2020/10/19
生產與作業管理

” Chapter 5: Project Management

Outline

1. What is project management?
2. Structuring projects
3. Work breakdown structure
4. Project control charts
5. Earned Value Management (EVM)
6. Network-planning models

1. What is project management?

- Project : a series of related jobs usually directed toward some major output and requiring a significant period of time to perform.
- Project management: planning, directing, and controlling resources (people, equipment, material) to meet the technical, cost, and time constraints of the project.

台南鐵路地下化預計2022年通車

2019-04-07 23:20

[記者劉婉君 / 台南報導] 台南鐵路地下化預計2022年底通車，全長8.23公里，沿線共有9處平交道、8處車行及人行地下道及2處鐵路橋涵、3處陸橋，也將在地下化後消除。

台南鐵路地下化北起大橋車站南端，南至大林路平交道以南約0.53公里，沿線經過包括實踐街、東豐路、青年路、復興路、榮譽街、生產路、龍寶路、後勤司令部、大林路等9處平交道；長榮、小東、民族四維、府連、林森大同地下道，以及台南車站、衛民街、崇明街等3處人行地下道；開元路、東門、中華陸橋；光華街、月見堂溪鐵路橋涵等。

鐵道局第六工務段表示，四維、林森大同、小東地下道及中華陸橋，均不在此次計畫中，開元國小兩座人行陸橋目前已拆除1座，另1座將改建。

工務局指出，地下道每遇颱風豪雨即易淹水，因此鐵路地下化後將填平，小東、四維、林森大同、中華陸橋等，若工程未來有剩餘款或向中央爭取經費，也希望納入填平與拆除。

不過，台南民間發起保留壽陸橋（四維地下道）連署活動，希望留下日治時期興建的壽陸橋，工務局也表示，雖然文資審議後評估整座橋梁未達文資價值，但也希望輔導做文資保存，至於保留方式還要再討論。

蘭子

嘖嘖 | 探索 故事牆 提案

群眾集資 | 地方創生

蘭子蘭編工藝復興計畫｜一起傳承 300 年台灣工藝！

提案人 蘭子

傳承近 300 年的蘭編產業，在多方的努力之下，踏實穩定的成長著，但是看似前景樂觀的產業，卻面臨老舊機器損毀的危機…。

NT$3,872,780

曾繁絹 嘖 贊助人 7 天前

請問 P4178SDPP3MYXEJDLBHU的出貨日期? 謝謝!

蘭子 提案人 贊助人 7 天前 3:59

您好，不好意思我們在出貨通知上沒有做到很完善，沒有及時更新給各位，如造成困擾十分抱歉。
我幫您查詢出貨的日期，您的商品預計於10/21-22之間寄出，謝謝您的耐心等候。也非常抱歉因為手工製作速度較不能掌控，我們在出貨期程上不斷更改，請您見諒。謝謝您～

回覆這則留言

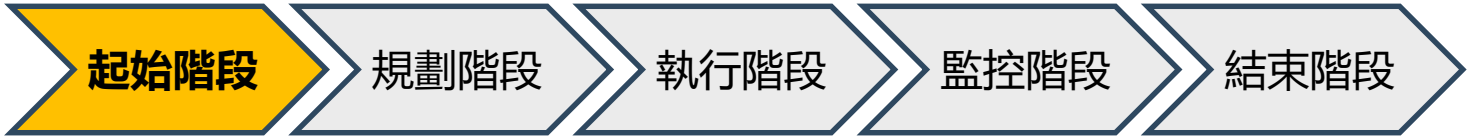
送出

執行專案的目的

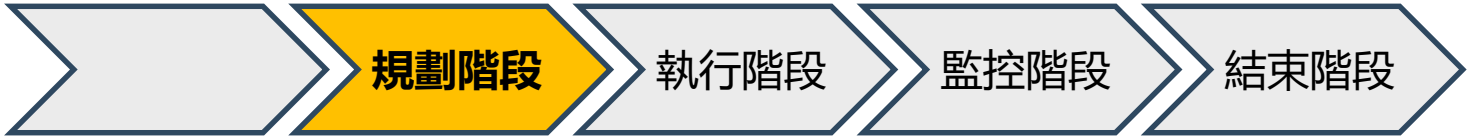
- 最後完成的任務結果為客戶所接受(The outcome of task is acceptable)
- 任務「如期」履行(The task is completed as scheduled)
- 任務「在預算之內」履行(The task is performed within the planned budget)
- 專案發展流程對進行中的企業營運影響最小(The less impact on the business operations)

專案管理五大流程（補充）

1. 起始階段（Initial）
2. 規劃階段（Planning）
3. 執行階段（Executing）
4. 監控階段（Control）
5. 結束階段（Closing）



- 定義問題
- 針對問題發展出解決方案和專案章程
- 辨識出與專案相關的利害關係者（例如：顧客、供應商、贊助者、職能經理等）
- 此階段有賴於專案經理的居中協調，使大家達到共識



- 縝密規劃，釐清專案「要做什麼」「誰負責做」「該如何做」「什麼時候完成」「需要耗費哪些成本」「需要供應哪些資源」，以及如何預防及減輕風險
- 一般而言，在此階段需投入最多心力，因為計畫越周詳，活動切割越細緻，顧全的層面越多，後續執行與追蹤階段會更加順暢與有效率

- 專案經理人運用溝通管理知識，了解及掌握專案利害關係者的需求與期望
- 運用人資管理知識，建立並發展自己的專案團隊
- 運用採購和品質管理知識，輔助專案的推行

- 專案執行過程中不斷監督及控制各個流程是否符合原先計畫
- 一旦發現有偏差，就必須立刻採取必要措施，將流程倒會正軌
- 若無法還原，也要做出修正或彌補，降低負面影響

- 專案經理運用採購管理知識，針對專案中所採購產品或服務進行「合約結案」及稽核審查工作
- 整合管理知識，將團隊成員在專案各個階段結束及整個專案結束之後，所學到的成功及失敗經驗，轉化為文件紀錄下來，做為日後其他專案的參考及借鏡

專案管理所需的十大知識領域（補充）

1. 整合管理
2. 範疇管理
3. 時間管理
4. 成本管理
5. 品質管理
6. 人力資源管理
7. 溝通管理
8. 風險管理
9. 採購
10. 利益關係人管理

2. Structuring projects

a. Pure project

b. Functional project

c. Matrix project

Pure project

- Small and self-contained team works full time on the project
- Project manager has full authority over the project
- Team members report to one boss
- Lines of communication are shortened. Quick decision
- Team pride, motivation, and commitment are high

國立臺南大學 National University of Tainan 高等教育深耕計畫

IR 品保
教學卓越

學習扎根
希望躍升

教創滿點
教專精進

寰宇移動
翱翔國際

智慧職搭
夢想職達

跨域整合
產學共榮

傳承實踐
在地創生

提升高教
公共性

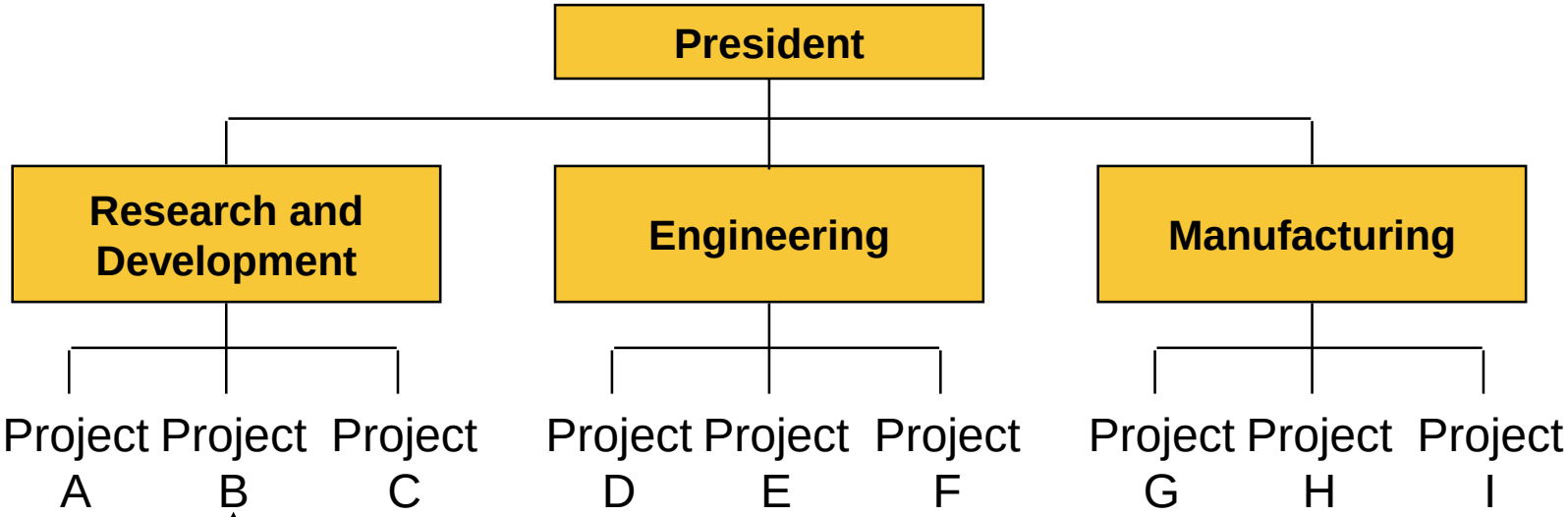
USR

But…

- Duplication of resources
- Team members are often both physically and psychologically removed from headquarters
- The organization falls behind in its knowledge of new technology due to weakened functional divisions
- Team members may worry about life-after-project, or the project termination is delayed

Functional project

- The project is executed within a functional division



Example, Project “B” is in the functional area of Research and Development.

