Remember:

- There is a Quiz next week and Assignment 1 submission due this week

What we learnt last week

- Building WBS (5 Steps)
- WBS and OBS linkage
- PBS
- Responsibility Matrices
- Project Communication Plan

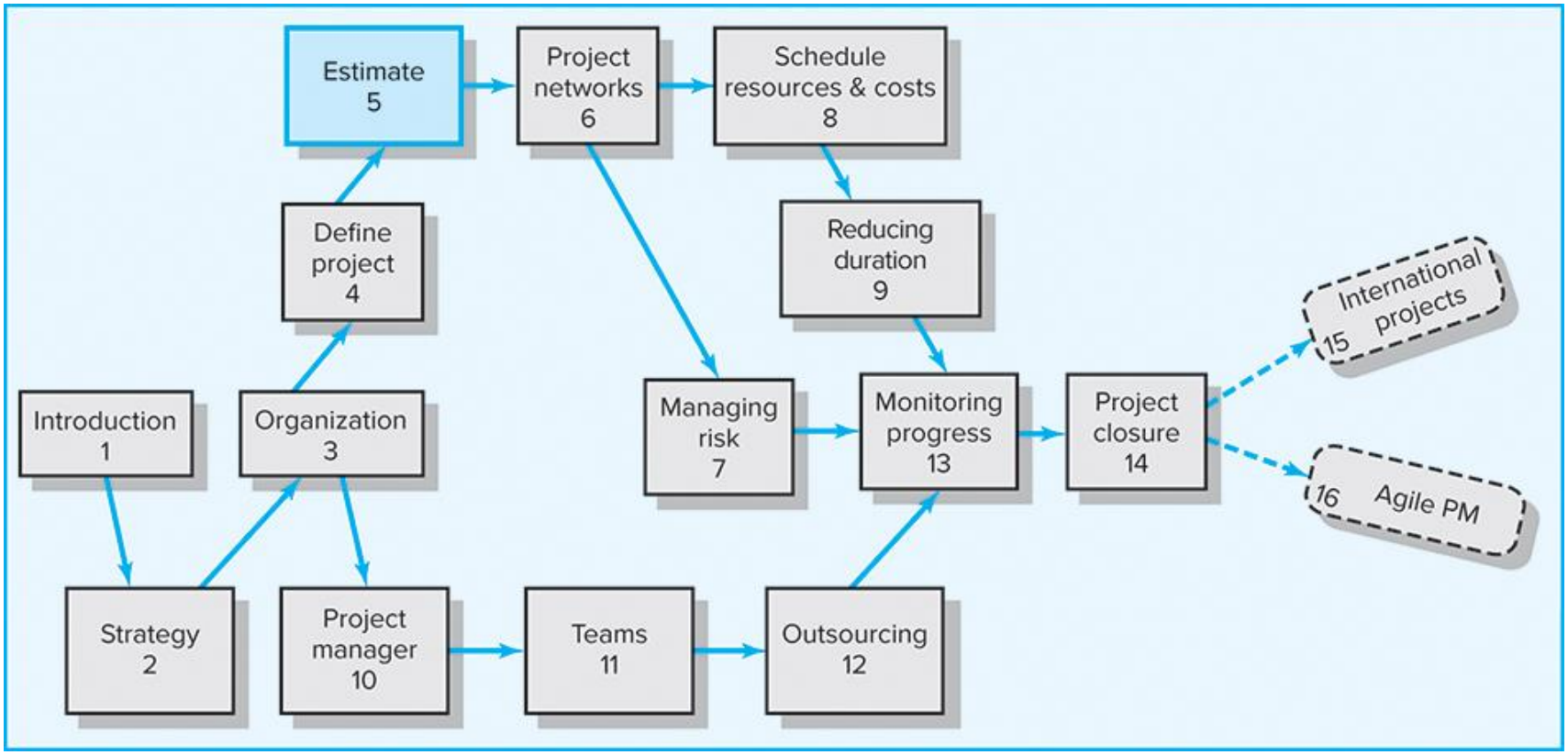
This week:

- Cost estimation including top down and bottom up estimation methods
- Types of project cost

Chapter Five

Estimating Project Times and Costs

Where We Are Now



Learning Objectives

1. Understand estimating project times and costs are the foundation for project planning and control
2. Describe the methods, uses, and advantages and disadvantages of top-down and bottom-up estimating methods
3. Distinguish different kinds of costs associated with a project
4. Suggest a scheme for developing an estimating database for future projects

Chapter Outline

- Factors Influencing the Quality of Estimates
- Estimating Guidelines for Times, Costs, and Resources
- Top-Down versus Bottom-Up Estimating
- Methods for Estimating Project Times and Costs
- Level of Detail
- Types of Costs
- Refining Estimates
- Creating a Database for Estimating

A huge mistake and costly

Given the urgency
to start work on the project,
managers sometimes minimize or avoid
the effort to follow through on estimating project
time and cost.

