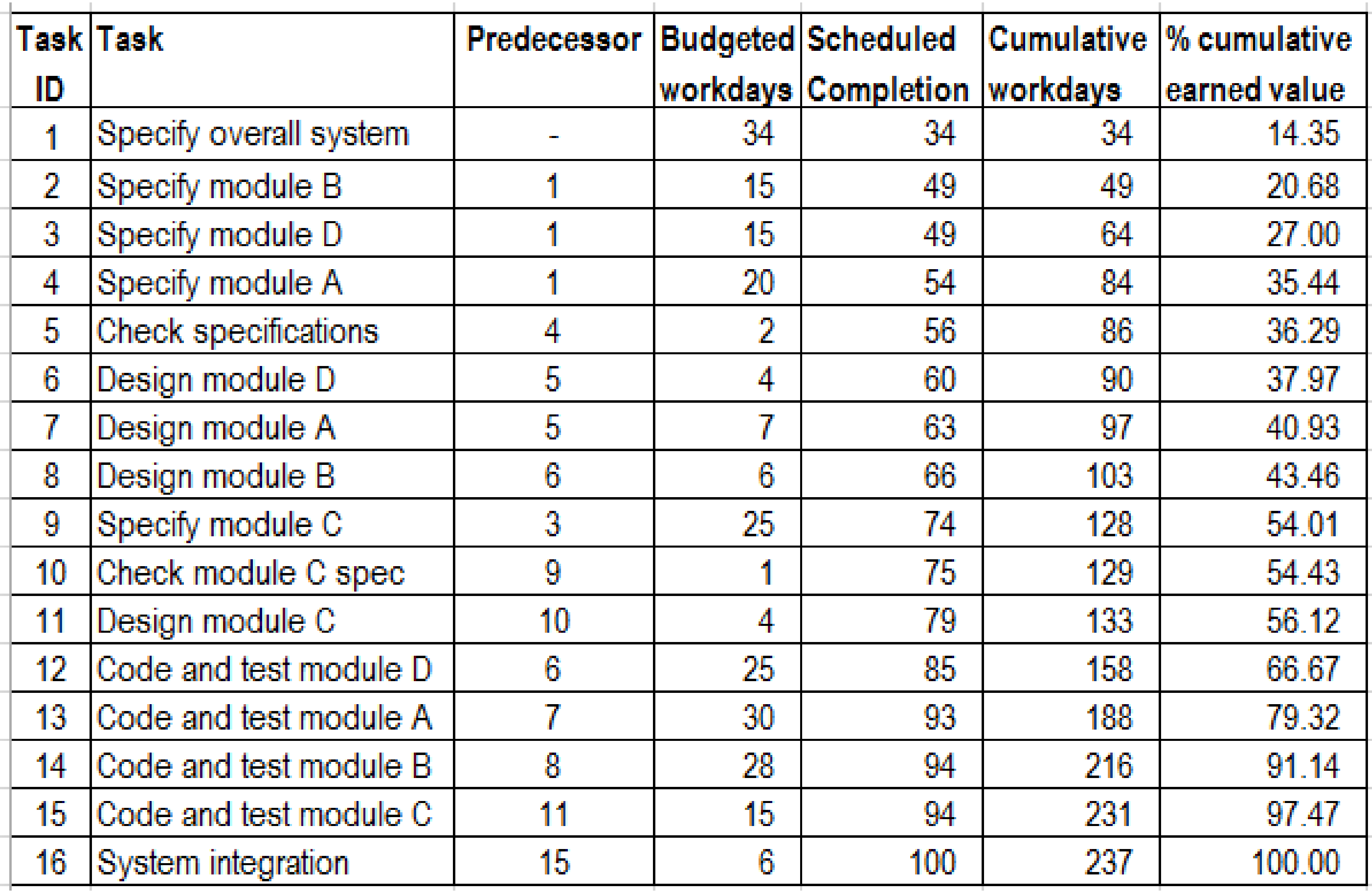
(assign 100% of PV to EV when the work is finished

Techniques for Crediting or assigning EV to a Project

- 0/100 technique: a task is assigned a value of 0 until it is completed, at which it is given a value of 100% of the budgeted value. (EV=0 when the job starts, when the job is finished EV=PV)
  (assign 100% of PV to EV when the work is finished
- 50/50 technique: a task is assigned a value of 50% of its value as soon as it is started and then given a value of 100% once it's completed. (EV=50% of the PV when the job starts, when the job is finished EV=PV)
  (add remaining 50% of PV to EV when the work is finished
- 75/25 technique: a task is assigned a value of 75% of its value as soon as it is started and then given a value of 25% once it's completed. (EV=75% of the PV when the job starts, when the job is finished EV=PV)
  (add remaining 25% of PV to EV when the work is finished
- milestone technique: a task is given a value based on the **achievement of milestones that have been assigned values** as part of the original budget plan. (assign a value to EV based on milestone achievement
- % complete: the EV is based on the % of the project that has been completed. (assign a value to EV based on percentage of work completed

Step 1: Create the baseline budget

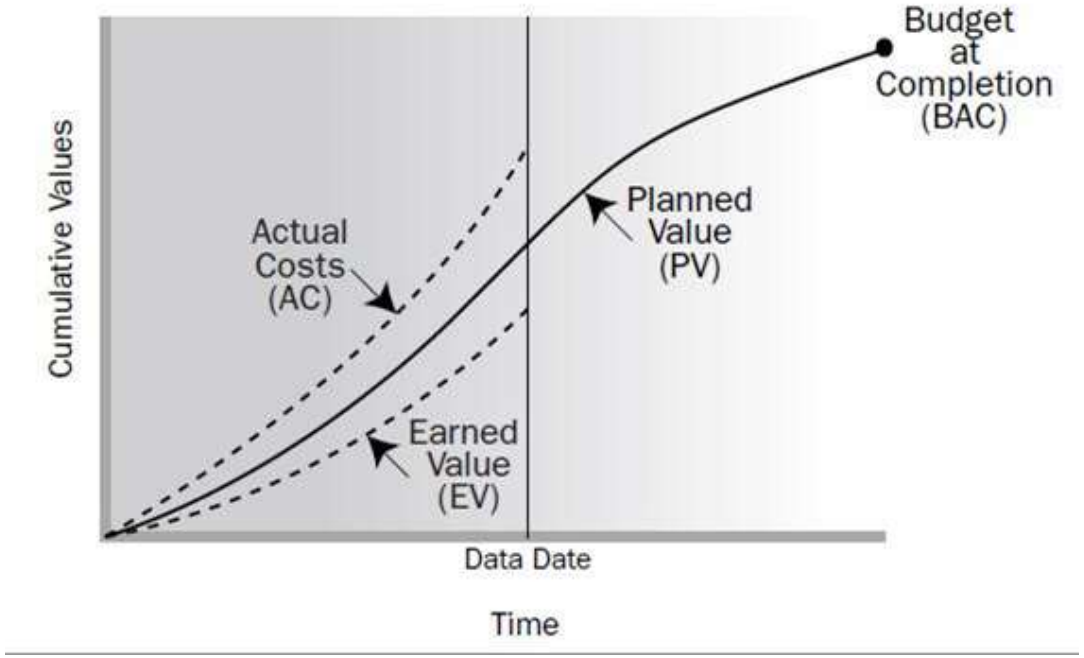
- The baseline budget (i.e. planned value, **PV**) is created based on the project plan.
- Shows the forecast growth in earned value through time.
- May be measured in monetary values or person-hours (or workdays).
- This example uses the 0/100 technique for crediting EV to the project.