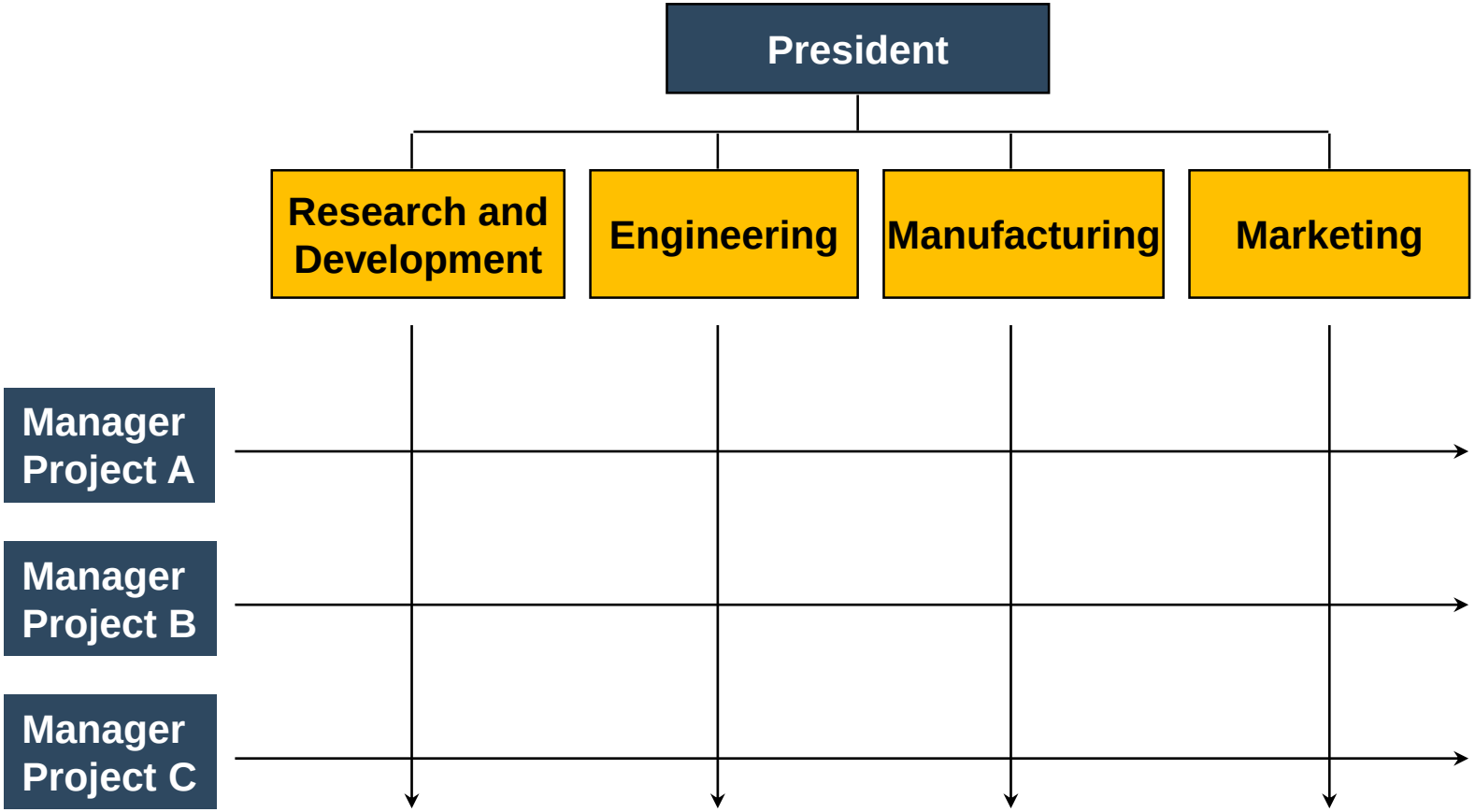
- A team member can work on several projects
- Technical expertise is maintained within the functional area
- The functional area is a “home” after the project is completed
- Critical mass of specialized knowledge

But…

- Aspects of the project that are not directly related to the functional area get short-changed (less changes)
- Motivation of team members is often weak
- Needs of the client are secondary and are responded to slowly

Matrix project

- To blend properties of functional and pure project structures
- The project manager decides what tasks and when they will be performed
- Different projects borrow/share resources from functional areas

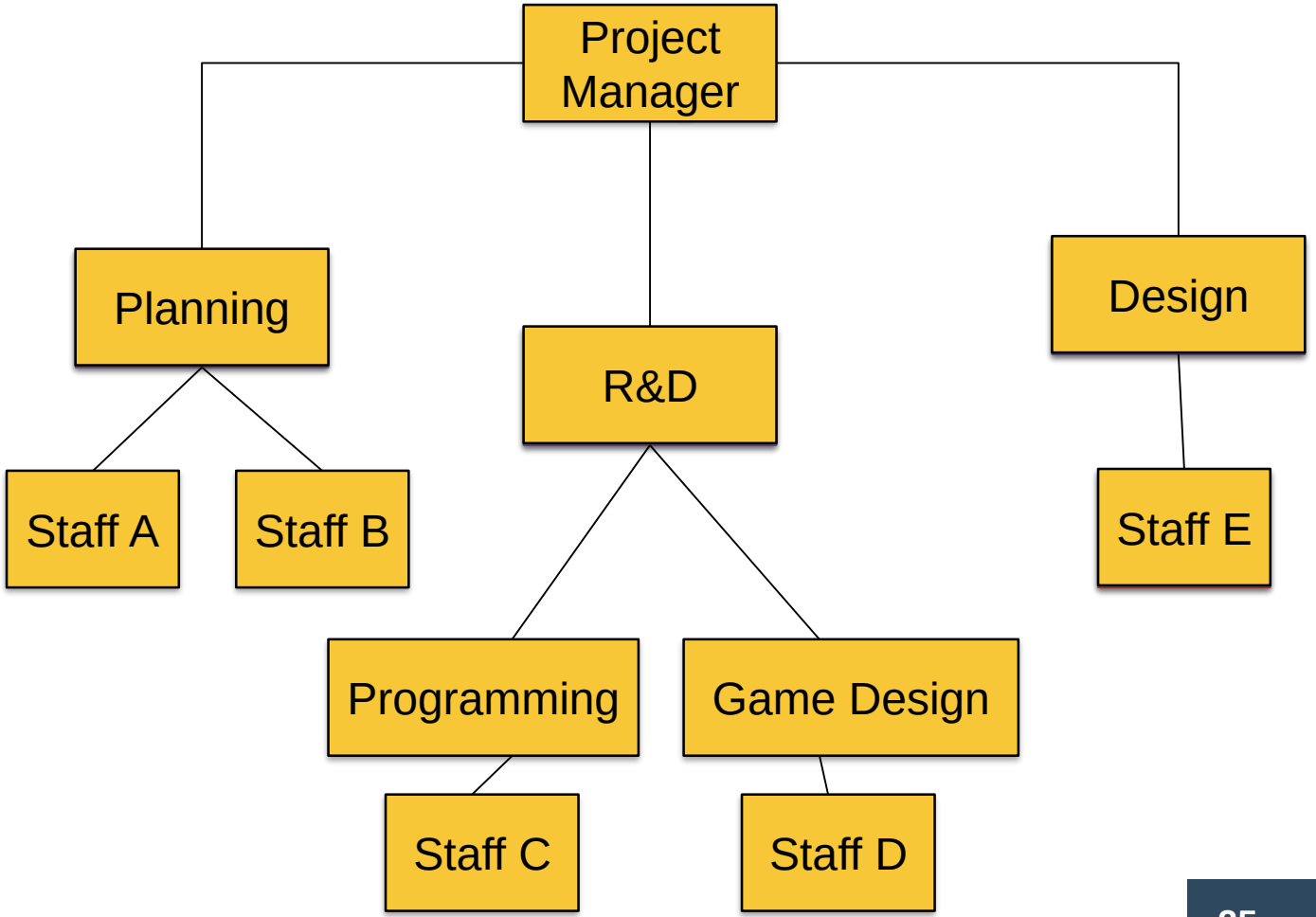

President
Research and Development
Engineering
Manufacturing
Marketing
Manager Project A
Manager Project B
Manager Project C

- Enhanced communications between functional areas
- Pinpointed responsibility
- Duplication of resources is minimized
- Functional “home” for team members
- Policies of the parent organization are followed

But…

- Too many bosses
- Depends on project manager’s negotiating skills
- Potential for sub-optimization（局部最佳化）

層級結構圖 (hierarchical structure) (補充)



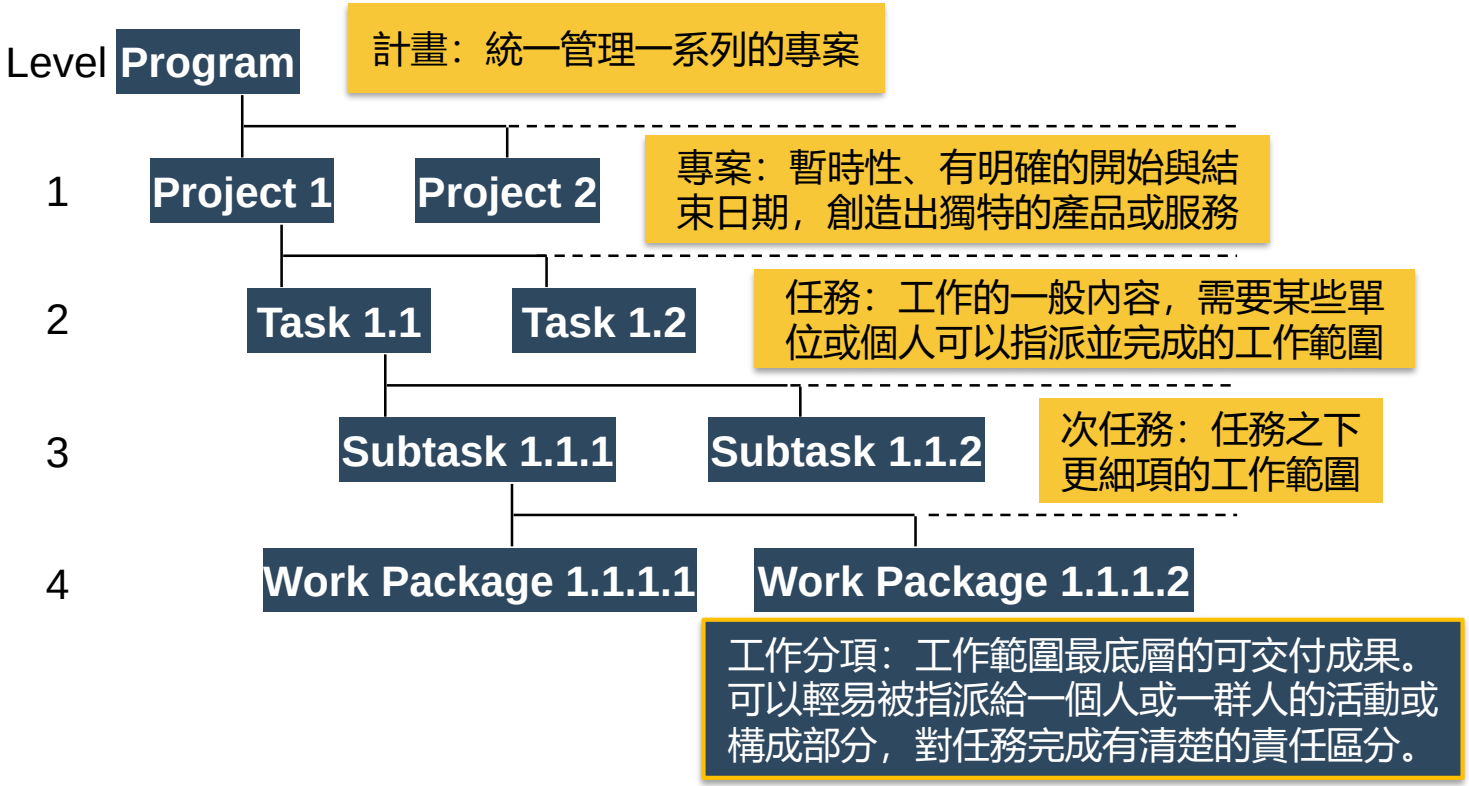
RACI矩陣（補充）

- R (Responsible，負責者)： 實際執行工作的人
- A (Accountable，當責者)： 為成果負起完全責任 (only 1 person)
- C (Consulted，諮詢者)： 顧問或提供諮詢者
- I (Informed，被告知者)： 任務完成後，必須被知會的人

