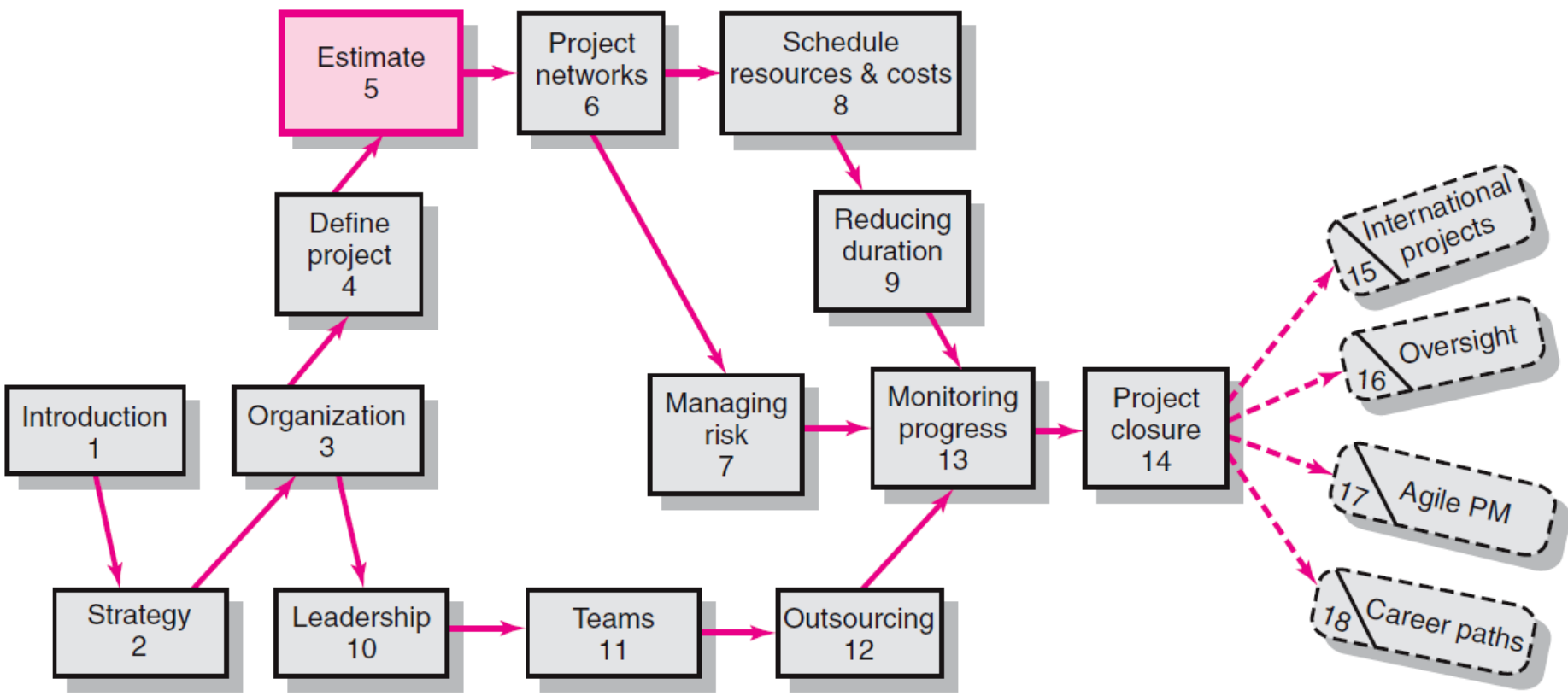


MGMT 4135  
**Project Management**

**Chapter-5**

**Estimating Project  
Times and Costs**

# Where We Are Now



# Importance of Estimating Time and Cost

- To support good decisions
- To schedule work to be done
- To determine how long the project should take
- To determine the project's cost
- To determine whether the project is worth doing
- To develop cash flow needs
- To determine how well the project is progressing
- To develop time-phased budgets and establish the project baseline