Task ID	Task	Predecessor	Budgeted workdays	Scheduled Completion	Cumulative workdays	% cumulative earned value
1	Specify overall system	-	34	34	34	14.35
2	Specify module B	1	15	49	49	20.68
3	Specify module D	1	15	49	64	27.00
4	Specify module A	1	20	54	84	35.44
5	Check specifications	4	2	56	86	36.29
6	Design module D	5	4	60	90	37.97
7	Design module A	5	7	63	97	40.93
8	Design module B	6	6	66	103	43.46
9	Specify module C	3	25	74	128	54.01
10	Check module C spec	9	1	75	129	54.43
11	Design module C	10	4	79	133	56.12
12	Code and test module D	6	25	85	158	66.67
13	Code and test module A	7	30	93	188	79.32
14	Code and test module B	8	28	94	216	91.14
15	Code and test module C	11	15	94	231	97.47
16	System integration	15	6	100	237	100.00

Step 2: Monitor the earned value

- Having created the baseline budget, the next task is to monitor earned value (**EV**) as the project progresses.
- This is done by monitoring the completion of tasks (or activity starts and milestone achievements in the case of other crediting techniques).
- In addition, the actual cost (**AC**) of each task is also recorded.



Earned Value Management (EVM) – Basic Metrics

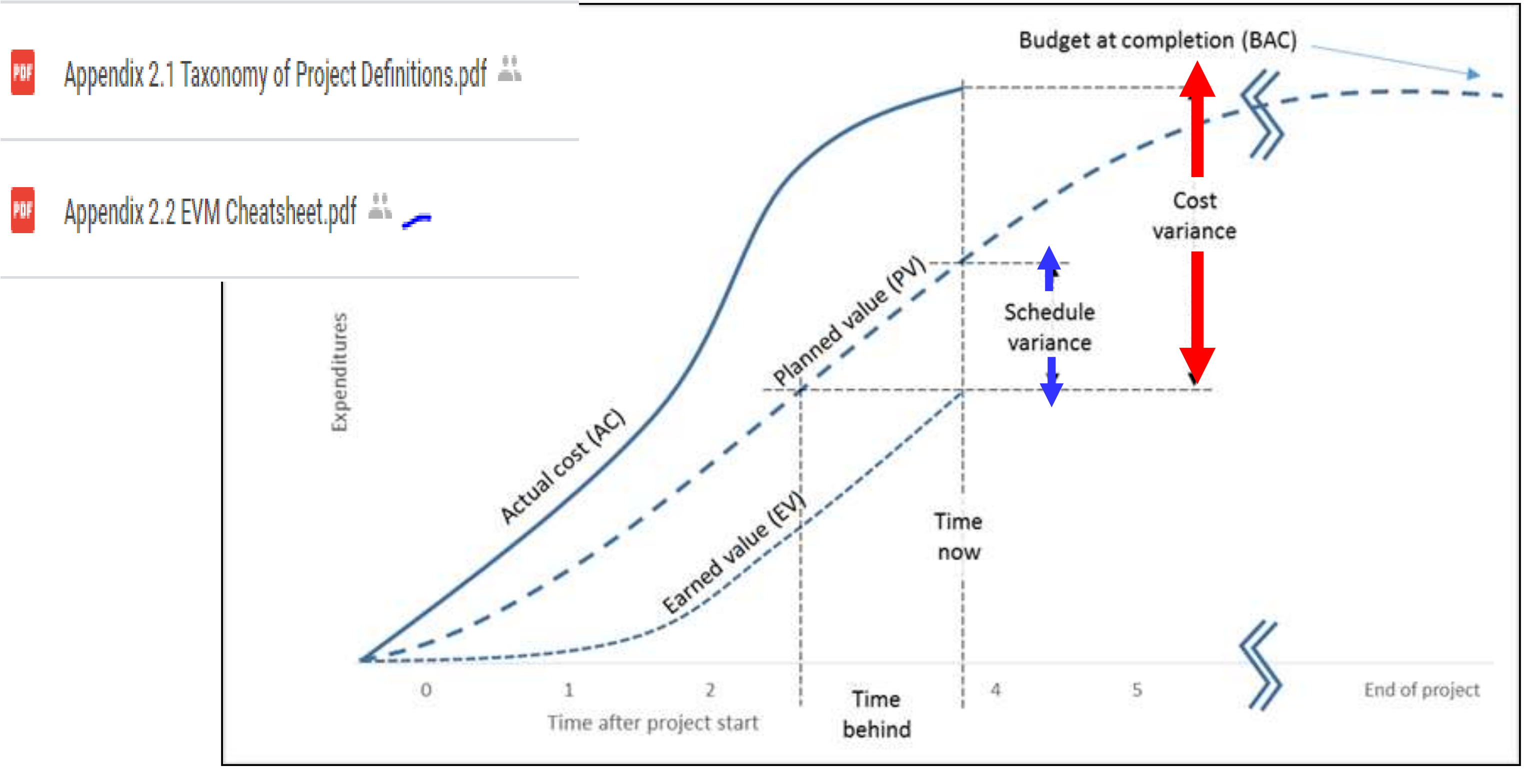
✓ **Planned Value (PV)**: Estimated value of the work planned to be done

✓ **Earned Value (EV)**: Estimated value of the work actually completed

✓ **Actual Cost (AC)**: Actual cost incurred for the work completed

✓ **Budget at Completion (BAC)**: Total project effort budget

Step 3: Compute Performance Statistics



Appendix 2.1 Taxonomy of Project Definitions.pdf

Appendix 2.2 EVM Cheatsheet.pdf

Cost Variance & Schedule Variance

Earned Value Management (EVM) Variances

Cost Variance (CV)

= **EV – AC** (negative indicates cost is exceeded)

(at time t, amount paid > value of work completed)

Schedule Variance (SV)

= **EV – PV** (negative indicates behind schedule)

(At time t, value of work completed is smaller than planned value of work)

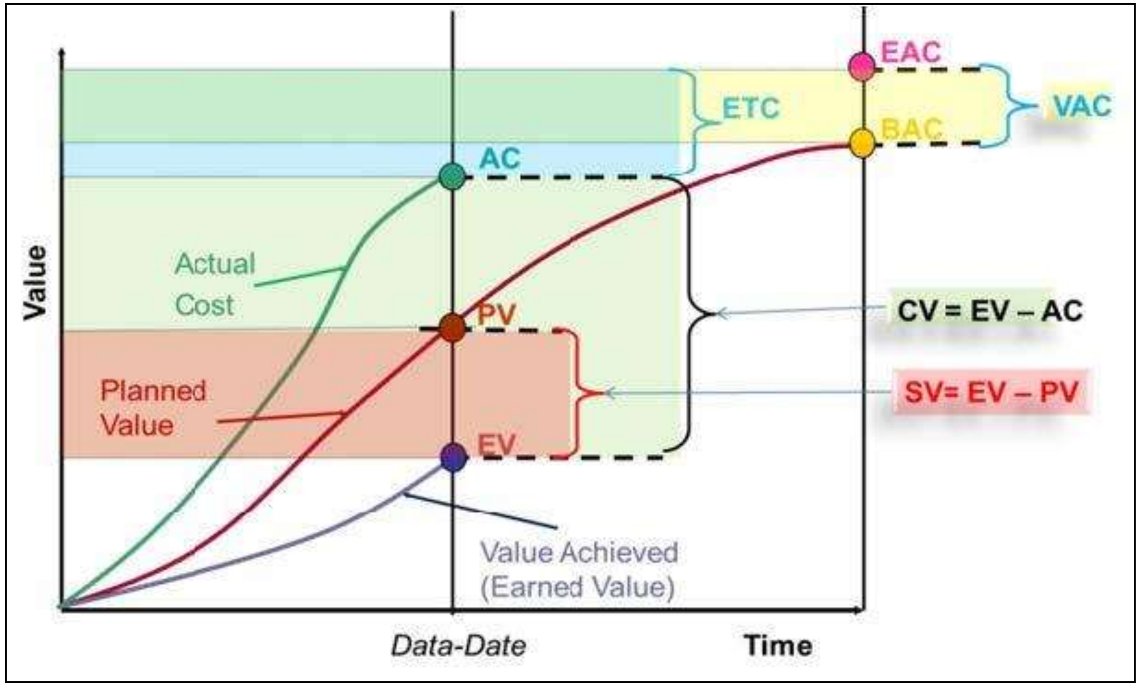
Earned Value Management (EVM) Variances

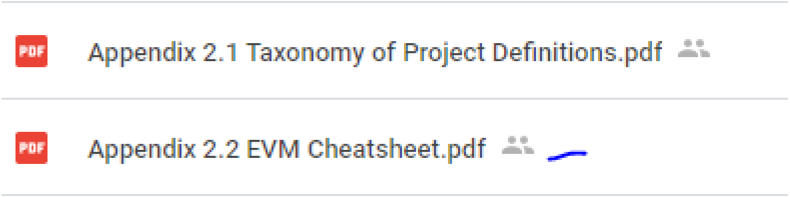
✓**Schedule Variance (SV) = EV – PV** (negative indicates behind schedule)