	王明	陳宜	曾美	李保	吳花
企畫	AR	C	I	I	C
製作	A	R	R	C	C
行銷	I	A	R	I	C
客服	I	A		R	I

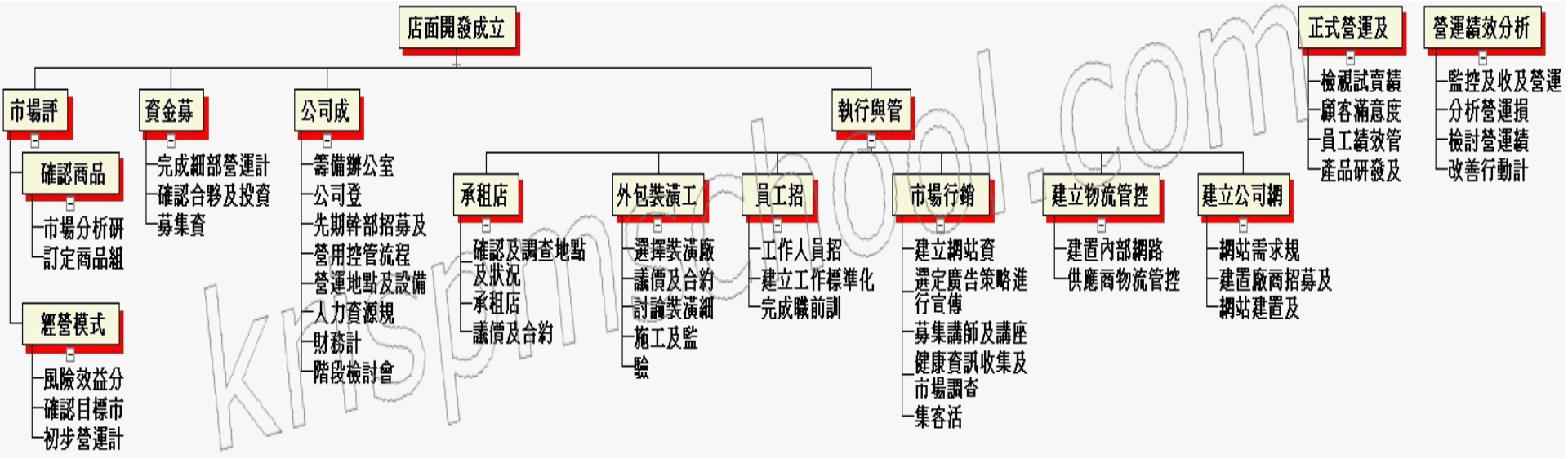
3. Work Breakdown Structure

A work breakdown structure defines the hierarchy of project tasks, subtasks, and work packages



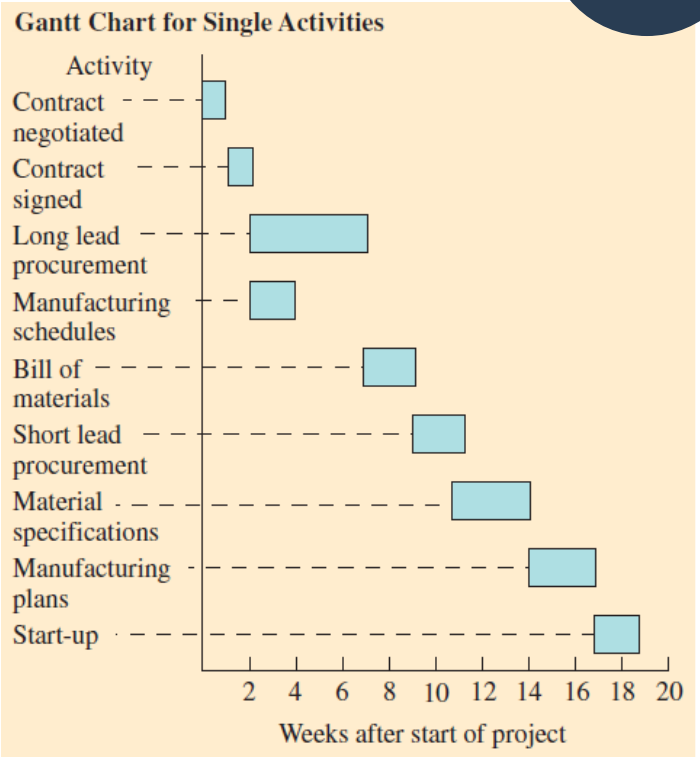
Level					
1	2	3	4		
x				1	Optical simulator design
	x			1.1	Optical design
		x		1.1.1	Telescope design/fab
		x		1.1.2	Telescope/simulator optical interface
		x		1.1.3	Simulator zoom system design
		x		1.1.4	Ancillary simulator optical component specification
	x			1.2	System performance analysis
		x		1.2.1	Overall system firmware and software control
			x	1.2.1.1	Logic flow diagram generation and analysis
			x	1.2.1.2	Basic control algorithm design
		x		1.2.2	Far beam analyzer
		x		1.2.3	System inter- and intra-alignment method design
		x		1.2.4	Data recording and reduction requirements
	x			1.3	System integration
	x			1.4	Cost analysis
		x		1.4.1	Cost/system schedule analysis
		x		1.4.2	Cost/system performance analysis
	x			1.5	Management
		x		1.5.1	System design/engineering management
		x		1.5.2	Program management
	x			1.6	Long lead item procurement
		x		1.6.1	Large optics
		x		1.6.2	Target components
		x		1.6.3	Detectors

WBS範例：店面開發成立

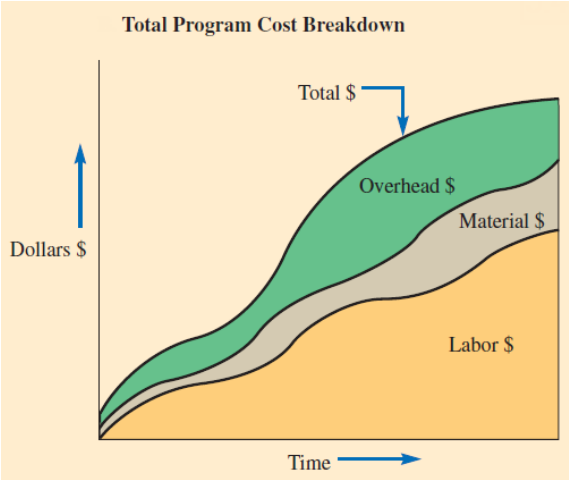


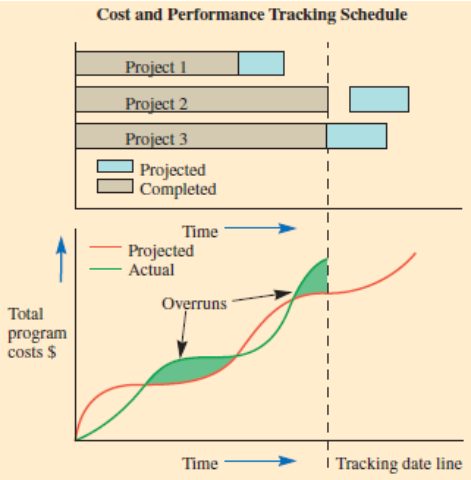
4. Project Control Charts

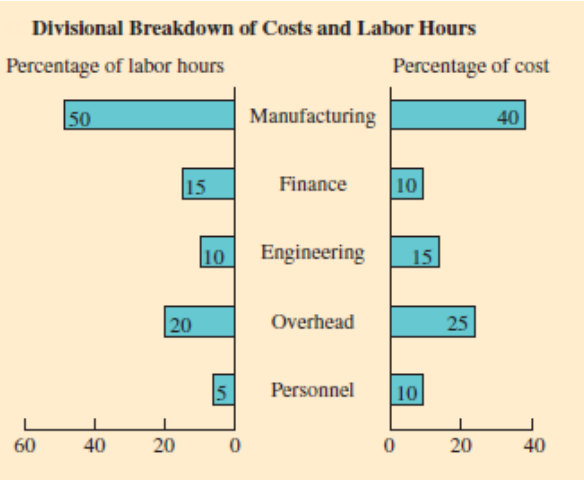
- Charts provide an easily understood visual presentation.
- Software can be used to create the charts.
- Gantt charts show, in a graphic manner, the amount of time involved and the sequence of activities. Often referred to as a **bar chart**.

