School of Engineering

Project Management & Engineering Practice
(GENG 5505)

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Project Management & Engineering Practice (GENG5505)

Time management:
Developing and controlling the schedule
(Ch 5)

(Week 3b) - Lecture six, 14th March, 2024

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Planning/Scheduling

- Refining project goals & documenting the best way to achieve them

- A variety of project plans are produced. The most common include:

Project timeline, cost & budget plan, risk plan (identification, assessment, analysis, management /response, monitoring), quality plan & communications plan, purchase & acquisition plan, TBL and life cycle plan, detailed assumptions, ...

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The answers we need to know

1. What work must be performed?
   - (Identifies all required tasks)

2. How long will each task take?
   - (Determines the task duration & effort)

3. What resources can perform the work?
   - (Determines what resources – human & physical – should be assigned)

4. How much investment is required?
   - (Determines what budget is needed)

Project planning/Schedule

- As highlighted, the scope should provide well-defined, achievable project goals & a road map for achieving them

- Completion of project scope statement (i.e. Project description & justification; goals & objectives; deliverables (output); milestones; assumptions; project success criteria; TBL, ...)

- Project manager to secure formal scope approval by key stakeholders

- Next step, is to divide the scope into activities - i.e. Work components that can be planned, estimated, scheduled & assigned to project team members

- These activities should be grouped into a hierarchical, deliverable oriented decomposition: The work break down structure (WBS)

- The WBS should be formally approved for the project manager to proceed to the next phase

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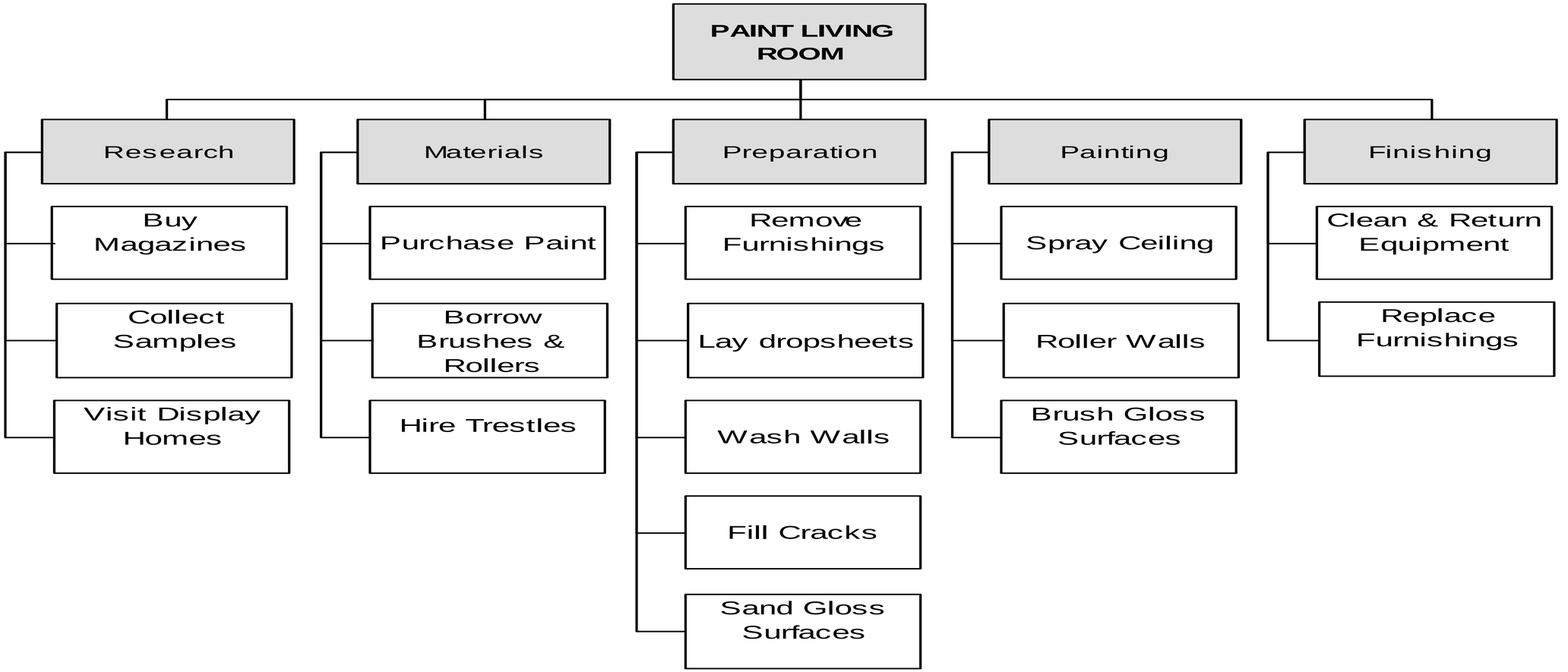
WBS: A multi-level perspective
(Deliverable oriented graphical format)



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WBS Table: Documenting stage, task & milestones

ID	Task	Duration	Effort	Links	Start	Finish	Who	Cost	Notes
1	Research								
1.1	Magazines	2d	4h	-					
1.2	Samples	3d	8h	1.1					
1.3	Visits	1d	8h	1.2					
2	Materials	1d							
2.1	Paint	4d	16h	1.3					
2.2	Brushes	2d	2h	2.1					
…	…	….	….	….					