✓**Cost Variance (CV) = EV – AC** (negative indicates cost is exceeded)

✓**Variance at Completion (VAC) = BAC – EAC**

EVM Forecasting




PDF Appendix 2.1 Taxonomy of Project Definitions.pdf

PDF Appendix 2.2 EVM Cheatsheet.pdf

Earned Value Management (EVM) - Forecasting

✓Estimate At Completion (**EAC**) – current expectation on the total project cost

✓**EAC = AC + ETC** used when the original assumptions are fundamentally flawed

✓**EAC = AC + BAC – EV** used when current variances are typical

✓**EAC = AC + (BAC-EV)/CPI** used when current variances are typical

EV = actual value of work completed
= estimated cost * status of completion
(assign a value to a task when it has started)

Exercise

AC (actual cost)

You are now **in the 9th month** of 29 months project. As of today, you have spent RM198.000 based on the invoices reconciliation. You need to provide data to Mr. Jordon (Project Sponsor), specifying if you are making a profit or loss in the Project. You are using EVM/EVA technique to provide the sponsor with this information.

Deliverable	Estimated Duration (month)	Estimated Cost ($)	Status
A	2	70,000	100%
B	3	27,000	85%
C	1.5	82,000	62%
D	2.5	25,000	48%
E	2	30,000	23%
F	0.5	48,000	16%
G	1.5	100,000	0
H	2	10,000	0
I	1	45,000	0
J	2.5	17,000	0
K	3	32,000	0
L	1.5	12,000	0
M	2	10,000	0
N	3	24,000	0
O	1	12,000	0
Total	29	**544,000**	0

PV (value of work planned to be completed)

BAC (budget at completion)
i.e. project budget

Exercise

You are now in the 9th month of 29 months project. As of today, you have spent RM198.000 based on the invoices reconciliation. You need to provide data to Mr. Jordon (Project Sponsor), specifying if you are making a profit or loss in the Project. You are using EVM technique to provide the sponsor with this information.

Answer

CV = EV- AC (over budget)
=170,370 - 198,000 = **-27,630**

PV

Deliverable	Estimated Duration (month)	Estimated Cost ($)	Status	EV
A	2	70,000	100%	**70,000**
B	3	27,000	85%	**22,950**
C	1.5	82,000	62%	**50,840**
D	2.5	25,000	48%	**12,000**
E	2	30,000	23%	**6900**
F	0.5	48,000	16%	**7680**
G	1.5	100,000	0	
H	2	10,000	0	
I	1	45,000	0	
J	2.5	17,000	0	
K	3	32,000	0	
L	1.5	12,000	0	
M	2	10,000	0	
N	3	24,000	0	
O	1	12,000	0	
Total	**29**	**544,000**	0	

You are now in the 9th month,

AC (actual cost) = 198,000

Budget At Completion (BAC) = 544,000

PV = 70k + 27k + 82k + 25k = 204,000 (9 months)

EV = (100%x70k) + (85%x 27k) + (62%x82k) + (48%x 25k) + (23%x30k) + (16%x 48k)

= 170, 370

Actual value of work completed in the 9th month

SV (schedule variance)= EV - PV

=170,370 – 204,000

= **-33,630**

value of work planned to be completed in the 9th month

- Negative means the project is behind schedule
- In the 9th month, actual value of work completed is less than what have been planned.

However, IF positive (EV > PV) the project is ahead of schedule.
- More work have been completed than planned!

Exercise

9th month :A, B, C, D : add up value as Planned Value (PV)

PV (value of work planned to be completed)

Deliverable	Estimated Duration (month)	Estimated Cost ($)	Status	Earned Value
A	2	70,000	100%	**70,000**
B	3	27,000	85%	**22,950**
C	1.5	82,000	62%	**50,840**
D	2.5	25,000	48%	**12,000**
E	2	30,000	23%	**6900**
F	0.5	48,000	16%	**7680**
G	1.5	100,000	0	
H	2	10,000	0	
I	1	45,000	0	
J	2.5	17,000	0	
K	3	32,000	0	
L	1.5	12,000	0	
M	2	10,000	0	-
N	3	24,000	0	
O	1	12,000	0	-
Total	29	544,000	0	

9th month, Actual Cost RM198,000

BAC = 544,000

PV = 70k + 27k + 82k + 25k = 204,000 (9 months)

AC = 198,000

EV = (100%x70k) + (85%x 27k) + (62%x82k) + (48%x 25k) + (23%x30k) + (16%x 48k)

= 170, 370

SV = EV - PV

=170,370 – 204,000 = **-33,630**

(behind schedule)

CV = EV- AC

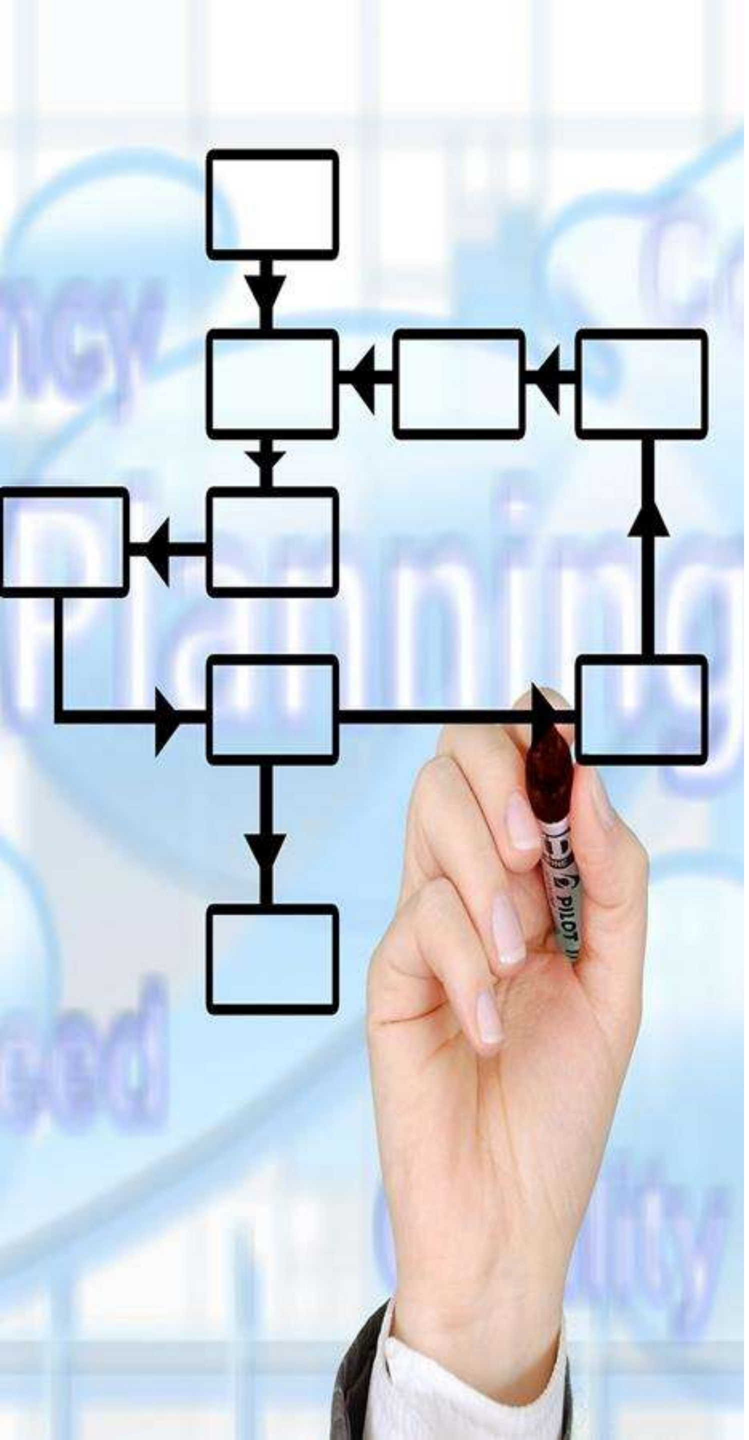
=170,370 - 198,000 = **-27,630**

(over budget)

If CV Positive indicates project is under budget.