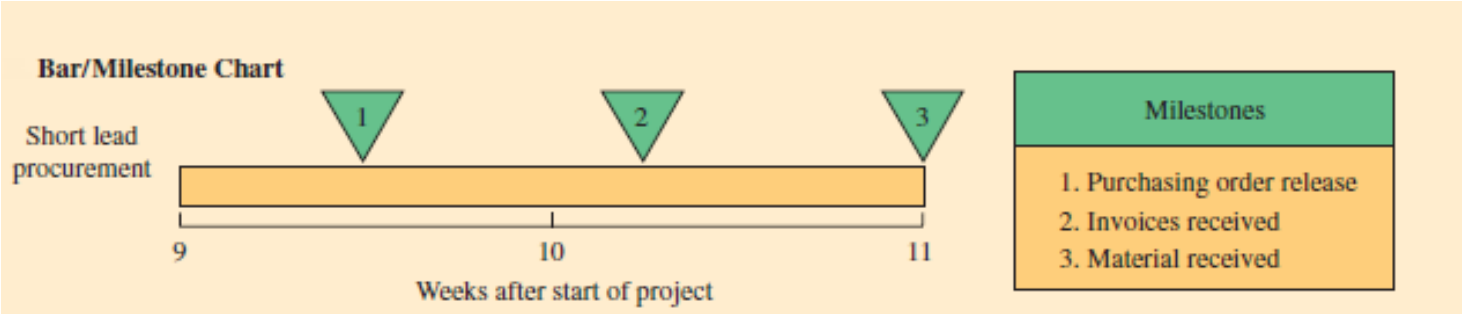


Project Report Samples

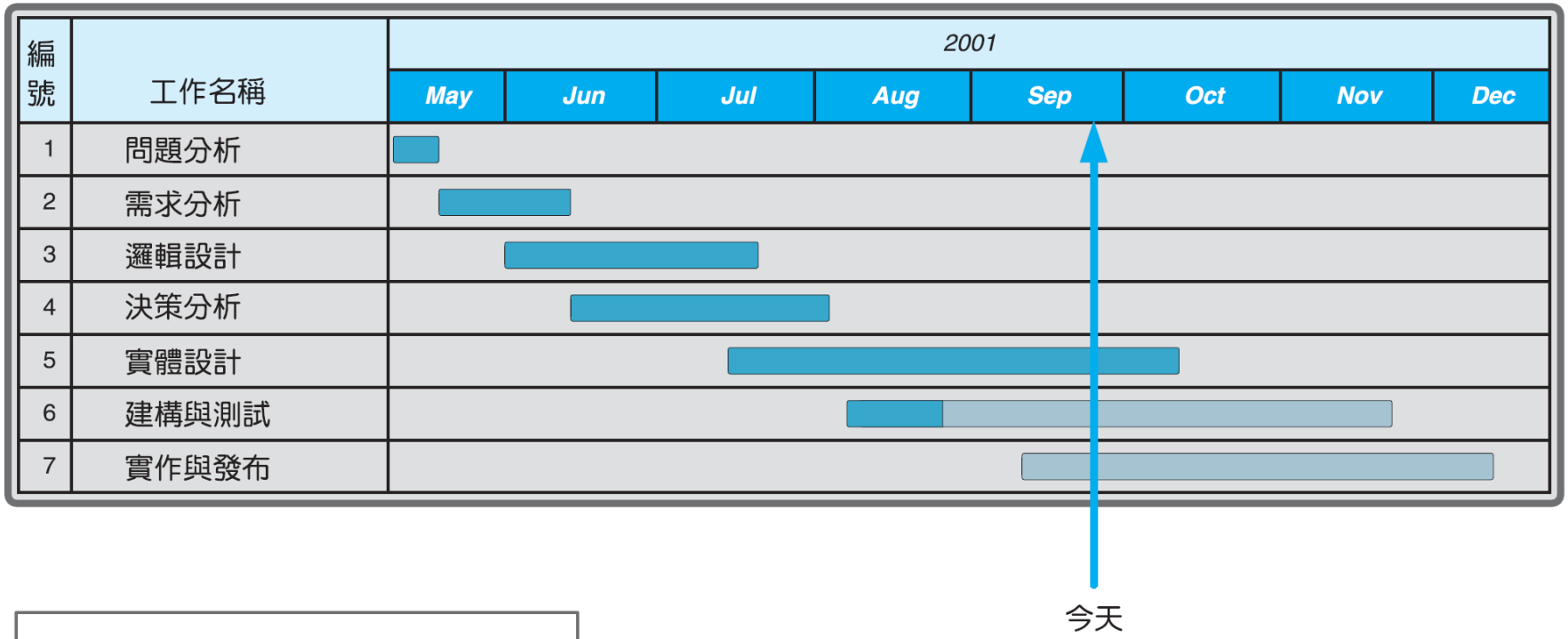








- **Gantt chart**
  - 由Henry Gannt於1900年代發展出來
  - 被使用來描述專案工作在日程表上進行的長條圖
    - 橫軸表示時間
    - 縱軸代表所需進行的各項活動
  - 可判斷各項活動的實際進度，以作為適當的時間規劃

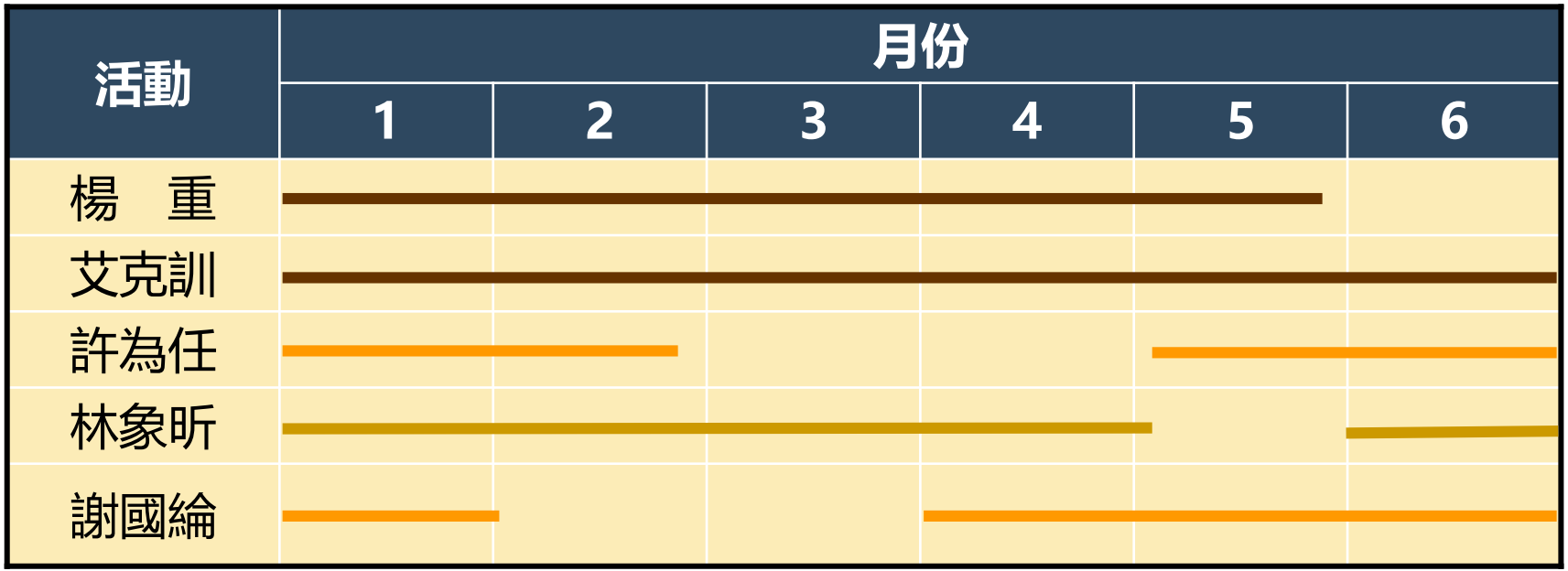

編號
工作名稱
2001
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1
問題分析
2
需求分析
3
邏輯設計
4
決策分析
5
實體設計
6
建構與測試
7
實作與發布
今天
圖例說明
完成的工作
未完成的工作

- 優點
  - 繪圖容易，易以手工方式完成
  - 易看、易瞭解
- 缺點
  - 作業間順序不清楚
  - 工程管理重點不易判斷
  - 作業延遲對專案影響難掌握

負荷圖（load chart)

- 經過調整的甘特圖
  - **縱軸是組織成員或各種資源**
- 可做適當的調度與調整

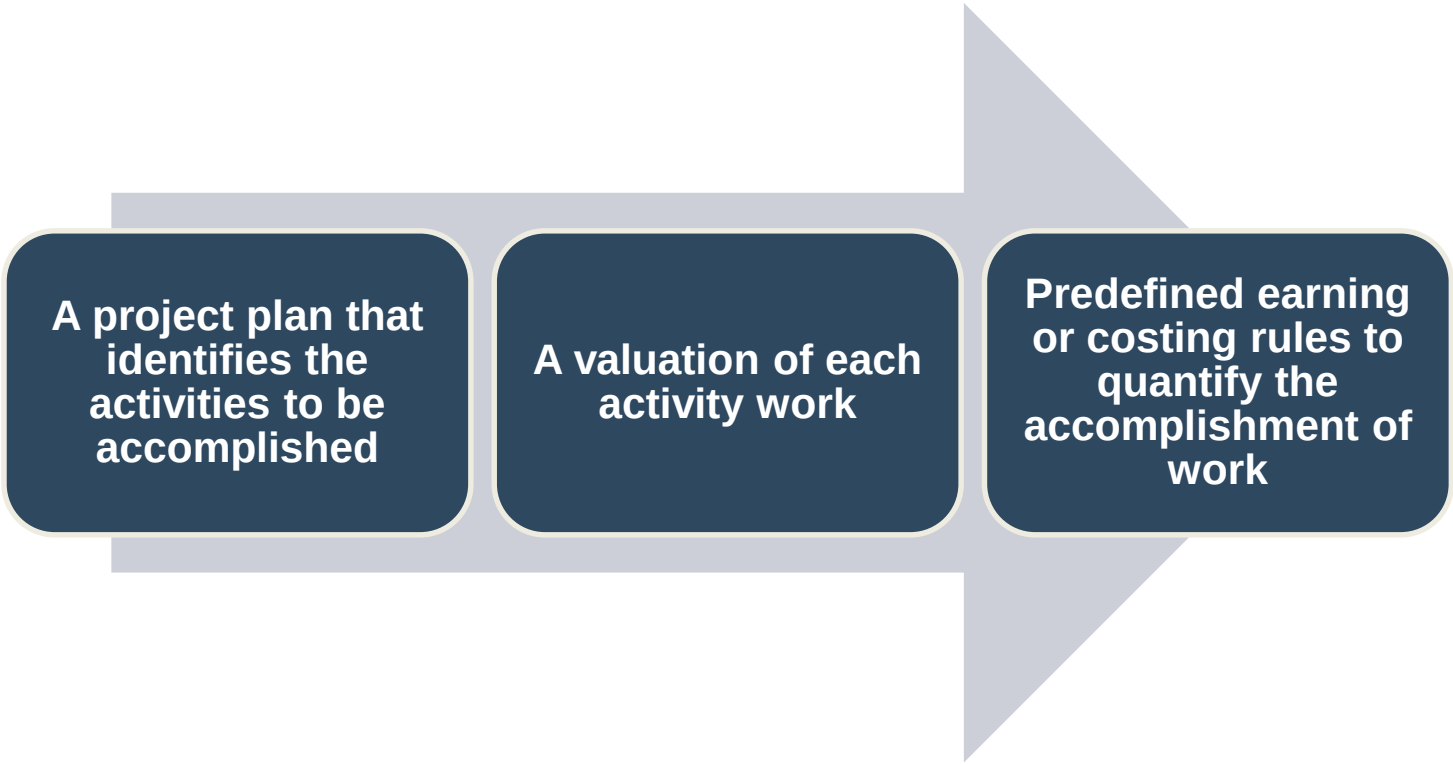
以腳踏車廠商研發團隊為例



5. Earned Value Management (EVM)

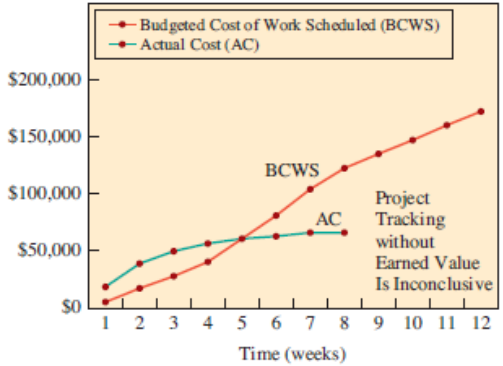
- A technique for measuring project progress in an objective manner
- Has the ability to combine measurements of scope, schedule, and cost in a project
- Provides a method for evaluating the relative success of a project at a point in time