Estimating Time and Cost Is Important !!!

- To support good decisions
- To schedule work
- To determine how long the project should take and its cost
- To determine whether the project is worth doing
- To develop cash flow needs
- To determine how well the project is progressing

EXHIBIT 5.1

Estimating Projects

- Estimating
  - The process of **forecasting or approximating** the TIME and COST of completing project deliverables
  - Inaccurate estimation → false expectations & consumer dissatisfaction
- Types of Estimates
  - Top-down (macro) estimates: Rough estimation
    - Consensus methods, Ratio methods, Apportionment methods, Function point methods, Learning curves
  - Bottom-up (micro) estimates: estimates of elements of the work breakdown structure
    - Template methods, Parametric procedures, Range estimates

Factors influencing the quality of estimates

1. Planning Horizon

- The longer the planning horizon, the less accurate the estimation.

2. Project complexity

- Poorly written scope specifications for new technology result in errors in estimating times and costs

3. People

- Estimation depends on the skills & experience of people making estimation
- It also depends on team members' skill & experience

4. Project Structure & Organisation

- Functional vs. Dedicated project team

5. Padding Estimates

- The "buffer" → safety factor to a time or cost
- Minimum <–> average <–> maximum

6. Organisation Culture

- e.g. "detail" vs "non-detail" culture

7. Other factors: nonproject factor

- e.g. equipment down-time, disaster, project priority, etc.

Poor estimates = Project failure

Past experience ➔ a good starting point

No past experience ➔ 7 guidelines

Estimating Guidelines for Times, Costs, and Resources – WP level

1. Have people familiar with the tasks make the estimate
2. Use several people to make estimates
3. Base estimates on normal conditions, efficient methods, and a normal level of resources
4. Use consistent time units in estimating task times
5. Treat each task as independent, don't aggregate
6. Do not make allowances for contingencies (extra fund for contingencies).
7. Add a risk assessment to avoid surprises to stakeholders

Top-Down versus Bottom-Up Estimating

- Top-Down Estimates
  - Are usually derived from someone who uses **experience** and/or **information** to determine the project duration and total cost.
  - Are sometimes made by **top managers** who have little knowledge of the processes used to complete the project.
- Bottom-Up Approach
  - Can serve as a check on cost elements in the WBS by rolling up the work packages and associated cost accounts to major deliverables at the work package level.

Top-Down versus Bottom-Up Estimating

Conditions for Preferring Top-Down or Bottom-up Time and Cost Estimates

Condition	Top-down Estimates	Bottom-up Estimates
- Strategic decision making	X	
- Cost and time important		X
- High uncertainty	X	
- Internal, small project	X	
- Fixed-price contract		X
- Customer wants details		X
- Unstable scope	X	

TABLE 5.1

Estimating Projects: Preferred Approach

- Make rough top-down estimates
- Develop the WBS/OBS
- Make bottom-up estimates
- Develop schedules and budgets
- Reconcile differences between top-down and bottom-up estimates

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)
3. Apportion method
4. Function point methods for software and system projects
5. Learning curves

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
   - brainstorming session
   - Uses the pooled experience of senior and/or middle managers
   - agree, funding and resource planning can be done quickly

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)

   Uses ratios to estimate project times & costs

   $200 per square foot so 2,000 square feet cost $400,000, 20 square feet/day, 100 days to build