AC > PV

- In the 9th month, more work were completed than planned AND actual amount paid out < the planned amount!



2.3 SELECTION OF PROCESS MODELS

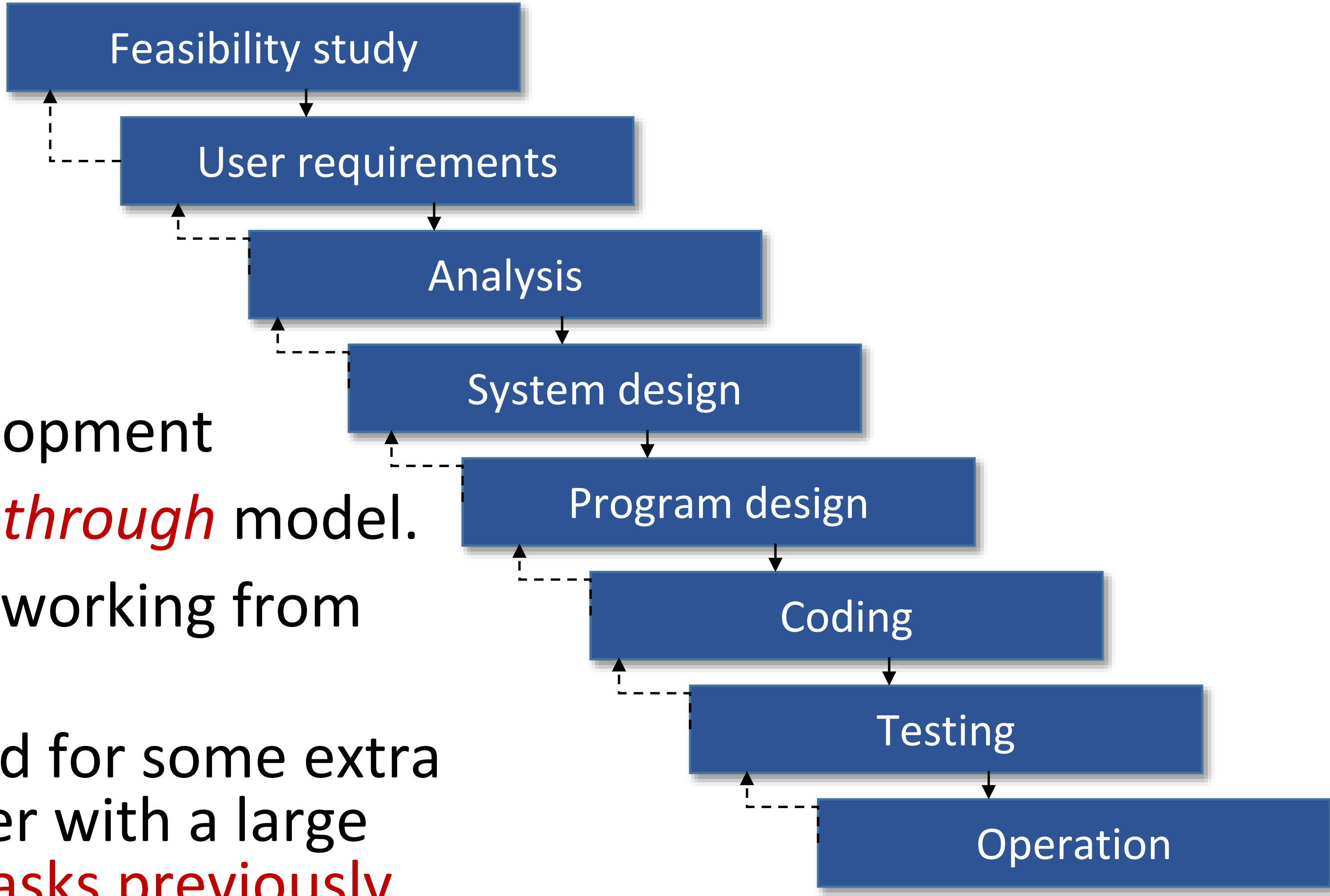
- Waterfall models
- Prototyping Model
- Rapid Application Development (RAD)
- Incremental Model
- Spiral model
- Component-based development

2.3 SELECTION OF PROCESS MODELS

Models	Budget	User Requirement	Man power	User	Development Time	Project scope
Waterfall	High	Well defined	Many staffs	Less involved	Long	Large-scale system
Prototyping	Limit	Uncertain	Few staffs	Highly involved	Flexible	Small to medium
Rapid Application Development (RAD)	High	Well defined	RAD teams to tackle component	Highly involved	3 months	System that can be partitioned/ componentized
Incremental	Low	Well defined	Lack of staff (few staff)	Highly involved	Short	Flexible/complex
Spiral	High	Uncertain	Need Experts	Highly involved	Long	Large-scale, risky system
Component-based development	Low	Well defined	Less staffs	Highly involved	Short	System that can be partitioned/ componentized

Waterfall Model

2.3 SELECTION OF PROCESS MODELS



- ‘classical’ model of system development
- Also known as *one-shot or once-through* model.
- There is a sequence of activities working from top to bottom.
- A later stage may reveal the need for some extra work at an earlier stage. However with a large project, try to avoid reworking tasks previously thought to be completed.