Breaking down the project

- Factors influencing the WBS:
  - The information captured by the charter & scope(inclusions & exclusions)
  - The complexity of the project
  - The accuracy required in the estimates
  - The extent of quality definitions, standards & requirements
  - The degree of risk involved & the risk profile of the stakeholders
  - The extent of any contractual performance obligations
  - The required level of measurement & control
  - TBL and life cycle requirements
  - ...

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WBS: Advantages & disadvantages

Advantages

- Captures tasks to complete the project
- Identifies tasks relationships
- Easy to read in the table format
- Makes possible to visualize a complex project
- Ties the project together
- .....

Disadvantages

- Time consuming
- No timeline
- Potential inconsistency between table & effective schedule
- Potential discrepancy between projected & effective resources;
- Some tasks may be constrained by factors other than predecessors;
- ....

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Common estimating techniques

- Analogous estimating (history) (strong similarity with previous projects in the database) – easy to use but appropriate assumptions needed
- Using resource unit rates (the lower the unit rates the more resources you get with your money)
- Bottom-Up estimating - each task is broken down into smaller components. The estimates for the smaller individual components are then aggregated to develop a larger estimate for the entire task as a whole
- Expert judgment/Educated guess = Opinion or a judgment based on expertise/specialized knowledge
- Vendor bid analysis – obtaining written bids from vendors (eg. Expression of Interest (EOI) minimum 3 vendors)
- Three point estimate/Wide band Delphi (weighted average): Involves team discussions – team members correct one another way that helps avoid errors & poor estimation. Very common for software projects
- Parametric estimating (metric), statistical/mathematical modeling
- *** Please note: No estimate is guaranteed to be accurate, but appropriate assumptions make estimates more accurate

Calculating the 3 point estimate

Analytical technique that uses three cost or duration estimates to represent the optimistic, probable and pessimistic scenarios. This approach is used to improve the accuracy of the estimates (of cost or duration) when the underlying activity or cost component is uncertain (Beta distribution, PMBOK, 2013)

$$Te = \frac{To + 4Tm + Tp}{6}$$

Example:

To - optimistic time = 5 days

Tm - probable time = 10 days

Tp - pessimistic time = 30 days

Te = 75:6 = 12.5 days (expected time)

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Estimation guidelines

So, given that no estimates will ever be entirely accurate, we should record:

- How the calculation was determined
- All underlying assumptions and impacting constraints
- The confidence level (+/-) .....(we should already know the acceptable tolerance level
- The optimistic, pessimistic & most likely range
- All source data
- Details of all stakeholders involved
- .....

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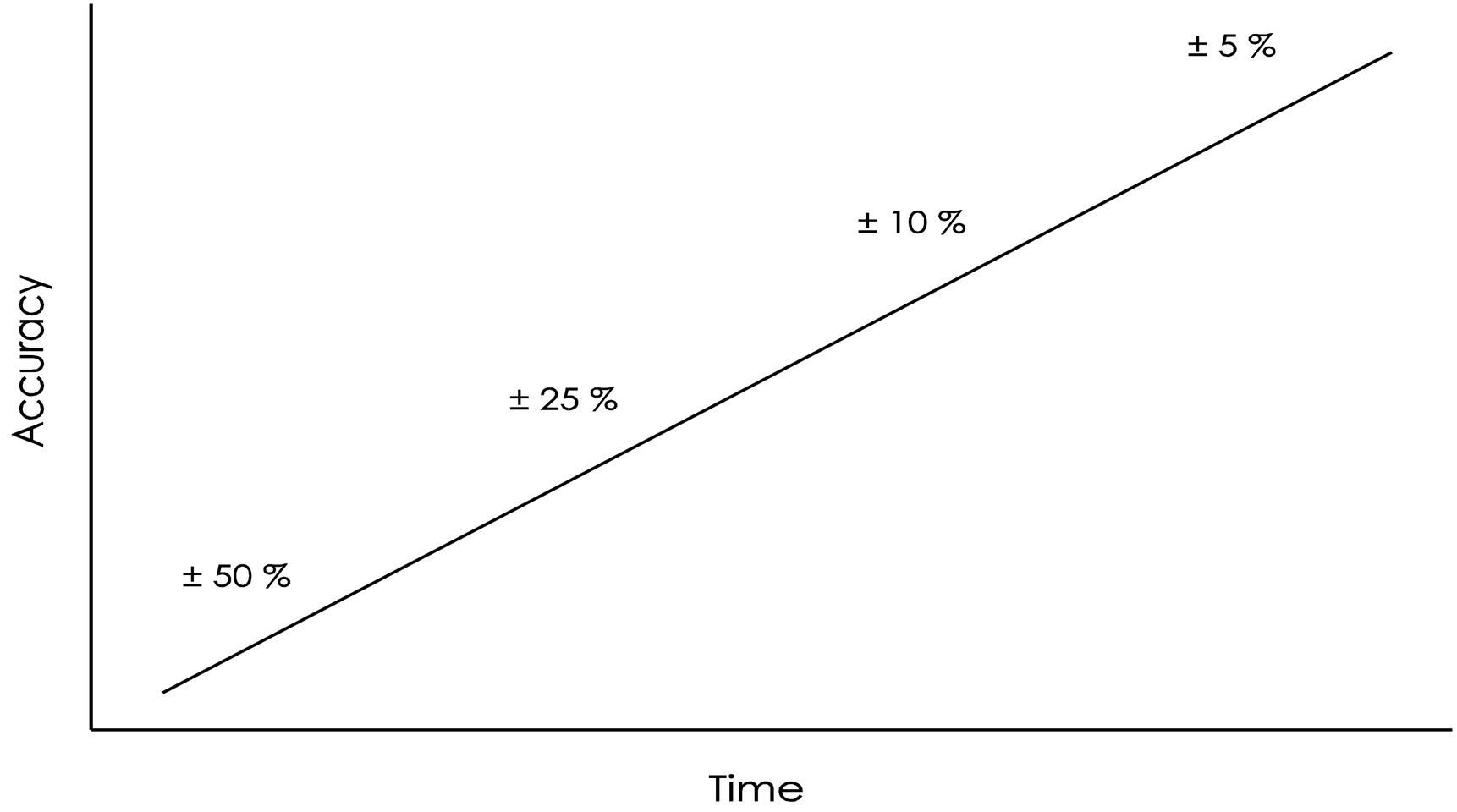
Estimating accuracy