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)
3. Apportion method

   Based on Historical data of similar project

   Percentage is assigned to the major segments of projects

Apportion Method of Allocating Project Costs Using the Work Breakdown Structure

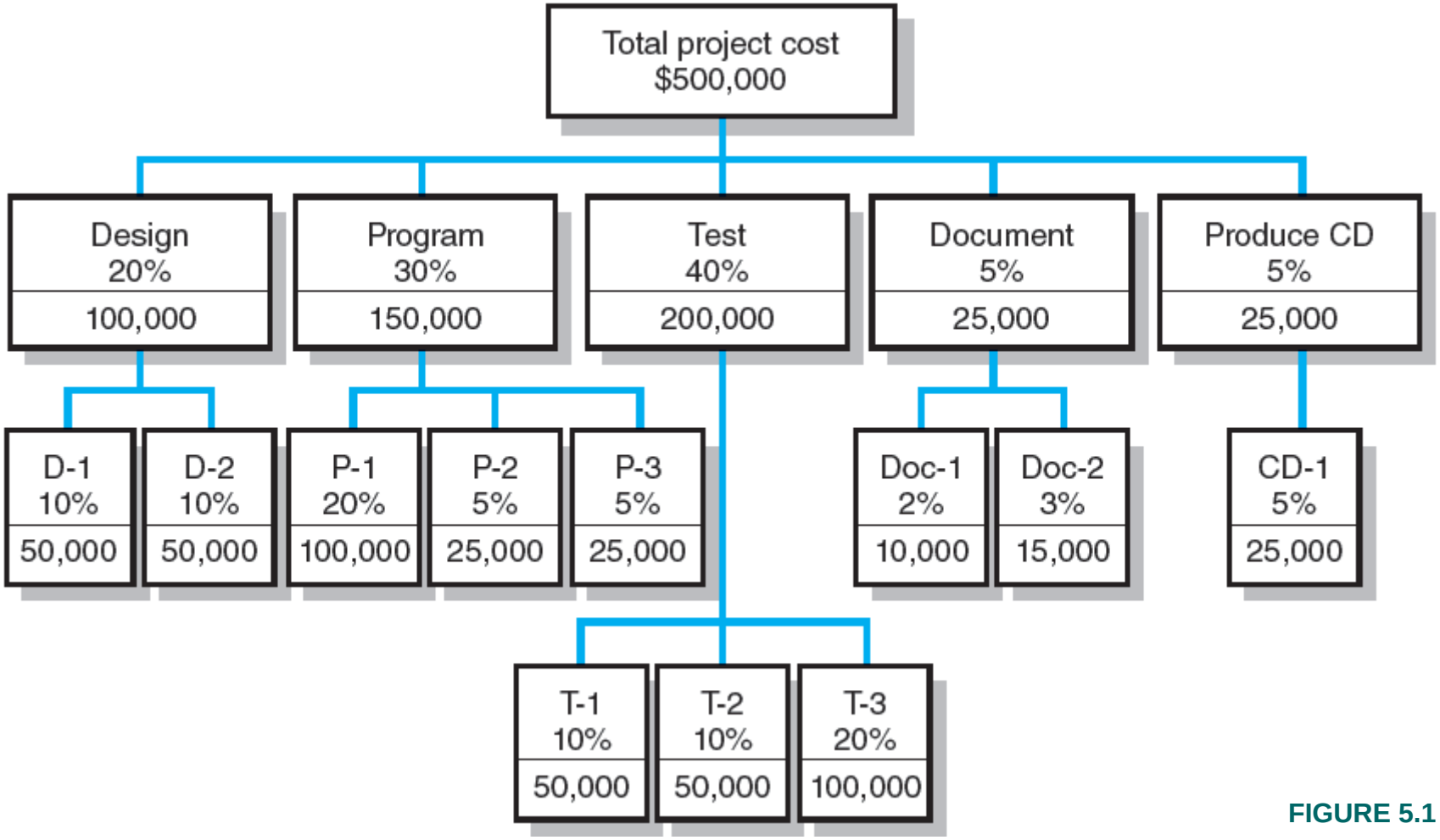
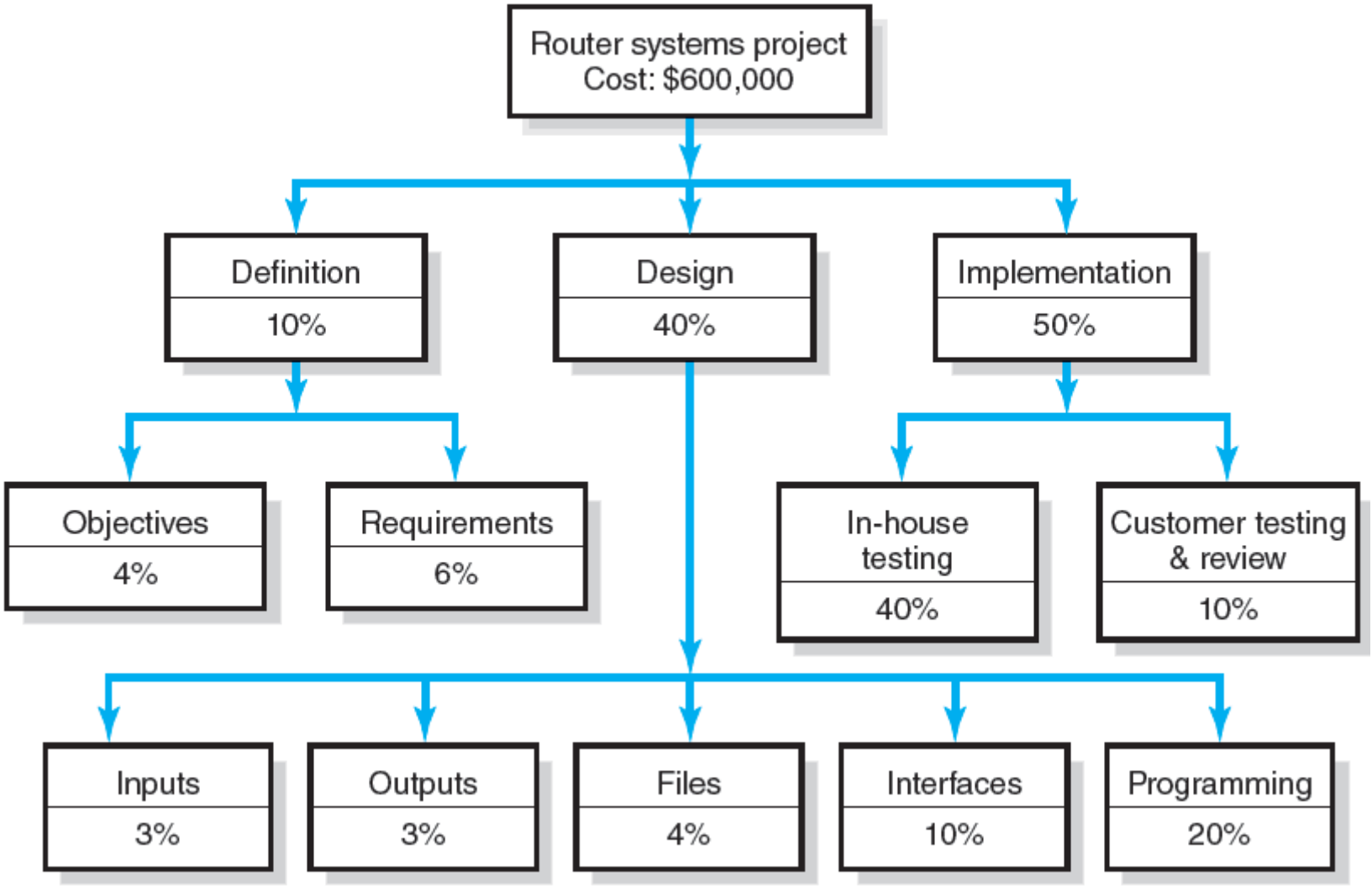