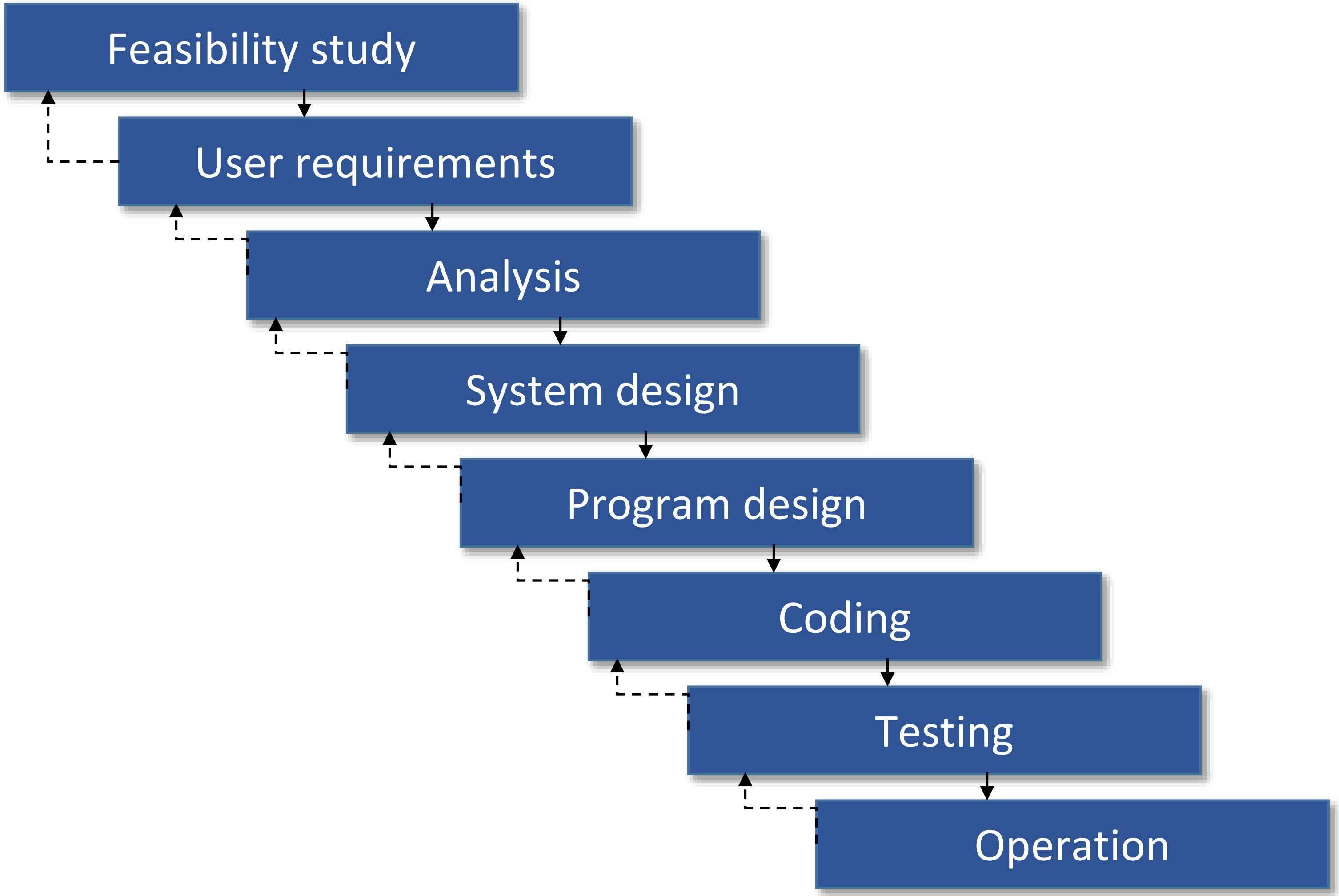
Waterfall Model

2.3 SELECTION OF PROCESS MODELS

- Advantages:
  - Creates natural milestones at the end of each phase.
  - Manager can review project progress.
  - Suitable for project where requirements are well defined and the development methods are well understood.
- Disadvantages:
  - Not suitable for project with uncertainty.
  - Not flexible – reluctant to go back to previous stage.

Waterfall Model

2.3 SELECTION OF PROCESS MODELS



Feasibility study

User requirements

Analysis

System design

Program design

Coding

Testing

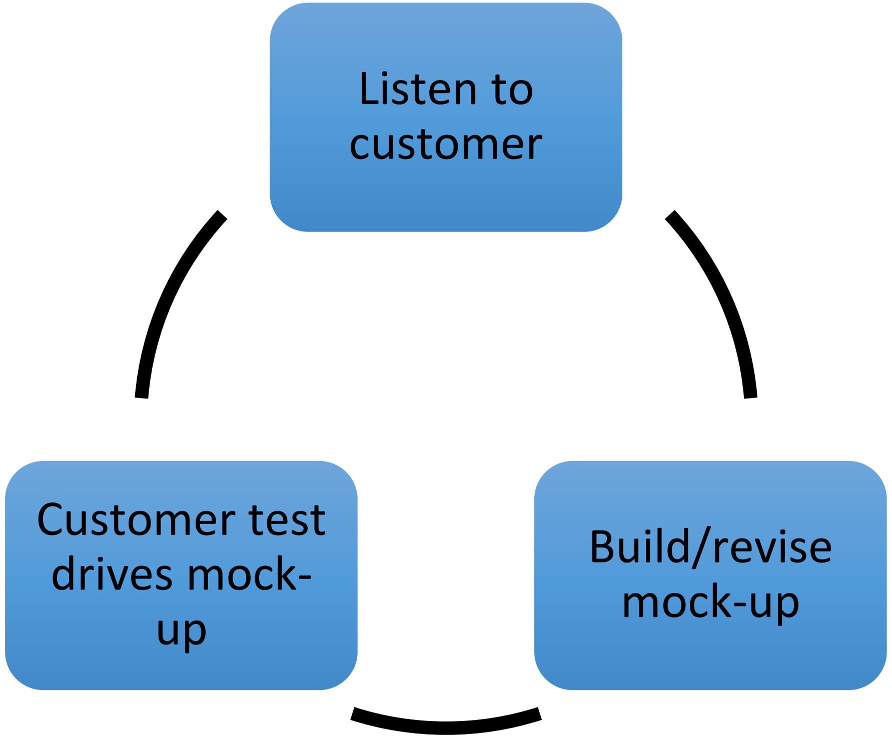
Operation

Prototyping Model

2.3 SELECTION OF PROCESS MODELS

- System prototype (evolutionary prototype)
  - working model of the information system, ready for implementation.

- Design prototype (throw-away prototype)
  - user-approved design prototype that documents and benchmarks the features of the finished system.



Prototyping Model

2.3 SELECTION OF PROCESS MODELS

- Advantages:
  - most useful when user requirements are uncertain.
  - Functional/valuable in designing information system's end-user interface (data-entry screen, reports or Web pages).
  - Encourages intensive user involvement.
- Disadvantages:
  - Rapid prototyping may skip essential steps in system development
  - e.g. skip the phase of analysis & design or testing in system development ---redo & incur more cost later.

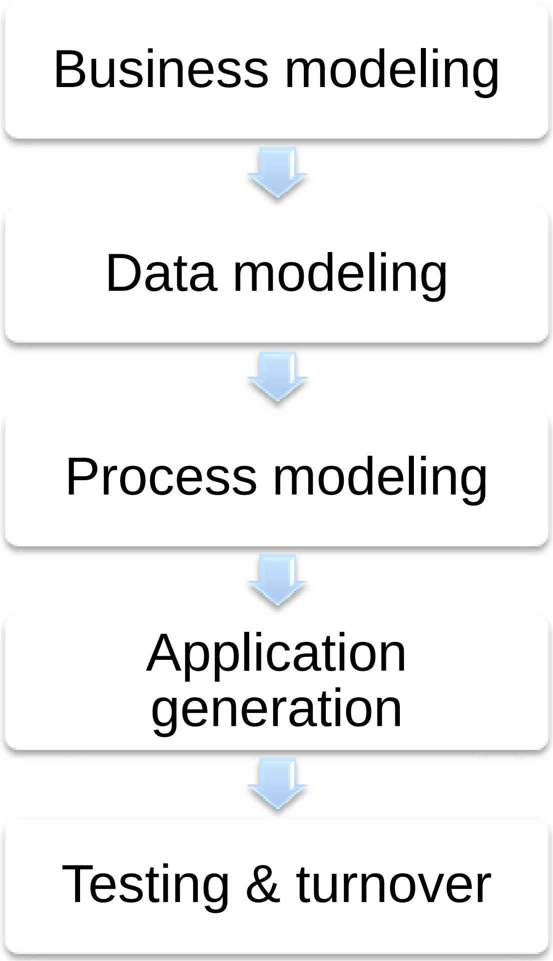
Rapid Application Development

2.3 SELECTION OF PROCESS MODELS

- Incremental software development process model that emphasizes an extremely short development cycle.
- If requirements and project scope is well defined, system can be produced within 60-90 days.
- Each RAD team will take up major function (component to be accomplished within 3 months) and then integrated to form a whole.