Earned Value Management – Essential Features

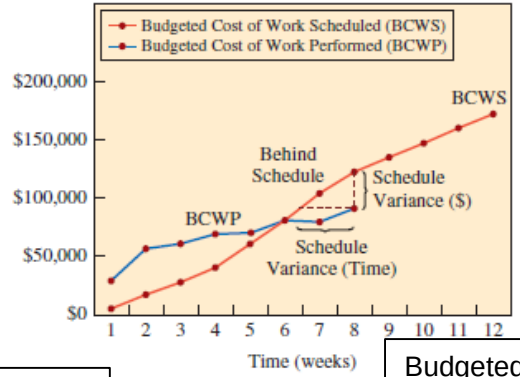


Earned Value Management Charts

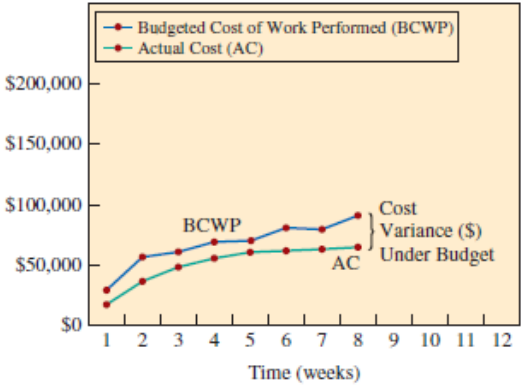
Budgeted costs (scheduled) and actual costs



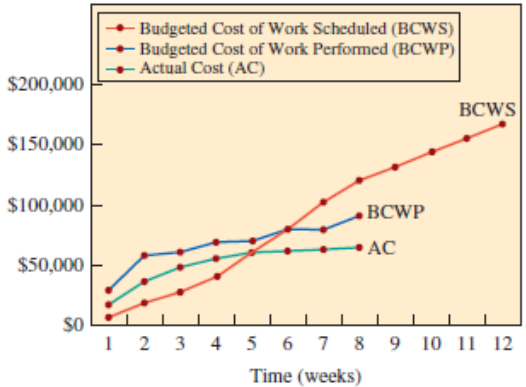
Costs of scheduled and performed work



Budgeted cost (work performed) and actual costs



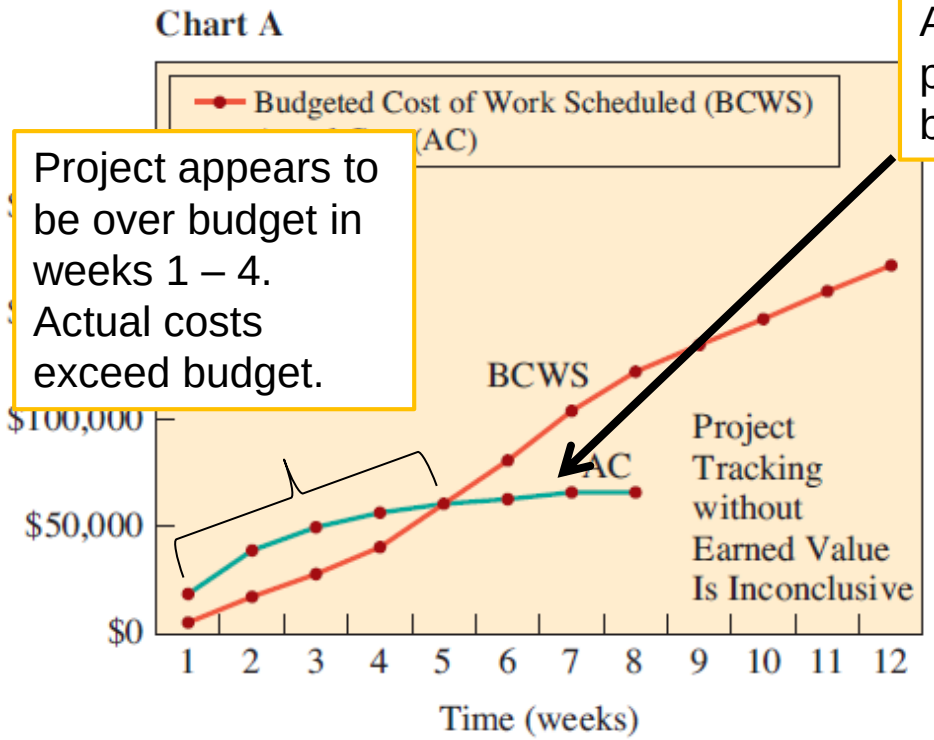
Budgeted costs (scheduled and performed work) and actual costs



Project Tracking without EVM

A simple comparison of just costs versus budget does not tell the whole story

Without a means of quantifying how much work has been accomplished, costs are the only available information.



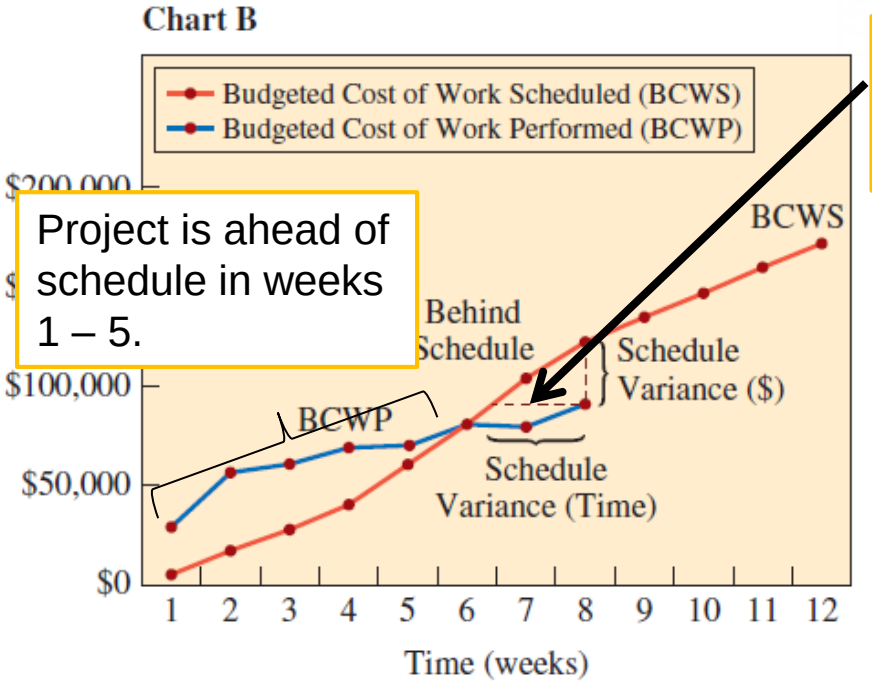
Project appears to be over budget in weeks 1 – 4. Actual costs exceed budget.

After week 5, the project appears to be under budget.

Project Tracking with EVM

With pre-defined methods of quantifying the quantity of work accomplished, EVM provides much more information.

EVM provides information about performance according to the schedule.

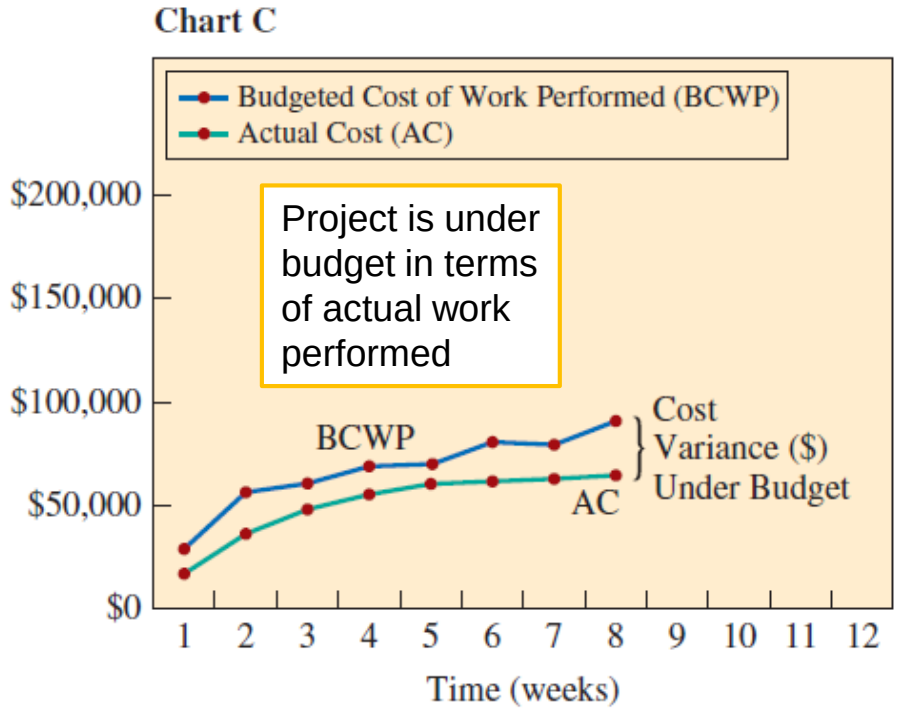


Project is ahead of schedule in weeks 1 – 5.

After week 6, the project has fallen behind schedule.

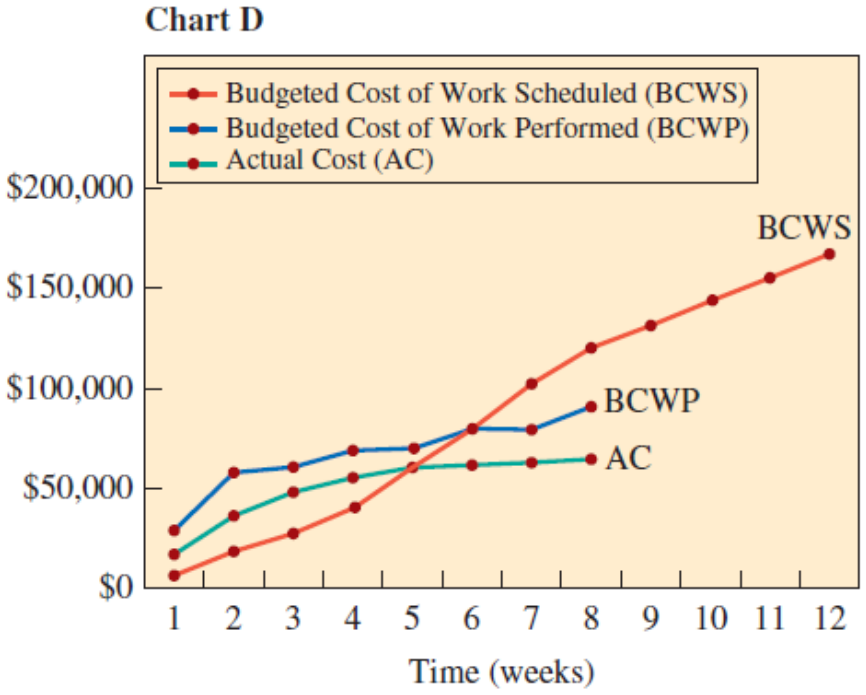
Project Tracking with EVM

With pre-defined methods of quantifying the quantity of work accomplished, EVM provides much more information.