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Identifying the resource capability

The following information about the resources should be identified in detail:

- Resource name—individual name or generic label (e.g. plumbers)
- Resource type—labour, material,…
- Resource group—the group to whom the resource belongs
- Resource capability—skills, expertise, prior experience, …
- Resource rate—what is their normal rate, or other fixed/variable costs
- Resource location—the physical (geographical) location
- Resource quantity—how many will be required
- Resource availability—the actual ‘free’ time they have to allocate
- Resource calendar—what dates are excluded throughout the project
- Resource report—who does the resource currently report to
- Resource development—will any additional training be required
- Resource evaluation—performance evaluations from past projects

Experimenting with the sequence

The development of the project schedule is driven by these activity-to-activity relationships in determining when activities start and finish.

1. Finish – Start: one activity finishes to start the other activity;

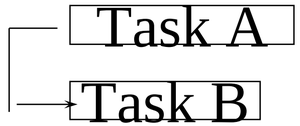
2. Start – Start: one activity starts to start the other activity;

3. Finish – Finish: one activity finishes to finish the other activity;

4. Start – Finish: one activity starts to finish the other activity.

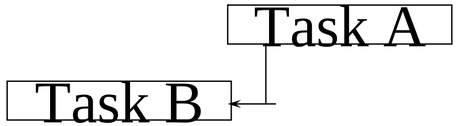
Designing flexible schedules

Finish - Start (FS)



Start - Start (SS)

Finish - Finish (FF)



Start - Finish (SF)

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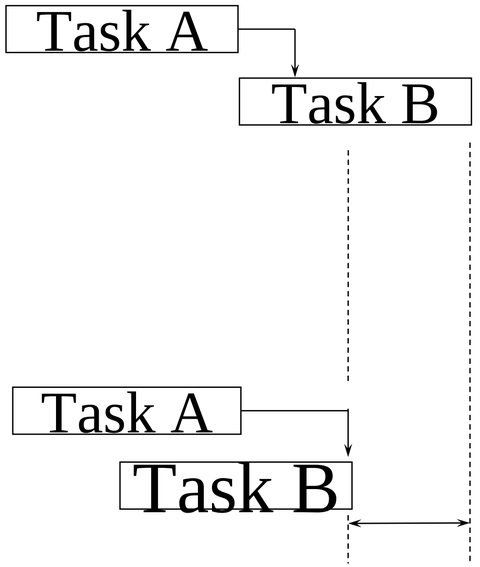
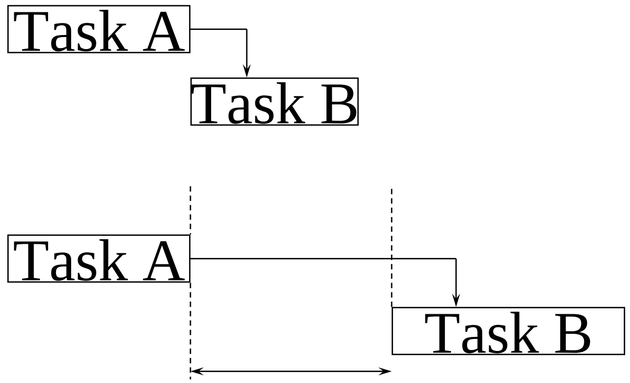
Scheduling lead time (fast-track)



The amount of time the successor task can be advanced (intentional acceleration)

Scheduling lag time (delay)

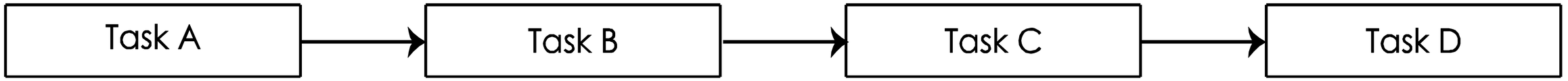


The amount of time the successor task can be delayed (intentional delay)