Rapid Application Development

2.3 SELECTION OF PROCESS MODELS



- **Business modeling:**
  - What information drives the business process?
  - What information is generated?
  - Who generates it? Where does the information go?
  - Who processes it?
- **Data modeling:**
  - The information flow is refined into a set of data objects with attributes and relationships between objects.
- **Process modeling:**
  - Processing descriptions are created for adding, modifying, deleting, or retrieving a data object.
- **Application generation:**
  - Reuse existing program components/create reusable components.
- **Testing and turnover:**
  - Reused components have been tested before and thus reduce testing time.
  - Need to test integration of different components

Rapid Application Development

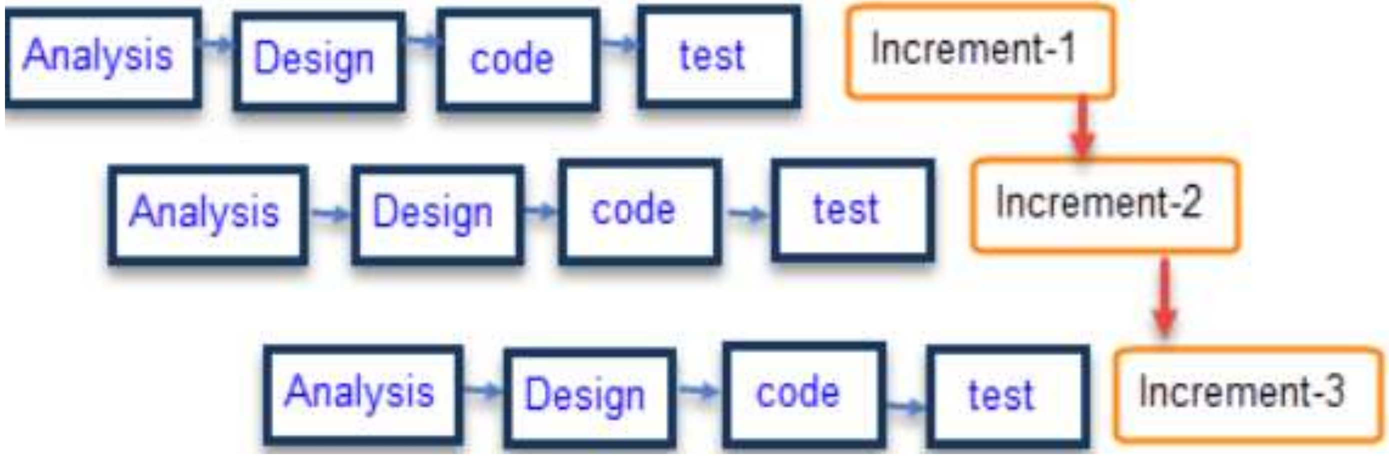
2.3 SELECTION OF PROCESS MODELS

- Drawbacks:
  - For large but scalable projects, RAD requires sufficient human resources to create the right number of RAD teams
  - Requires developers and customers committed to the rapid-fire activities.
  - Not suitable for system that cannot be modularized.
  - Not appropriate when technical risks are high:
    - New system use new technology
    - New software needs to integrate with existing system.

Incremental Model

2.3 SELECTION OF PROCESS MODELS

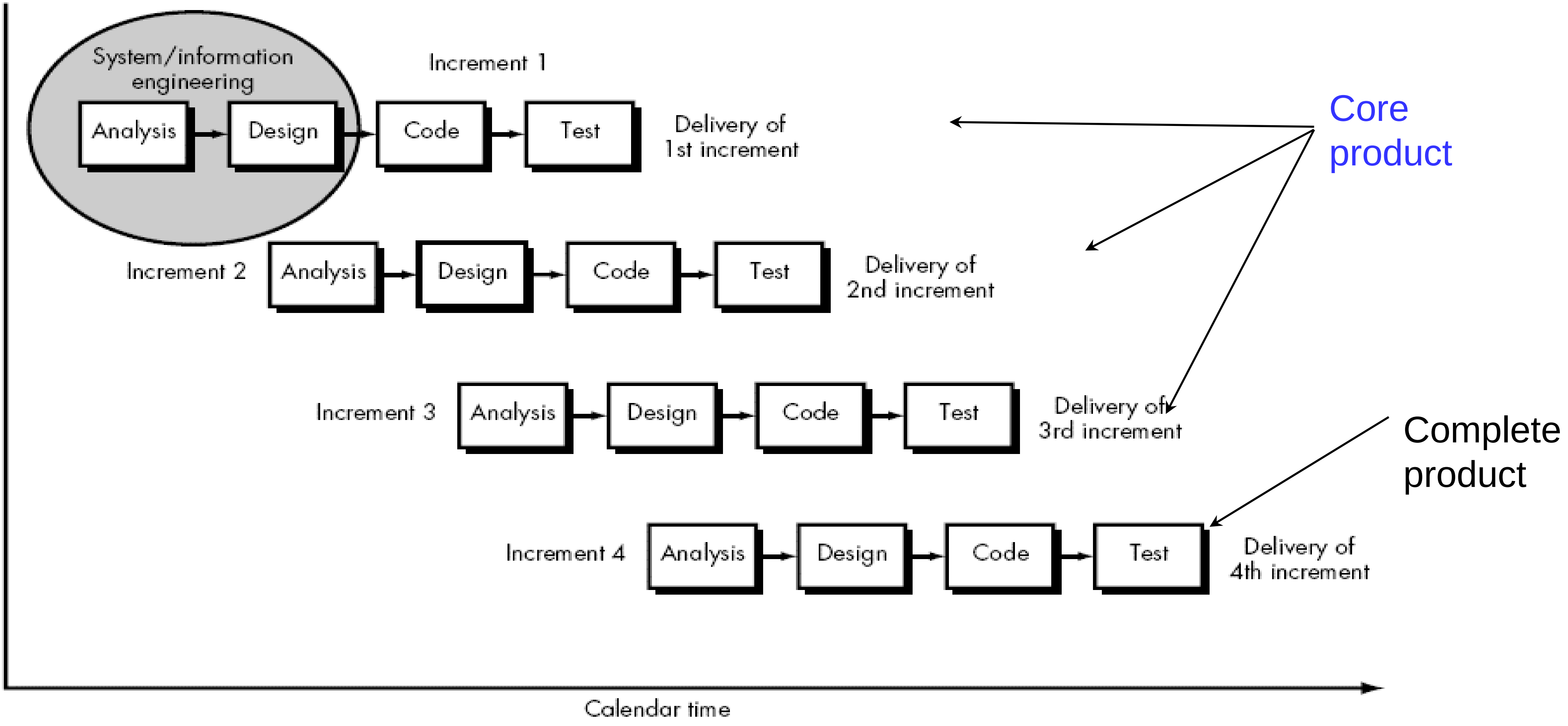
- Linear sequential model + prototyping
- Delivers software in small but usable pieces, called “increments”.
- Each increment builds on those that have already been delivered.



- Each iteration passes through the **requirements, design, coding and testing phases**. And each subsequent release of the system adds function to the previous release until all designed functionality has been implemented.