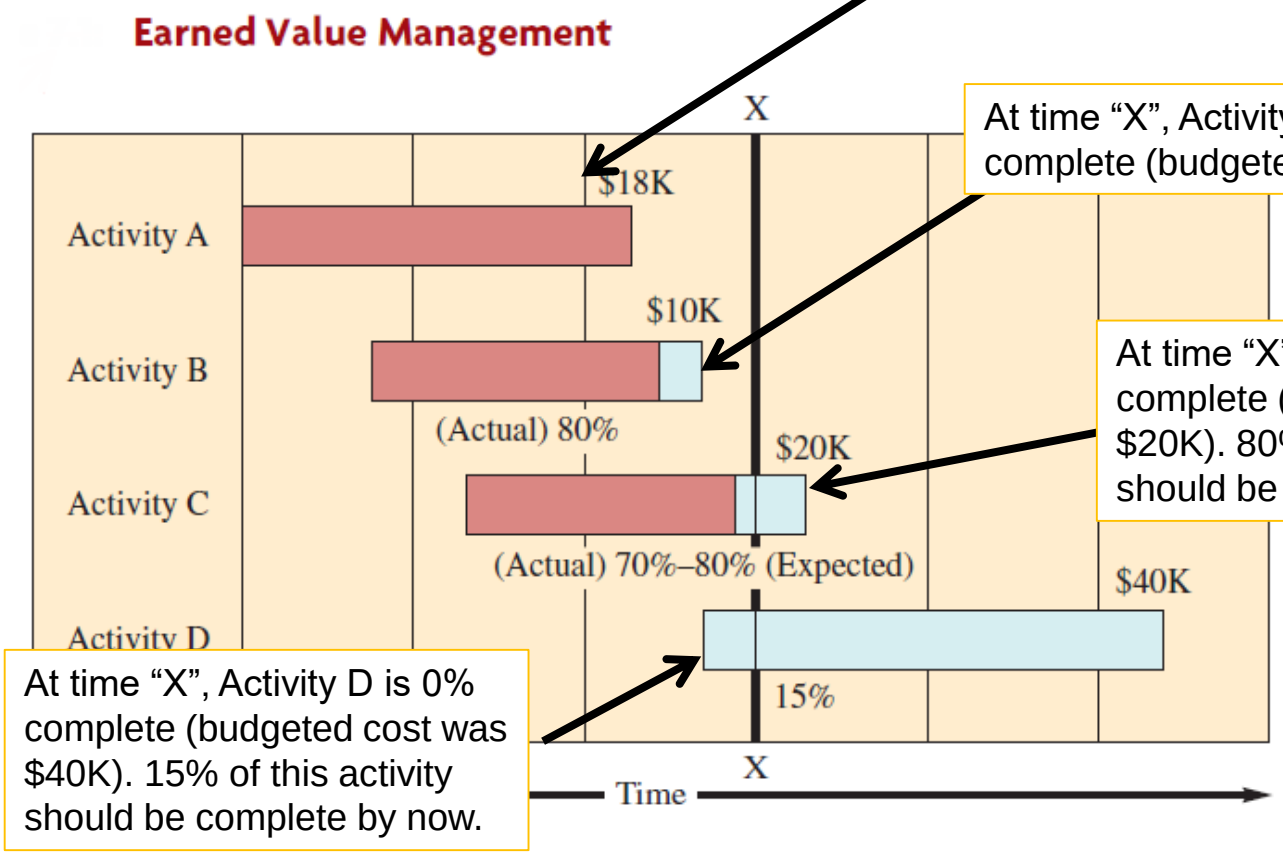


Project Tracking with EVM

A combined view gives an overview of project performance in terms of the original plan.



Example 5.1



At time “X”, Activity A is 100% complete (budgeted cost was $18K).

At time “X”, Activity B is 80% complete (budgeted cost was $10K).

At time “X”, Activity C is 70% complete (budgeted cost was $20K). 80% of this activity should be complete by now.

At time “X”, Activity D is 0% complete (budgeted cost was $40K). 15% of this activity should be complete by now.

Example 5.1 – Budgeted Cost of Work Scheduled (BCWS)

- Activity A – 100% of $18K = $18K
- Activity B – 100% of $10K = $10K
- Activity C – 80% of $20K = $16K
- Activity D – 15% of $40K = $6K
- BCWS = $18K + $10K + $16K + $6K = $50K

Example 5.1 – Budgeted Cost of Work Performed (BCWP)

- Activity A – 100% of $18K = $18K
- Activity B – 80% of $10K = $8K
- Activity C – 70% of $20K = $14K
- Activity D – 0% of $40K = $0K
- BCWP = $18K + $8K + $14K + $0K = $40K

Example 5.1 – Performance Measures

Schedule Variance: $SV = BCWP - BCWS = \$40K - \$50K = -\$10K$

Schedule Performance Index: $SPI = \frac{BCWP}{BCWS} = \frac{\$40K}{\$50K} = 0.8$

Cost Variance: $CV = BCWP - AC = \$40K - \$45K = -\$5K$

Cost Performance Index: $CPI = \frac{BCWP}{AC} = \frac{\$40K}{\$45K} = 0.89$

Actual cost of $45K obtained from accounting records

For performance indices:
CPI < 1 means costs are higher than planned
CPI = 1 means costs are exactly as planned
CPI > 1 means costs are lower than planned

6. Network-planning models

- PERT
- CPM

計畫評核術（program evaluation and review technique, PERT）

- 1958年由美國海軍北極星潛水艇的飛彈計畫研究小組所研發
- 針對較大型且較難控制的專案所設計
- PERT呈現網路狀
  - 事件（event）：完成某項活動
  - 要徑（critical path）：在PERT網路裡需時最長的路徑
  - 寬鬆時間（slack time）：在不會對整體任務造成延遲的情形下，單一活動可以延誤的時間

Critical path method (CPM)

- A project is made up of a sequence of activities that form a network representing a project
- The path taking longest time through this network of activities is called the “critical path”
- If any one of the activities in the critical path is delayed, then the entire project is delayed.

Types of Critical Path Methods

a) CPM with a Single Time Estimate

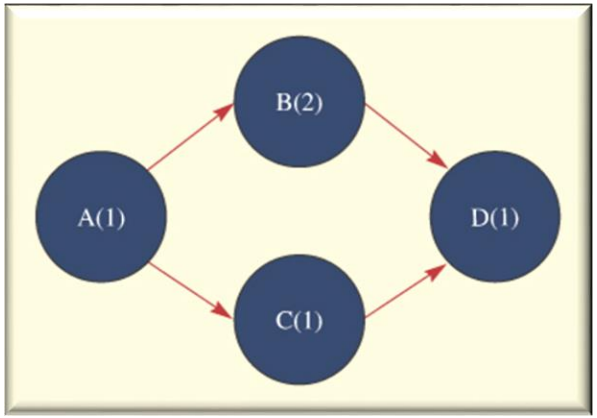
b) CPM with Three Activity Time Estimates

c) Time-Cost Models

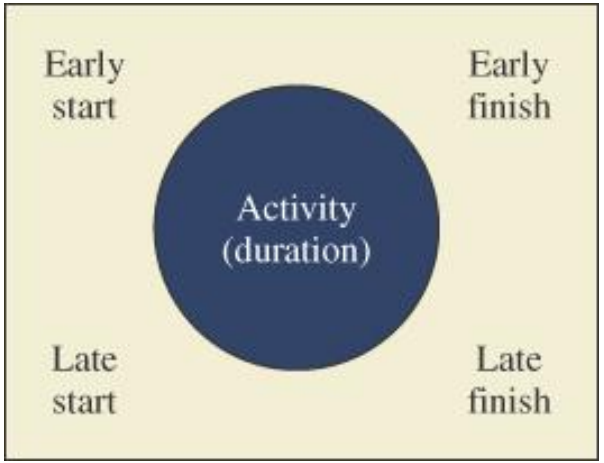
A. CPM with a Single Time Estimate

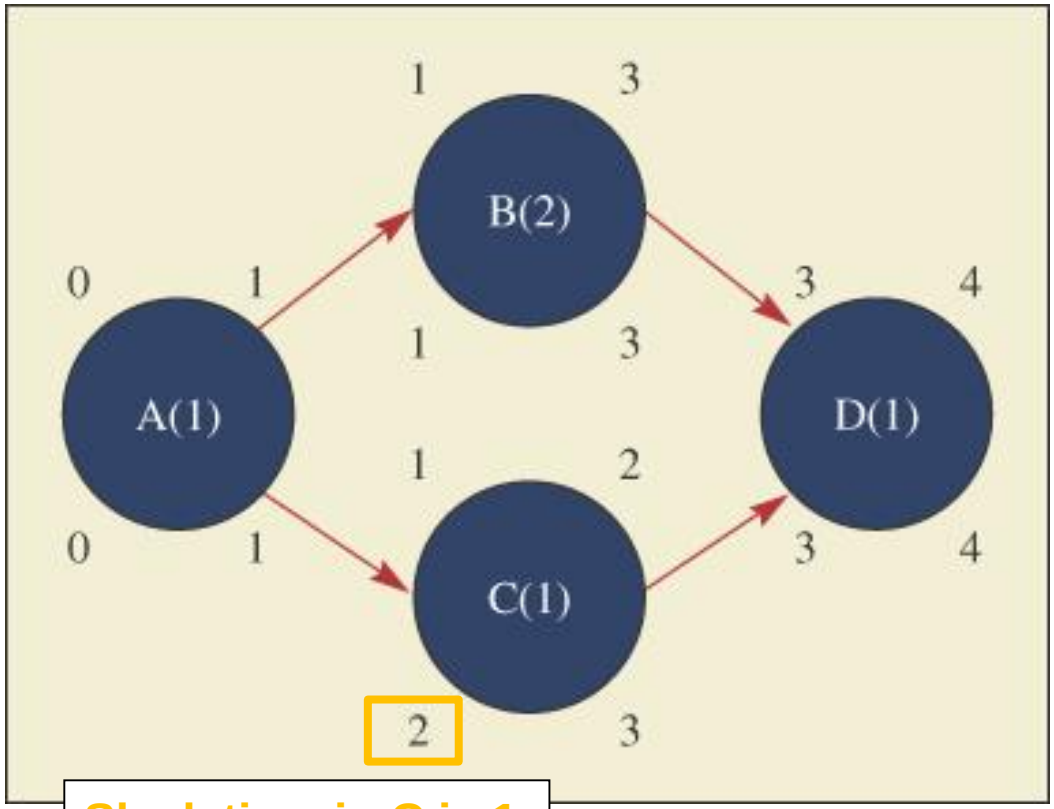
- Used when activity times are known with certainty
- Identify each activity to be done in the project and estimate how long it will take to complete each activity.
  - For example, A(1), B(2), C(1), D(1)
- Determine the required sequence of activities and construct a network reflecting the precedence relationships.