FIGURE 5.1

WBS Figure



Exercise Figure 5.1

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)
3. Apportion method

Based on Historical data of similar project

Percentage is assigned to the major segments of projects

What weaknesses are inherent in this approach?

- Requires good, realistic historical data.
- Project must be very similar to past projects for sub deliverables to be useful.

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)
3. Apportion method
4. Function point methods for **software and system projects**

   Using parameters **x** complexity

   Using weighted macro variables called “function point”

Simplified Basic Function Point Count Process for a Prospective Project or Deliverable

	Complexity Weighting			
Element	**Low**	**Average**	**High**	**Total**
Number of *inputs*	_____ × 2 +	_____ × 3 +	_____ × 4	= _____
Number of *outputs*	_____ × 3 +	_____ × 6 +	_____ × 9	= _____
Number of *inquiries*	_____ × 2 +	_____ × 4 +	_____ × 6	= _____
Number of *files*	_____ × 5 +	_____ × 8 +	_____ × 12	= _____
Number of *interfaces*	_____ × 5 +	_____ × 10 +	_____ × 15	= _____

TABLE 5.2

Example: Function Point Count Method

Software Project 13: Patient Admitting and Billing			
15	Inputs	Rated complexity as low	(2)
5	Outputs	Rated complexity as average	(6)
10	Inquiries	Rated complexity as average	(4)
30	Files	Rated complexity as high	(12)
20	Interfaces	Rated complexity as average	(10)