Incremental Model

2.3 SELECTION OF PROCESS MODELS



Spiral Model

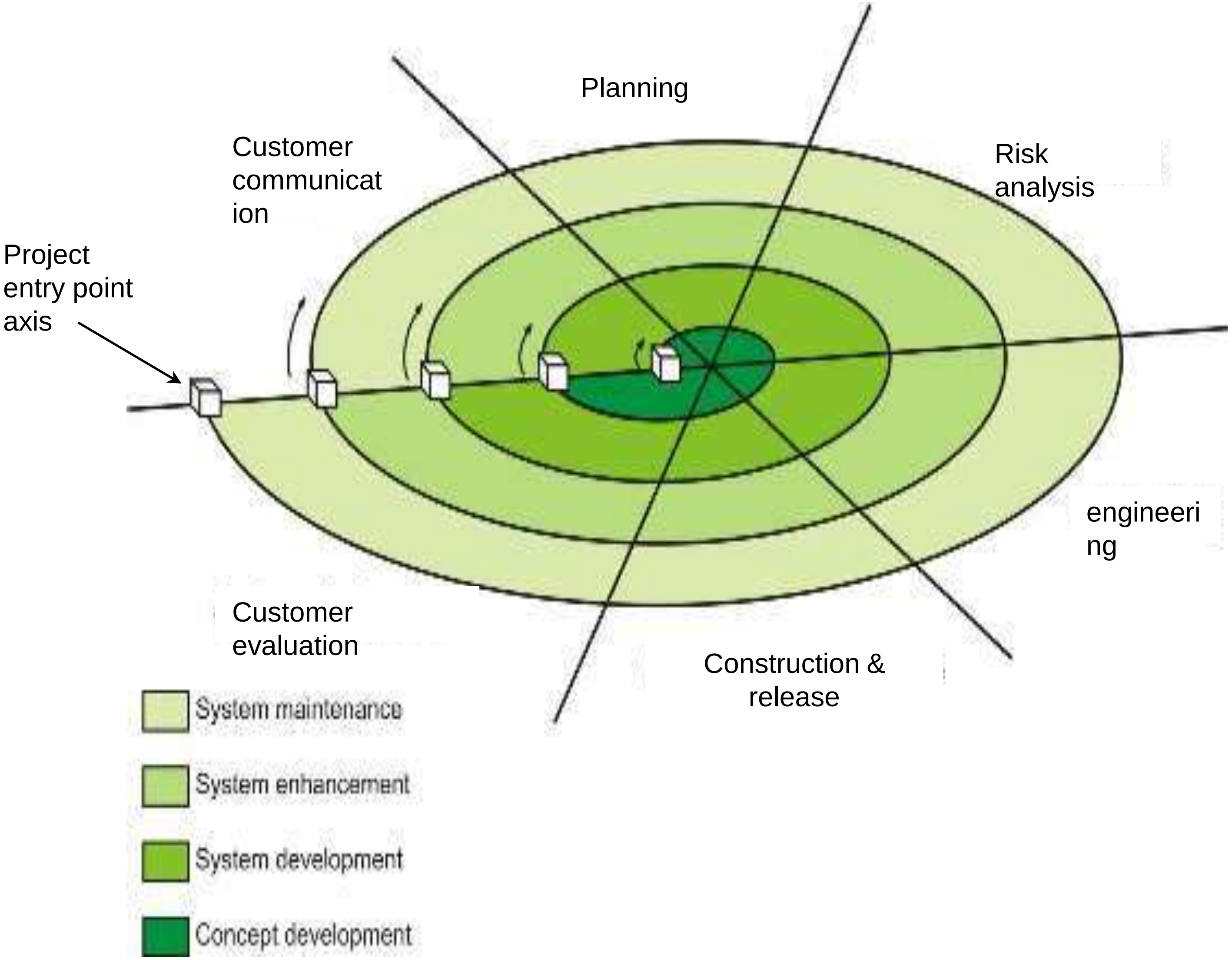
2.3 SELECTION OF PROCESS MODELS

- A greater level of detail is considered at each stage of the project.
- System to be implemented is considered in more detail in each sweep in a loop or spiral.
- Each sweep terminates with an evaluation before the next iteration is embarked upon.
- Key point: uncertainty is eliminated through thorough and repeated steps because more knowledge about the project is gained.

- When the project is large
- When requirements are unclear and complex
- When risk and costs evaluation is important: Risk analysis needed

Spiral Model

2.3 SELECTION OF PROCESS MODELS



Planning

Customer communication

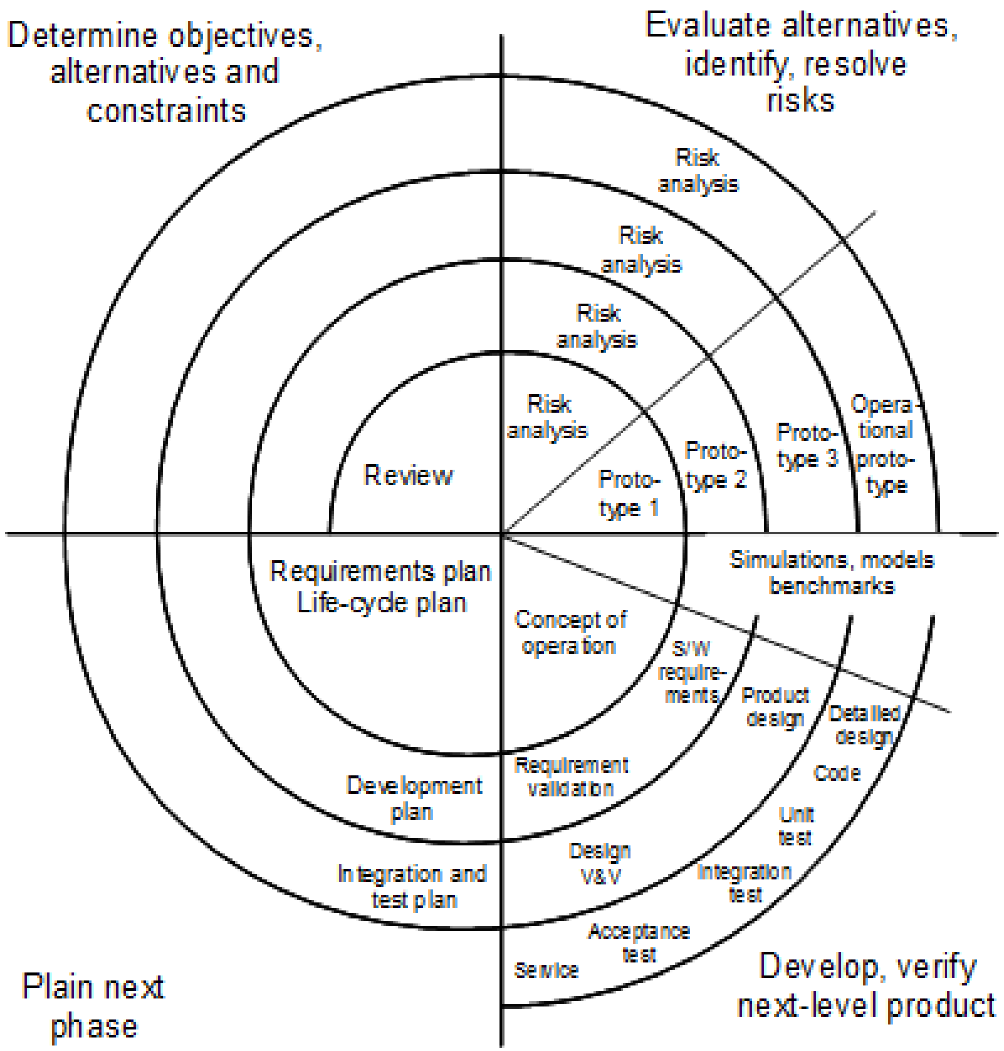
Risk analysis

Project entry point axis

engineering

Customer evaluation

Construction & release



Spiral Model

- Six task regions:
  - Customer communication
    - Tasks required to establish effective communication between developer and customer.
  - Planning
    - Tasks required to define resources, timelines, and other project-related information.
  - Risk analysis
    - Tasks required to assess both technical and management risks.
  - Engineering (Coding)
    - Tasks required to build one or more representations of the application.
  - Construction and release
    - Tasks required to construct, test, install, and provide user support (e.g. documentation and training)
  - Customer evaluation
    - Tasks required to obtain customer feedback based on evaluation of the software representations created during the engineering stage and implemented during the installation stage.