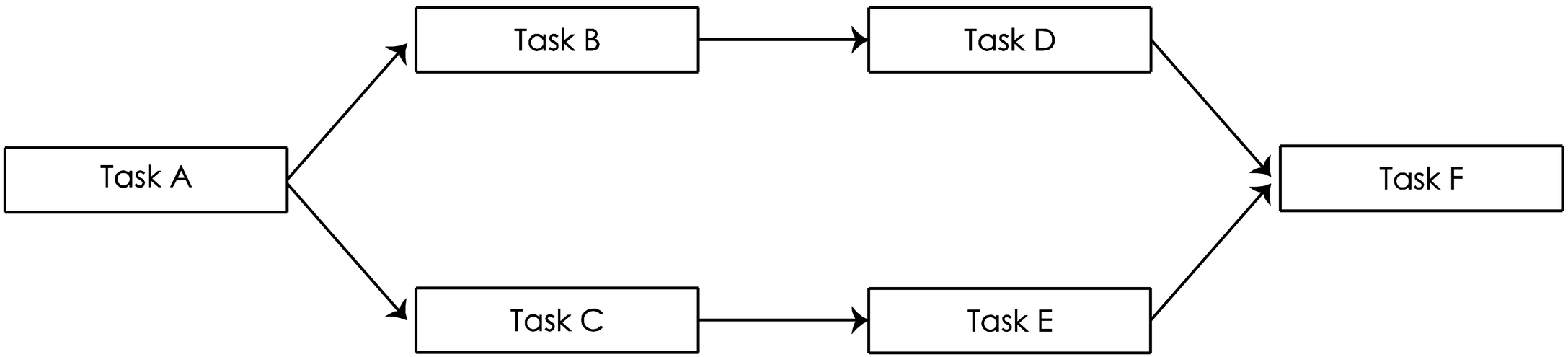
Developing the schedule

- From WBS to PERT = the need for building a project picture
- A work breakdown structure is not a schedule
- Network diagrams and/or Gantt charts create schedules
- Schedules often represent intent, not necessarily reality unless they are updated regularly
- Activities can be sequenced in–series or in parallel
- When dealing with in-series activities, schedule tasks to commence when their predecessor(s) have finished
- Schedule tasks to commence as soon as possible
- All tasks must be linked through to the project completion
- Work backwards to try and eliminate errors and time

Network diagram (linear path)



Network diagram (parallel paths)



MIGRATING FROM THE WBS TO THE NETWORK DIAGRAM

ID	Task	Duration	Predecessor	Resource	Cost
1	A		-		
2	B		1		
3	C		1		
4	D		2		
5	E		3, 4		

WBS table

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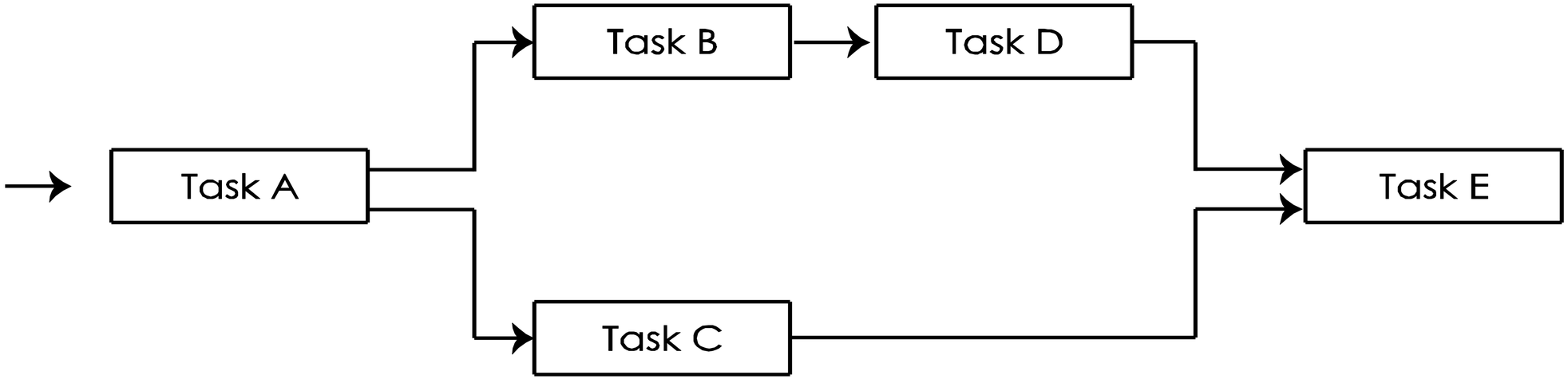
Migrating from the WBS to the network diagram: Program Evaluation Review Technique (PERT) Network diagram