Application of Complexity Factor

Element	Count	Low	Average	High	Total
Inputs	15	× 2			= 30
Outputs	5		× 6		= 30
Inquiries	10		× 4		= 40
Files	30			× 12	= 360
Interfaces	20		× 10		= 200
				Total	660

TABLE 5.3

Top-Down Approaches for Estimating Project Times and Costs

1. Consensus methods
2. Ratio methods (sometimes called parametric)
3. Apportion method
4. Function point methods for software and system projects
5. Learning curves (=improvement curves)
   - Uses mathematical model to predict the cost & time estimation
   - It's based on the experience & knowledge **gained** (learning curve) from performing the same tasks over and over

Learning Curve Example – Appendix 5.1

- Assume a manufacturer has a new contract for 16 prototype units and a total of 800 labour hours were required for the first unit.
- Past experience indicates the improvement rate for similar types of units was 80%
- If the first unit takes 800 hours to make, what is the per/unit time estimate for the 16th unit?

  Look at the 80% column and the 16 unit row

  => per unit ratio of 0.4096

Learning Curves Unit Values

Units	60%	65%	70%	75%	80%	85%	90%	95%
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	.6000	.6500	.7000	.7500	.8000	.8500	.9000	.9500
3	.4450	.5052	.5682	.6338	.7021	.7729	.8462	.9219
4	.3600	.4225	.4900	.5625	.6400	.7225	.8100	.9025
5	.3054	.3678	.4368	.5127	.5956	.6857	.7830	.8877
6	.2670	.3284	.3977	.4754	.5617	.6570	.7616	.8758
7	.2383	.2984	.3674	.4459	.5345	.6337	.7439	.8659
8	.2160	.2746	.3430	.4219	.5120	.6141	.7290	.8574
9	.1980	.2552	.3228	.4017	.4930	.5974	.7161	.8499
10	.1832	.2391	.3058	.3846	.4765	.5828	.7047	.8433
12	.1602	.2135	.2784	.3565	.4493	.5584	.6854	.8320
14	.1430	.1940	.2572	.3344	.4276	.5386	.6696	.8226
16	.1296	.1785	.2401	.3164	.4096	.5220	.6561	.8145
18	.1188	.1659	.2260	.3013	.3944	.5078	.6445	.8074
20	.1099	.1554	.2141	.2884	.3812	.4954	.6342	.8012
22	.1025	.1465	.2038	.2772	.3697	.4844	.6251	.7955
24	.0961	.1387	.1949	.2674	.3595	.4747	.6169	.7904
25	.0933	.1353	.1908	.2629	.3548	.4701	.6131	.7880

Learning Curve Example – Appendix 5.1

- Assume a manufacturer has a new contract for 16 prototype units and a total of 800 labour hours were required for the first unit.
- Past experience indicates the improvement rate for similar types of units was 80%
- If the first unit takes 800 hours to make, what is the per/unit time estimate for the 16th unit?

  Look at the 80% column and the 16 unit row

  => per unit ratio of 0.4096

  $\Rightarrow$ 0.4096 * 800 = 328 hours (approx) to make the 16th unit.

Learning Curve Example – Appendix 5.1

- Assume a manufacturer has a new contract for 16 prototype units and a total of 800 labour hours were required for the first unit.
- Past experience indicates the improvement rate for similar types of units was 80%

How long would it take to make ALL 16 units?

Look in the **Cumulative** Learning Curve table for 16 units at an 80% improvement rate

=> ratio is 0.8920

Learning Curves Cumulative Values

Units	60%	65%	70%	75%	80%	85%	90%	95%
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	1.600	1.650	1.700	1.750	1.800	1.850	1.900	1.950
3	2.045	2.155	2.268	2.384	2.502	2.623	2.746	2.872
4	2.405	2.578	2.758	2.946	3.142	3.345	3.556	3.774
5	2.710	2.946	3.195	3.459	3.738	4.031	4.339	4.662
6	2.977	3.274	3.593	3.934	4.299	4.688	5.101	5.538
7	3.216	3.572	3.960	4.380	4.834	5.322	5.845	6.404
8	3.432	3.847	4.303	4.802	5.346	5.936	6.574	7.261
9	3.630	4.102	4.626	5.204	5.839	6.533	7.290	8.111
10	3.813	4.341	4.931	5.589	6.315	7.116	7.994	8.955
12	4.144	4.780	5.501	6.315	7.227	8.244	9.374	10.62
14	4.438	5.177	6.026	6.994	8.092	9.331	10.72	12.27
16	4.704	5.541	6.514	7.635	8.920	10.38	12.04	13.91
18	4.946	5.879	6.972	8.245	9.716	11.41	13.33	15.52
20	5.171	6.195	7.407	8.828	10.48	12.40	14.64	17.13
22	5.379	6.492	7.819	9.388	11.23	13.38	15.86	18.72
24	5.574	6.773	8.213	9.928	11.95	14.33	17.10	20.31
25	5.668	6.909	8.404	10.19	12.31	14.80	17.71	21.10