Spiral Model

2.3 SELECTION OF PROCESS MODELS

- Six task regions:
  - Engineering (Coding)
    - Tasks required to build one or more representations of the application.
  - Construction and release
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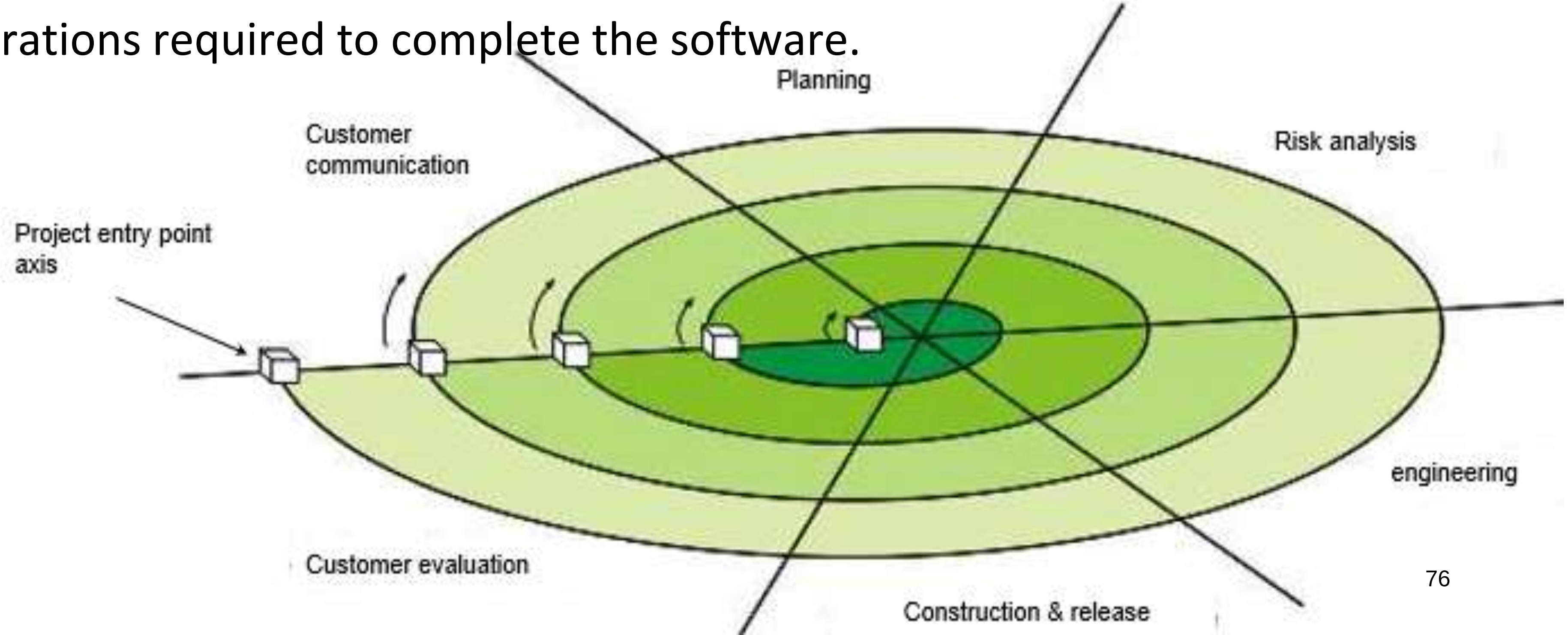
  - Customer evaluation
    - Tasks required to obtain customer feedback based on evaluation of the software representations created during the engineering stage and implemented during the installation stage.

Spiral Model

2.3 SELECTION OF PROCESS MODELS

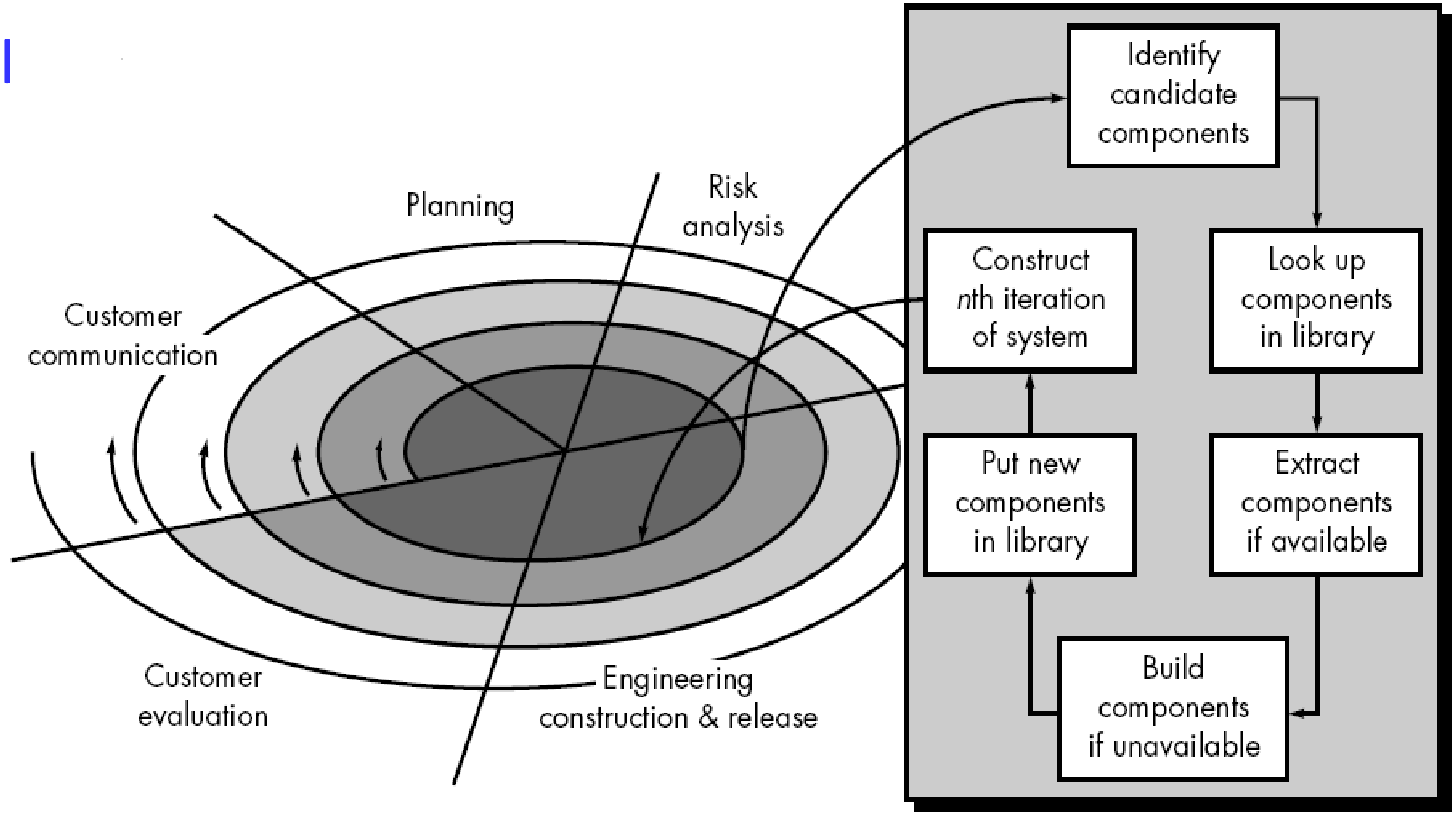
- As this evolutionary process begins, the software engineering team moves around the spiral in a clockwise direction, beginning at the center.
- The first circuit around the spiral might result in the development of a product specification; subsequent passes around the spiral might be used to develop a prototype and then progressively more sophisticated versions of the software.
- Each pass through the planning region results in adjustments to the project plan. Cost and schedule are adjusted too.
- PM decides number of iterations required to complete the software.



Component-based Development

2.3 SELECTION OF PROCESS MODELS

- Incorporates many of the characteristics of the spiral model.
- It is evolutionary in nature
- Iterative approach
- Composes applications from prepackaged software components (called classes)


Planning
Risk analysis
Customer communication
Customer evaluation
Engineering construction & release
Identify candidate components
Look up components in library
Extract components if available
Build components if unavailable
Put new components in library
Construct nth iteration of system

Software Project Process Model Selection

Models	Budget	User Requirement	Man power	User	Development Time	Project scope
Waterfall	High	Well defined	Many staffs	Less involved	Long	Large-scale system
Prototyping	Limit	Uncertain	Few staffs	Highly involved	Flexible	Small to medium
Rapid Application Development (RAD)	High	Well defined	RAD teams to tackle component	Highly involved	3 months	System that can be partitioned/ componentized
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Summary

2.1 Project Planning and Estimation

2.2 Project Monitoring and Control

2.3 Selection of Process Models