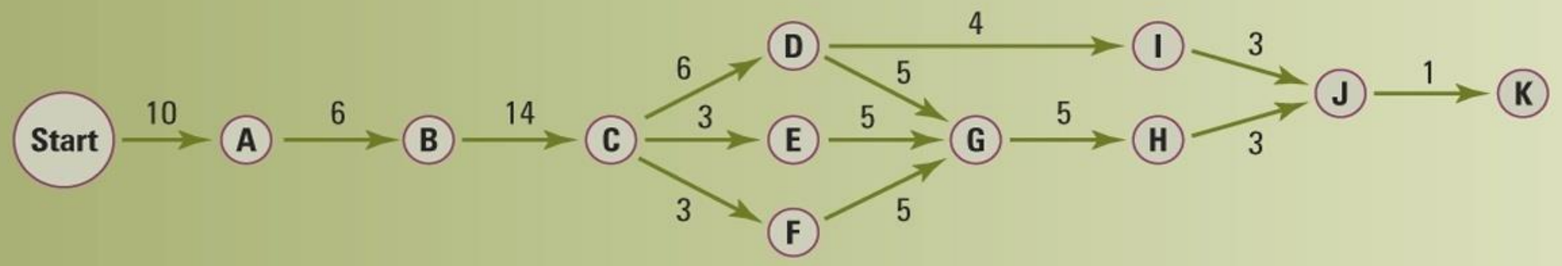


Creating the Program Evaluation Review Technique (PERT) network diagram – (Robbins et al, 2009)

TABLE 9.5 A PERT network for constructing an office building

EVENT	DESCRIPTION	EXPECTED TIME (IN WEEKS)	PRECEDING EVENT
A	Approve design and get permits	10	None
B	Dig subterranean garage	6	A
C	Erect frame and siding	14	B
D	Construct floor	6	C
E	Install windows	3	C
F	Put on roof	3	C
G	Install internal wiring	5	D,E,F
H	Install lift	5	G
I	Put in floor covering and panelling	4	D
J	Put in doors and interior decorative trim	3	I,H
K	Turn over to building management group	1	J

FIGURE 9.5 A PERT network for constructing an office building



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The PERT illustrates:

- The project's logic and how it is tied together
- The relationships between required tasks
- The flow of work throughout the project
- Where the critical path lies throughout the project
- The potential bottlenecks
- How is task required for the project to be completed
- ...

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PERT network diagram: Advantages & disadvantages

Advantages

- Excellent visual & interactive graphic to demonstrate the schedule
- Participative decision making
- Joint risk identification & response strategy
- Negotiated concessions
- Improved team ownership
- Shows Critical Path
- Eliminates idle time
- ...

Disadvantages

- Difficult to read if the project is large
- No timeline
- Difficult to monitor & report performance
- Not always easy to understand
- Limited amount of information that can display
- .....

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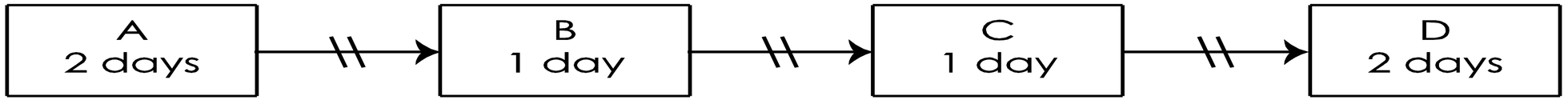
Working with critical path analysis (CPA)

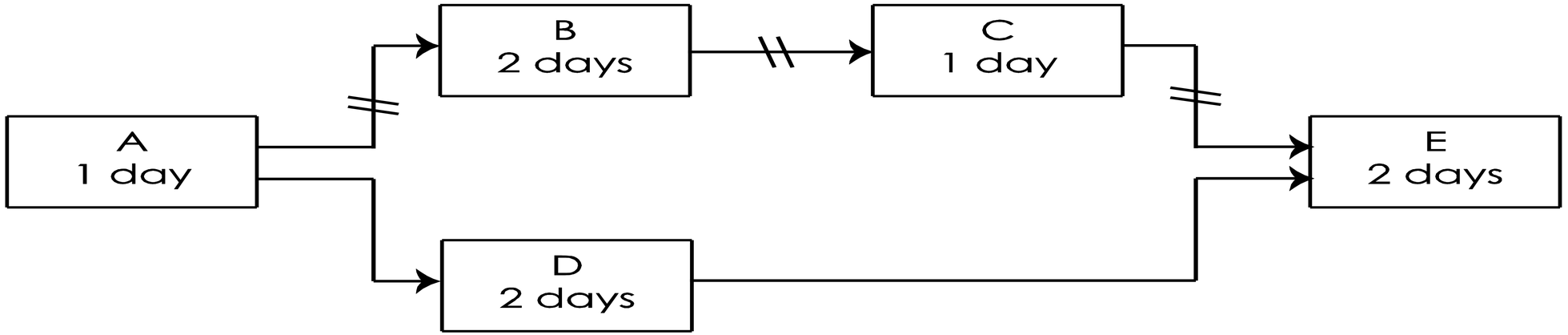
- The longest path (task) through the network, critical to be completed on time to prevent project delays – a delay in critical tasks means project delay
- The shortest project completion time
- The path with no ‘float’ (no delay)
- The tasks that must start & finish as scheduled for the project to finish as scheduled

- Critically important for good reason
  - Tasks that must be closely managed
  - No delays possible
  - Accurate estimates
  - Regular performance reporting
  - Timely corrective action
  - Contingency actions required
  - …

CRITICAL PATH (PERT NETWORK DIAGRAM)



1. In-series critical path - sample PERT



2. In-parallel critical path - sample PERT

The Gantt chart

- A valuable scheduling tool
- Details activities, order of completion & establishes completion times
- Visualizing actual & planned output over time
- Control tool to identify deviations
- Different task relationships are possible (i.e. finish-start; start-start; finish-finish; start-finish) which offer varying degrees of flexibility & complexity in relation to time, resources & costing
- ...