Learning Curve Example – Appendix 5.1

- Assume a manufacturer has a new contract for 16 prototype units and a total of 800 labour hours were required for the first unit.
- Past experience indicates the improvement rate for similar types of units was 80%

How long would it take to make ALL 16 units?

Look in the **Cumulative** Learning Curve table for 16 units at an 80% improvement rate

$\Rightarrow$ ratio is 8.920 So the Total labour hours for ALL 16 units

= 800 * 8.920 = 7,136 hours (without learning curves, 800 hours x 16 units = 12,800 h)

Average production time for all 16 units = 7136/16

= 446 hours per unit

Bottom-Up Approaches for Estimating Project Times and Costs **(10 mins break)**

1. Template methods
2. Parametric procedures applied to specific tasks
3. Range estimates for the WBS work packages
4. Phase estimating: A hybrid

Bottom-Up Approaches for Estimating Project Times and Costs

1. Template methods
   - If the project is similar to past projects, the costs from past projects can be used as a starting point for the new project.
   - eg. A ship repair drydock firm has a set of standard repair projects (templates for overhaul, electrical mechanical) that are used for any new projects.

Bottom-Up Approaches for Estimating Project Times and Costs

1. Template methods
2. Parametric procedures applied to specific tasks
   - Uses parameters to estimate cost & time
   - This is similar to the ratio method but is more detailed
   - Parametric techniques: MS office conversion project
     - 36 computers,
     - one person converts 3 computers / day,
     - three technicians convert 9 computers / day,
     - so it will take ___ days

Bottom-Up Approaches for Estimating Project Times and Costs

1. Template methods
2. Parametric procedures applied to specific tasks
3. Range estimates for the WBS work packages
   - Best used when there is uncertainty associated to work packages
   - Experienced people or group determine the low, average, and high cost or duration

Range Estimating Template

	A	B	C	D	E	F	G	H
1	Project number: 18				Project Manager: Dawn O'Connor			
2	Project description: New Organic Wine Launch				Date: 2/17/2xxx			
3			Organic Wine Launch Project					
4			Range Estimates					
5								
6	WBS	Description	Low	Average	High	Range	Risk	
7	ID		Estimate	Estimate	Estimate		Level	
8			Days	Days	Days	Days		
9								
10	102	Approval	1	1	3	2	low	
11	103	Design packaging	4	7	12	8	medium	
12	104	ID potential customers	14	21	35	21	high	
13	105	Design bottle logo	5	7	10	5	low	
14	106	Contract kiosk space	8	10	15	7	medium	
15	107	Construct kiosk	4	4	8	4	medium	
16	108	Design fair brochure	6	7	12	6	high	
17	109	Trade journal advertising	10	12	15	5	medium	
18	110	Production test	10	14	20	10	high	
19	111	Produce to inventory	5	5	10	5	high	
20	112	Business card scanner hookup	1	2	3	2	low	
21	113	Video hook up	2	2	4	2	medium	
22	114	Event rehearsal	2	2	5	3	high	

FIGURE 5.2

Bottom-Up Approaches for Estimating Project Times and Costs

1. Template methods
2. Parametric procedures applied to specific tasks
3. Range estimates for the WBS work packages

4. Phase estimating: A hybrid

- Begins with a top-down estimate then refines estimates for phases
- Used in extremely uncertain project
  - e.g., development of new technology, projects that may involve new or innovative designs