Activity	Designation	Immediate Predecessors	Time (week)
Select company	A	None	1
Obtain annual report and perform ratio analysis	B	A	2
Collect stock price data and perform technical analysis	C	A	1
Review data and make a decision	D	B & C	1



3. Determine the critical path (from the beginning to the end of the project)
   - A – B – D
   - A – C – D
4. Determine the early start/finish and late start/finish schedule





Slack time in C is 1

Example 5.2

CPM Activity Designations and Time Estimates

Activity	Designation	Immediate Predecessors	Time (weeks)
Design	A	–	21
Build prototype	B	A	5
Evaluate equipment	C	A	7
Test prototype	D	B	2
Write equipment report	E	C, D	5
Write methods report	F	C, D	8
Write final report	G	E, F	2

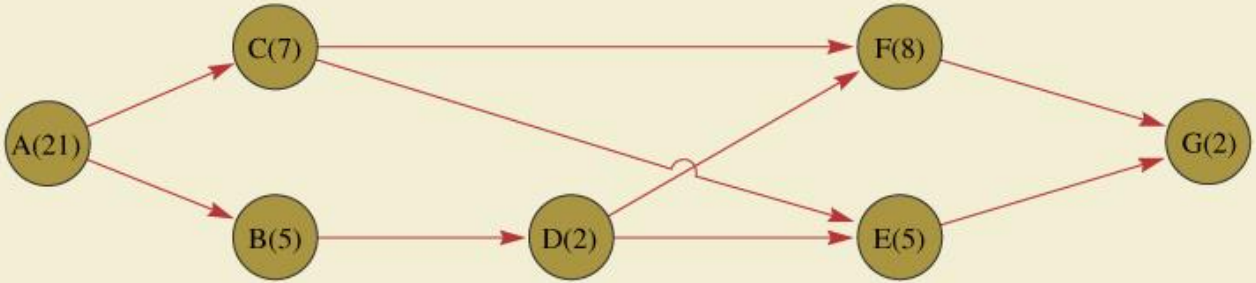
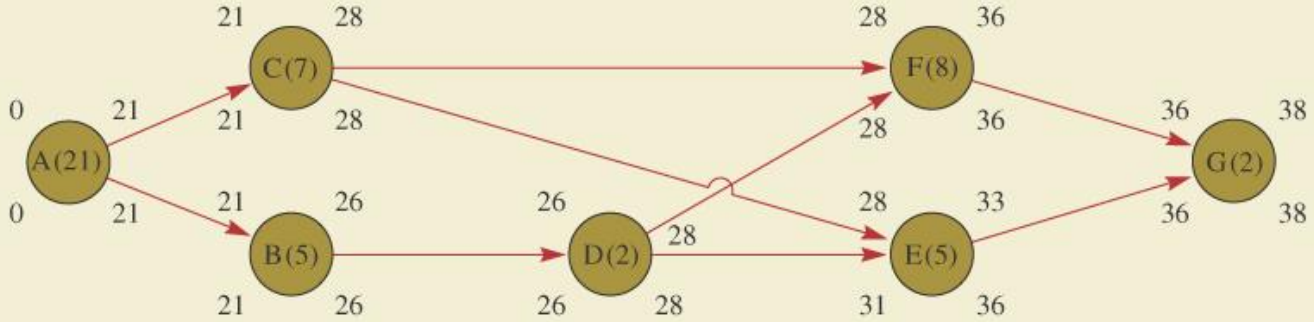


Exhibit 4.5



SLACK CALCULATIONS AND CRITICAL PATH DETERMINATIONS

ACTIVITY	LS−ES	SLACK	ON CRITICAL PATH
A	0−0	0	✓
B	21−21	0	✓
C	21−21	0	✓
D	26−26	0	✓
E	31−28	3	
F	28−28	0	✓
G	36−36	0	✓

B. CPM with Three Activity Time Estimates

- Used when activity times are uncertain
- Used to obtain the same information as the Single Time Estimate model and probability information
- Refer to pp. 145-146 for more steps.

$$Expected\ time(ET) = \frac{a + 4m + b}{6}$$

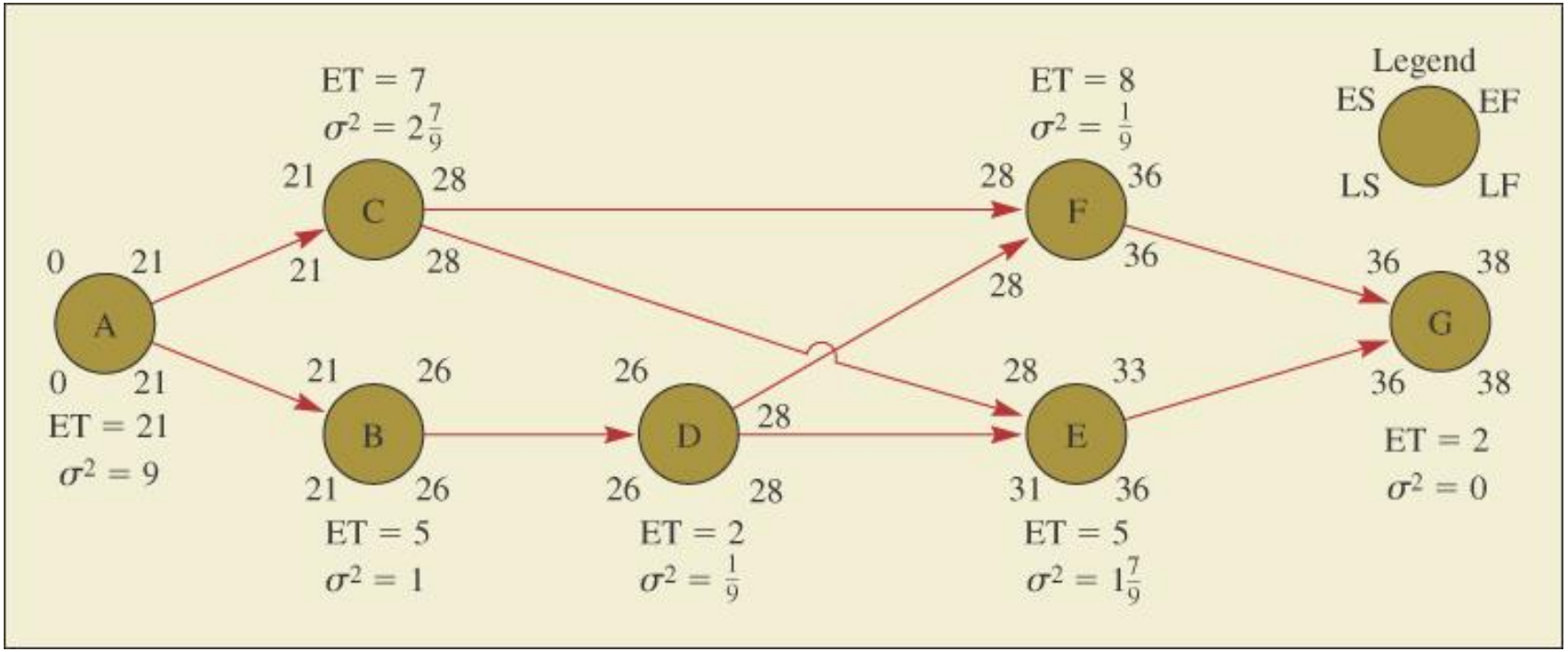
$$\sigma^2 = \left(\frac{b - a}{6} \right)^2$$

$$Z = \frac{D - T_E}{\sqrt{\sum \sigma^2_{cp}}}$$

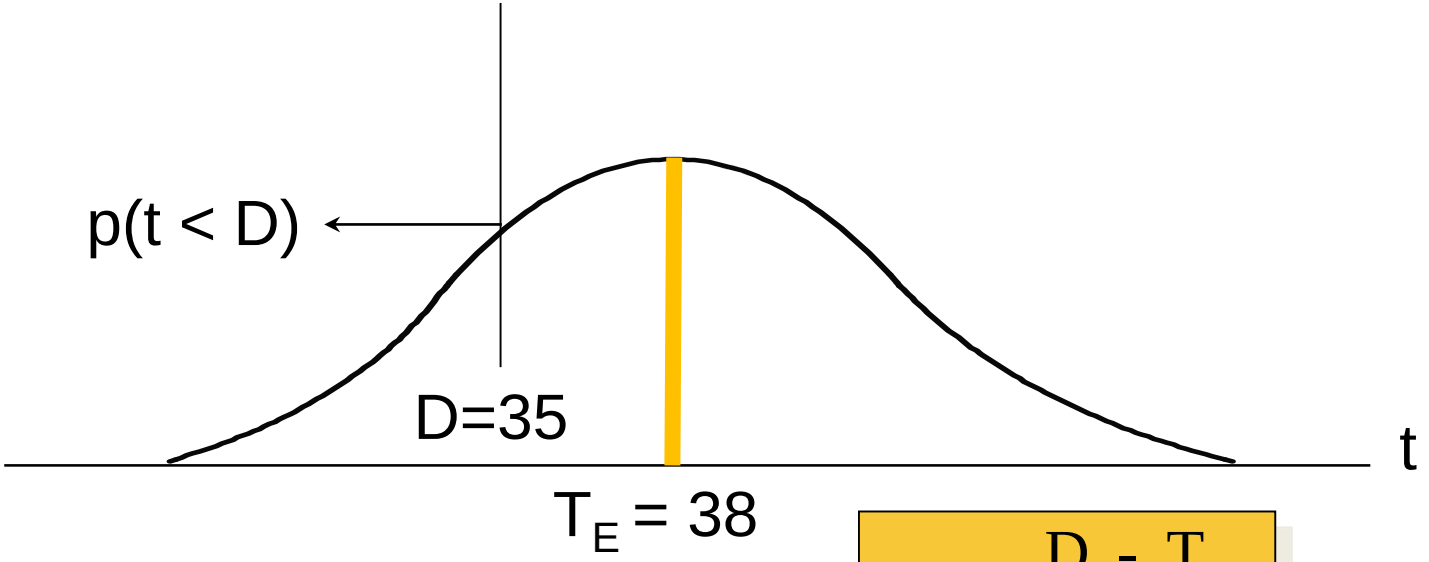
Exhibit 5.8

Activity Expected Times and Variances

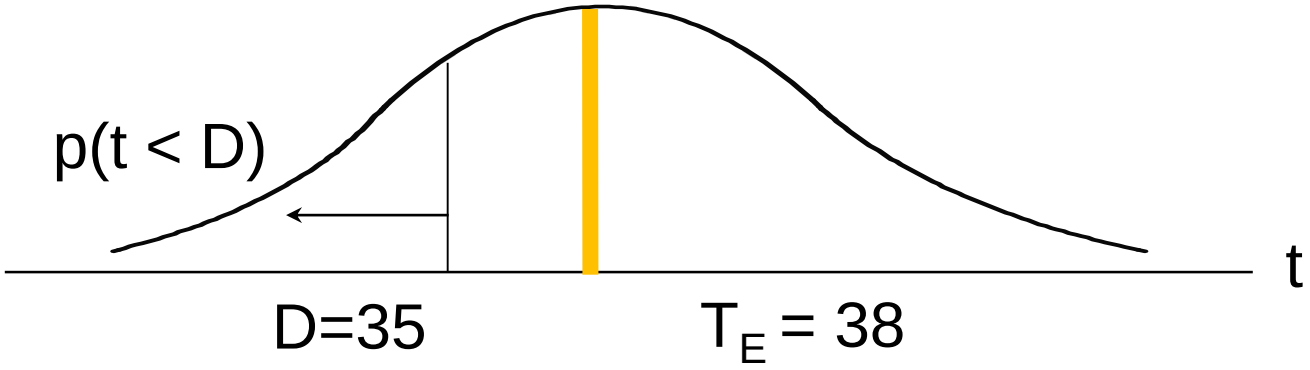
Activity	Activity Designation	Time Estimates a	m	b	Expected Times (ET) $\frac{a+4m+b}{6}$	Activity Variances (σ^2) $\left(\frac{b-a}{6}\right)^2$
Design	A	10	22	28	21	9
Build prototype	B	4	4	10	5	1
Evaluate equipment	C	4	6	14	7	$2\frac{7}{9}$
Test prototype	D	1	2	3	2	$\frac{1}{9}$
Write report	E	1	5	9	5	$1\frac{7}{9}$
Write methods report	F	7	8	9	8	$\frac{1}{9}$
Write final report	G	2	2	2	2	0


Legend
ES
EF
LS
LF
A
0
21
0
21
ET = 21
$\sigma^2 = 9$
B
21
26
21
26
ET = 5
$\sigma^2 = 1$
C
ET = 7
$\sigma^2 = 2\frac{7}{9}$
21
28
21
28
D
26
28
26
28
ET = 2
$\sigma^2 = \frac{1}{9}$
E
28
33
31
36
ET = 5
$\sigma^2 = 1\frac{7}{9}$
F
ET = 8
$\sigma^2 = \frac{1}{9}$
28
36
28
36
G
36
38
36
38
ET = 2
$\sigma^2 = 0$

What is the probability of finishing this project in less than 35 days?