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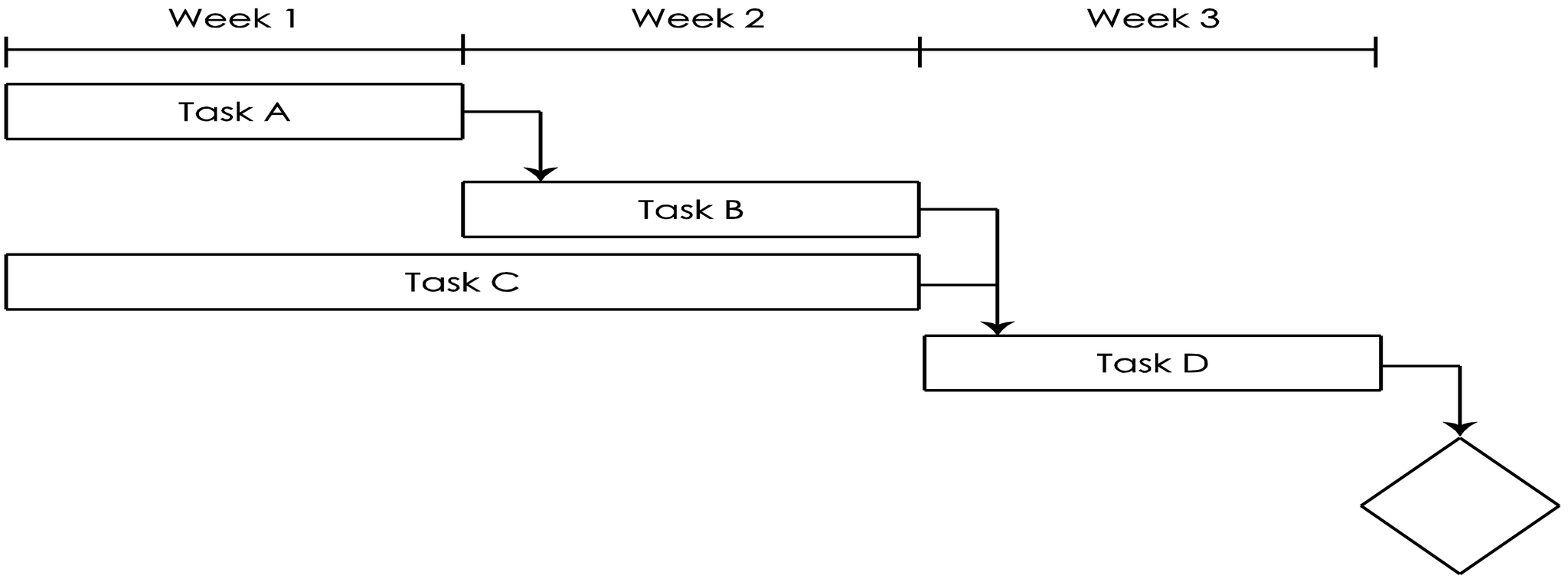
THE GANTT CHART (LINEAR AND PARALLEL PATHS)