Phase Estimating over Product Life Cycle

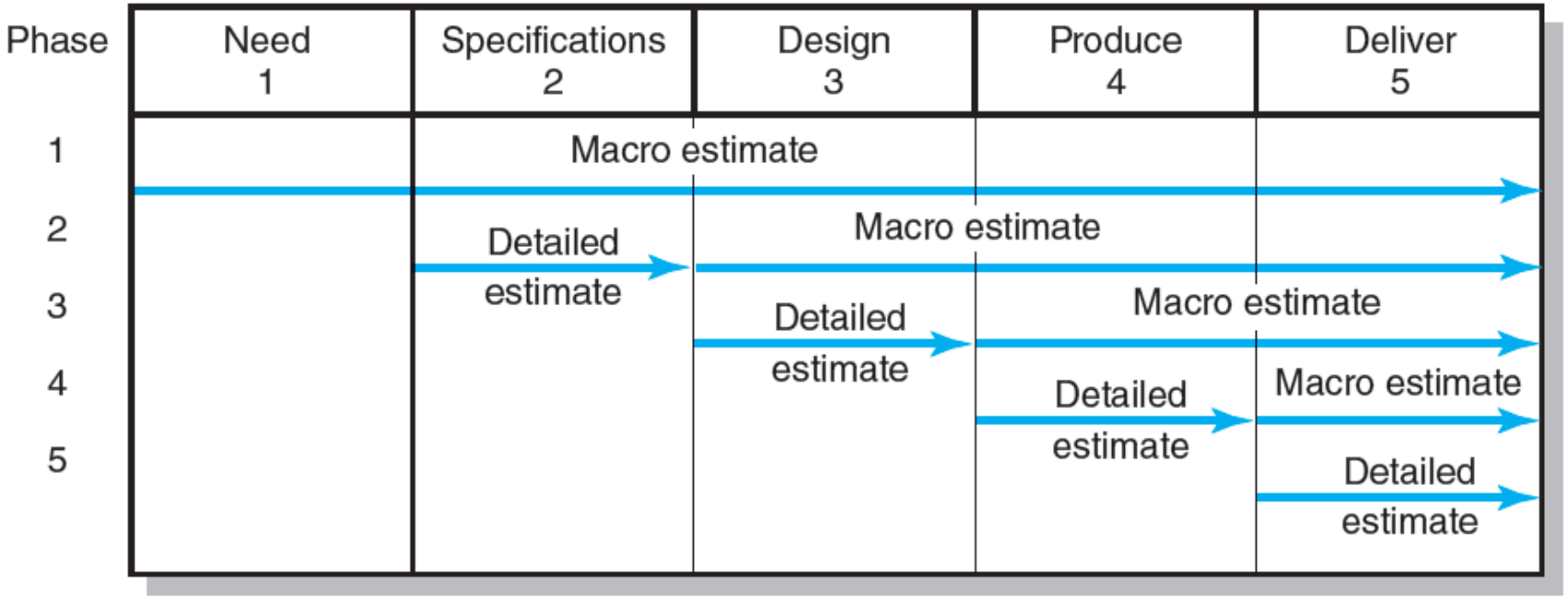


FIGURE 5.3

Types of Costs

- Direct Costs
  - Costs that are clearly chargeable to a specific work package.
    - Labor, materials, equipment, and other
  - Real cash outflows and must be paid as the project progresses
- Direct (Project) Overhead Costs
  - Costs incurred that are directly tied to project deliverables or work packages: is not an immediate out-of-pocket expense
    - Salary of the project manager, temporary rental space, stationary supplies, specialized machinery
    - Resources of the organization
- General and Administrative Overhead Costs
  - Organization costs indirectly linked to a specific package that are apportioned (as a %) to the project.
    - Accounting, human resources, etc.

Contract Bid Summary Costs

Direct costs	$80,000
Direct overhead	$20,000
Total direct costs	$100,000
G&A overhead (20%)	$20,000
Total costs	$120,000
Profit (20%)	$24,000
Total bid	$144,000

FIGURE 5.5

Refining Estimates

The actual cost and schedule of some projects significantly exceed original work package-based estimates.

e.g., total estimated cost x 1.20

Why???

Refining Estimates

- Reasons for Adjusting Estimates
  - Interaction costs are hidden in estimates.
    - Coordination between tasks (one task is dependent upon prior tasks)
  - Normal conditions do not apply.
    - Resource availability
      - Under normal conditions four bulldozers are used, but the availability of only three bulldozers …
    - The decision to outsource certain tasks can increase costs and durations
  - Things go wrong on projects.
  - Changes in project scope and plans
- Adjusting Estimates
  - Time and cost estimates of specific activities are **adjusted** as the risks, resources, and situation particulars become more clearly defined.

Can we improve estimation?