$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}}$$



$$Z = \frac{D - T_E}{\sqrt{\sum \sigma_{cp}^2}} = \frac{35 - 38}{\sqrt{11.89}} = -.87$$

p(Z < -.87) = .1922, or 19.22 %

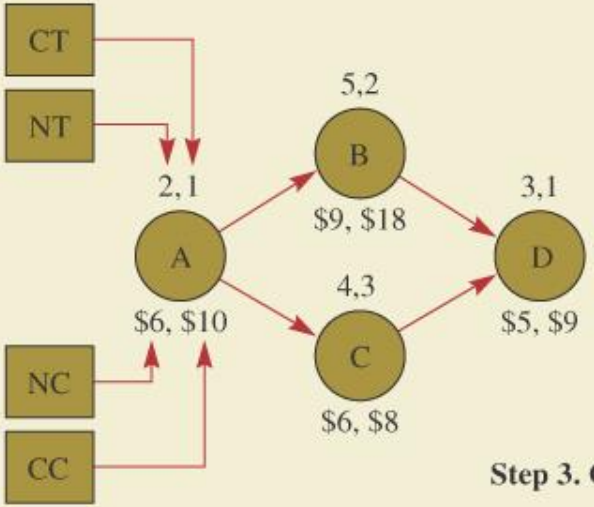
There is a 19.22% probability that this project will be completed in less than 35 weeks.

C. Time-cost models

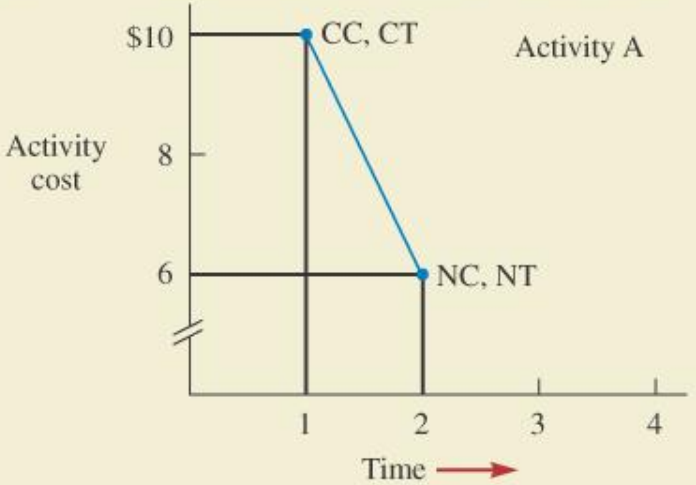
- Used when cost trade-off information is a major consideration in planning
- Used to determine the least cost in reducing total project time

- Prepare a CPM-type network diagram
  - NC, NT, CT, CC
- Determine the cost per unit of time
- Compute the critical path
- Shorten the critical path at the least cost
- Plot project direct, indirect, and total cost curves and find the minimum-cost schedule

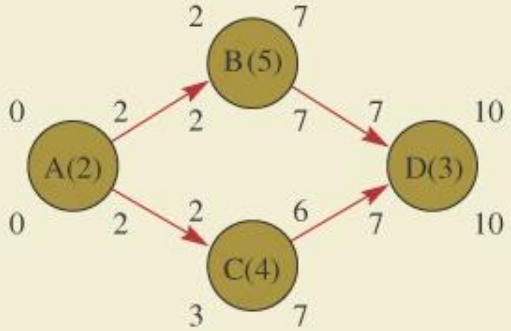
Step 1. Prepare CPM Diagram with Activity Costs



Step 2. Determine Cost per Unit of Time



Step 3. Compute the Critical Path



CC Crash cost
CT Crash time
NC Normal cost
NT Normal time

Exhibit 5.11

Calculation of Cost per Day to Expedite Each Activity

Activity	CC − NC	NT − CT	$\frac{CC - NC}{NT - CT}$	Cost per Day to Expedite	Number of Days Activity May Be Shortened
A	$10 − $6	2 − 1	$\frac{\$10 - \$6}{2 - 1}$	$4	1
B	$18 − $9	5 − 2	$\frac{\$18 - \$9}{5 - 2}$	$3	3
C	$8 − $6	4 − 3	$\frac{\$8 - \$6}{4 - 3}$	$2	1
D	$9 − $5	3 − 1	$\frac{\$9 - \$5}{3 - 1}$	$2	2

Exhibit 4.9

exhibit 4.9 A. Calculation of Cost per Day to Expedite Each Activity

Activity	CC − NC	NT − CT	$\frac{CC - NC}{NT - CT}$	Cost per Day to Expedite	Maximum Number of Days Activity May Be Shortened
A	$10 − $6	2 − 1	$\frac{\$10 - \$6}{2 - 1}$	$4	1
B	$18 − $9	5 − 2	$\frac{\$18 - \$9}{5 - 2}$	$3	3
C	$8 − $6	4 − 3	$\frac{\$8 - \$6}{4 - 3}$	$2	1
D	$9 − $5	3 − 1	$\frac{\$9 - \$5}{3 - 1}$	$2	2

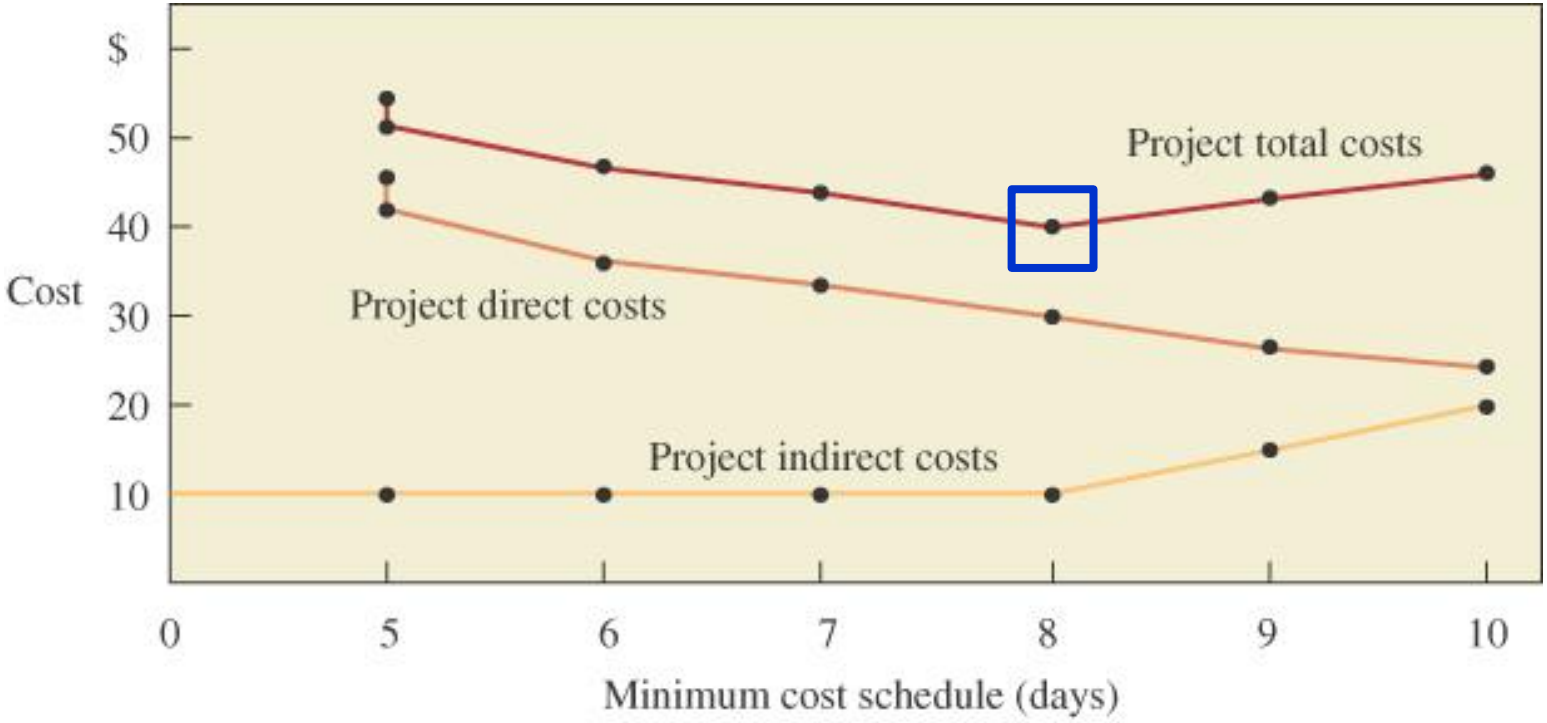
B. Reducing the Project Completion Time One Day at a Time

Current Critical Path(s)	Remaining Number of Days Activity May Be Shortened	Cost per Day to Expedite Each Activity	Least-Cost Activity to Expedite	Total Cost of All Activities in Network	Project Completion Time
ABD	All activity times and costs are normal.			$26	10
ABD	A–1, B–3, D–2	A–4, B–3, D–2	D	28	9
ABD	A–1, B–3, D–1	A–4, B–3, D–2	D	30	8
ABD	A–1, B–3	A–4, B–3	B	33	7
ABD ACD	A–1, B–2, C–1	A–4, B–3, C–2	A*	37	6
ABD ACD	B–2, C–1	B–3, C–2	B&C†	42	5
ABD ACD	B–1	B–3	B+	45	5

*To reduce the critical path by one day, reduce either A alone or B and C together at the same time (either B or C by itself just modifies the critical path without shortening it).

†B and C must be crashed together to reduce the path by one day.

+Crashing activity B does not reduce the length of the project, so this additional cost would not be incurred.


$
50
40
30
20
10
Cost
Project total costs
Project direct costs
Project indirect costs
0
5
6
7
8
9
10
Minimum cost schedule (days)

Solution & HW