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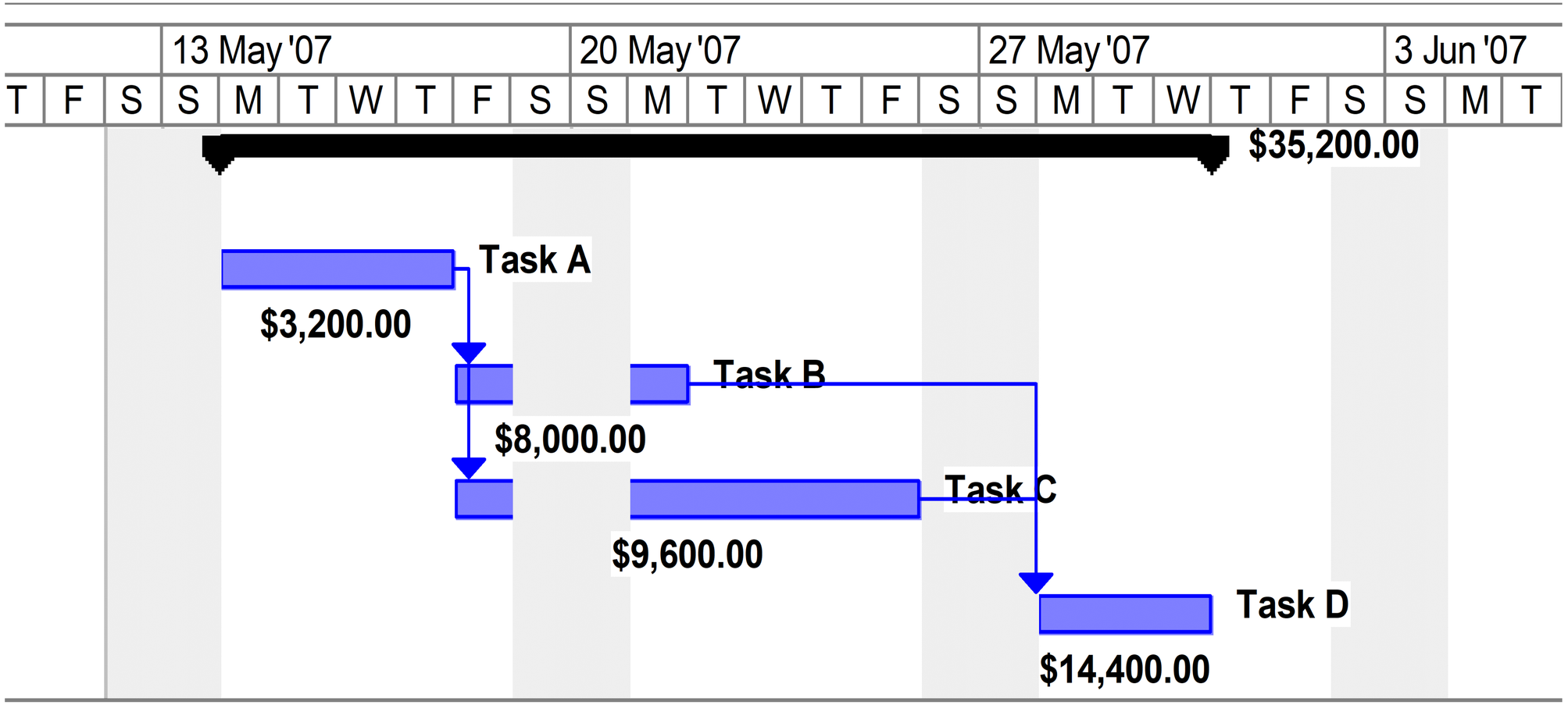
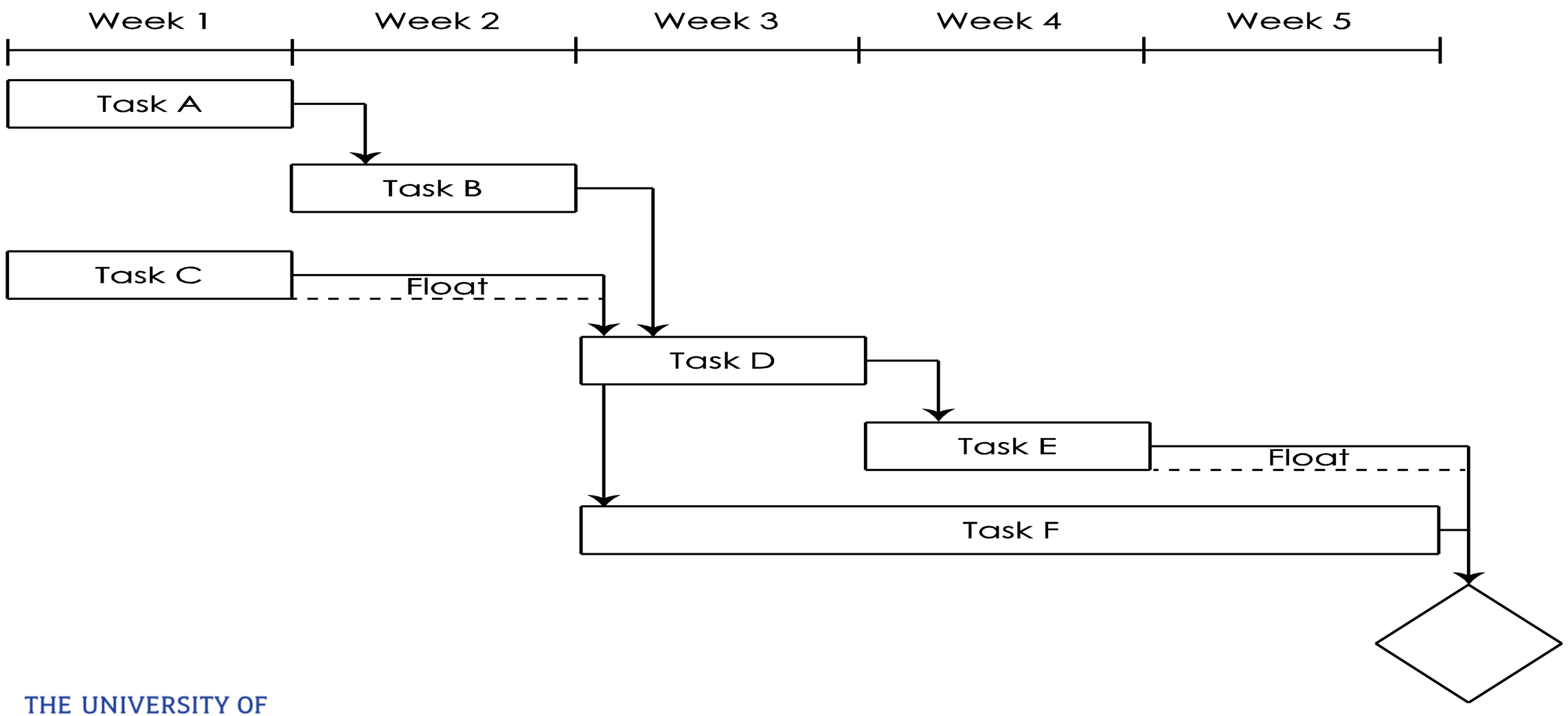
Example of Time phased budgeting