Estimating Database Templates

- The best way to improve estimates is to collects and archive data on past project estimates and actuals.
  - Saving historical data: estimate and actual
- It provides a knowledge base for improving project time and cost estimating.

Estimating Database Templates

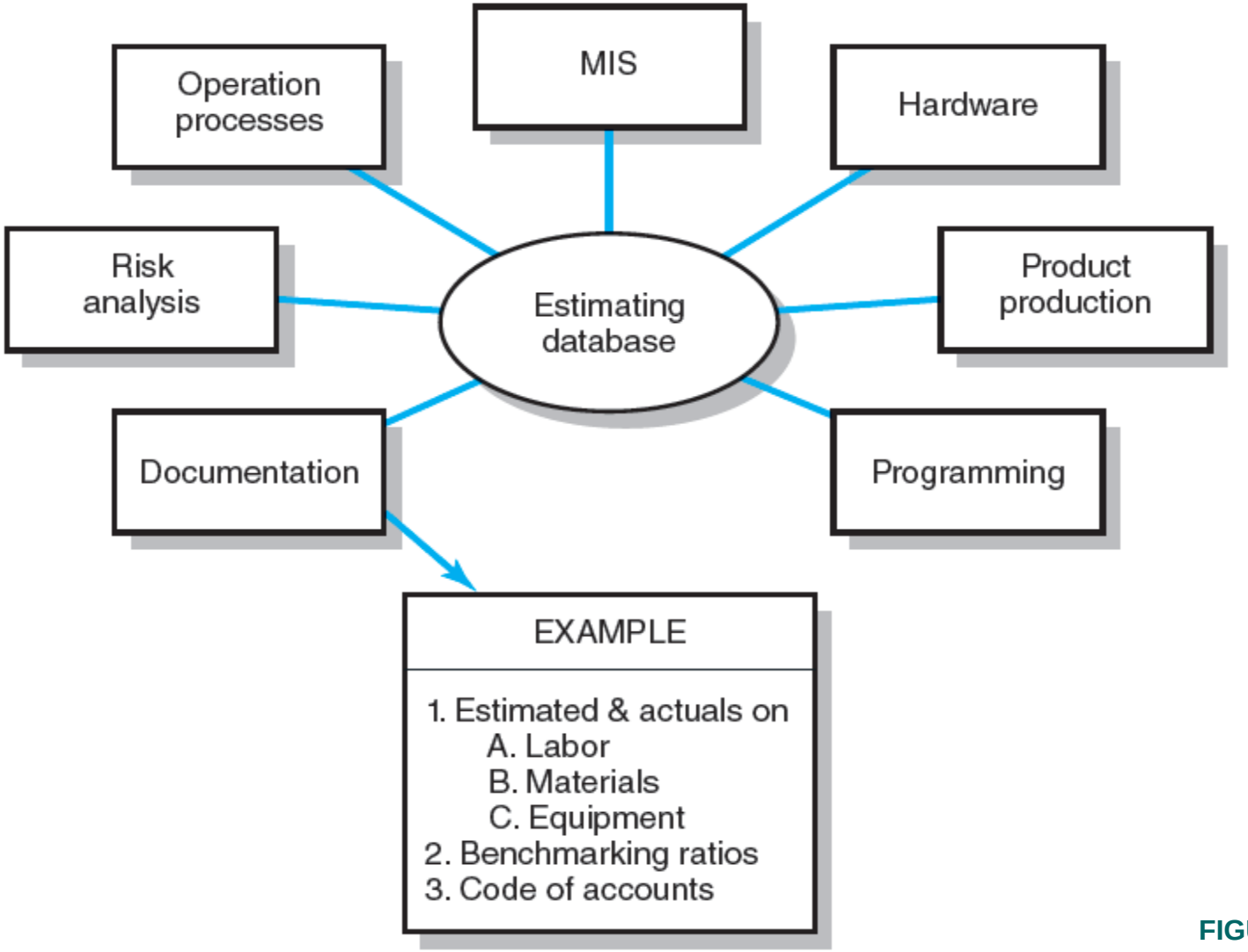


FIGURE 5.7

Key Terms

Apportionment
Bottom-up estimates
Direct costs
Function points
Learning curves
Overhead costs
Padding estimates
Phase estimating
Range estimating
Ratio methods
Template method
Time and cost databases
Top-down estimates

Next week

- Skim through Chapter 6
- We will look at
  - Planning and Scheduling
  - Managing Change