CRITICAL PATH (GANTT CHART)



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Gantt chart: Advantages & disadvantages

Advantages

- Illustrates task duration
- Clarifies the 4 task relationship types
- Ideal for monitoring actual progress to date
- Identifies the critical path/s
- Easy to allocate resources
- Easy to read from top down & from left to right
- Illustrates the application of lead & lag time
- ....

Disadvantages

- Difficult to read due to the amount of information
- Time consuming to update & report
- Need software to avoid excessive time spent drawing & reviewing schedules
- Often bears little resemblance to reality
- Easily outdated given the frequency of scope changes & revisions
- ...

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Controlling the schedule

To effectively control the project schedule, the following actions should be considered:

- Updating changes to the schedule as they occur
- Determining the current reporting date of the project
- Assessing the current status of the project against the published plan to identify true performance
- Re-scheduling remaining activities
- Re-circulating the agreed schedule revision and have approval from key stakeholders
- Conducting retrospective reviews and walkthroughs to record lessons learned
- ....

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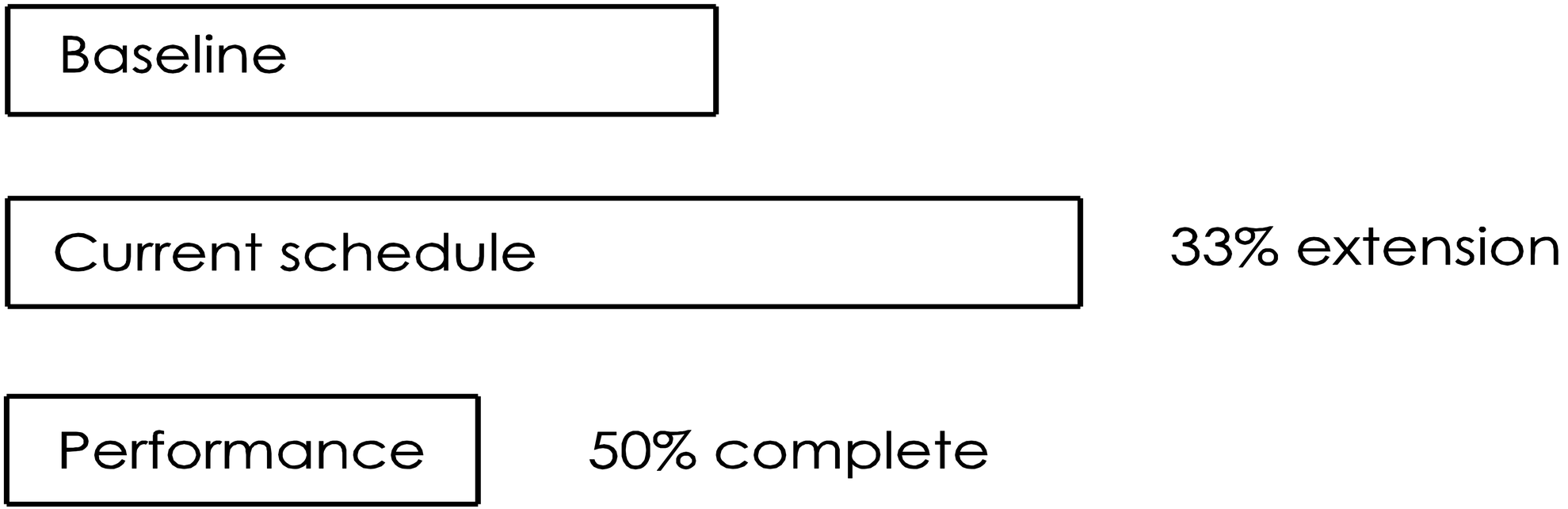
Tracking actual performance against the baseline and current schedule



SMART – Project planning framework

Hartman et al. 2004)

- Strategically managed projects: i.e. project vision & mission to be aligned with company goals, mission & vision;
- Alignment: Stakeholders aligned with project objectives; project team aligned with project plan; project priorities aligned with management metrics;
- Regenerative - A regenerative team has: open communication, job ownership, risk taking propensity, trust, fun/motivation in undertaking the project, creativity, etc.
- Transitional: appropriately managing change & stakeholder relationships, while dealing with environmental complexity, uncertainty & risk

Reading week 3

Hartman F. and Ashrafi R, 2004, Development of the SMART project planning framework, *International Journal of Project Management*, pp 499 – 510