# Factors Influencing the Quality of Estimates

Past experience is a good starting point for developing time and cost estimates but these must be further refined for the current project. The following factors will have a strong influence on the accuracy of estimates:



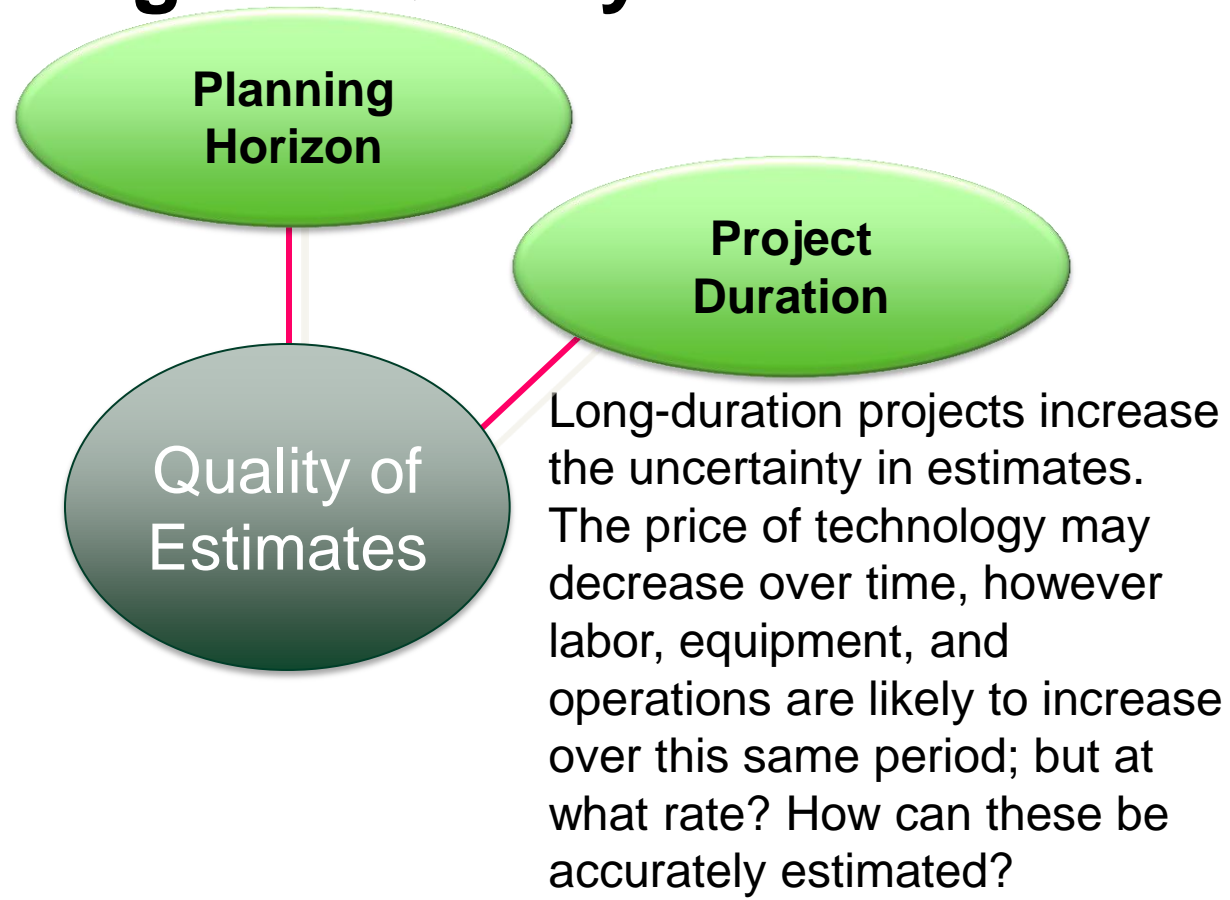
Quality of  
Estimates

# Factors Influencing the Quality of Estimates



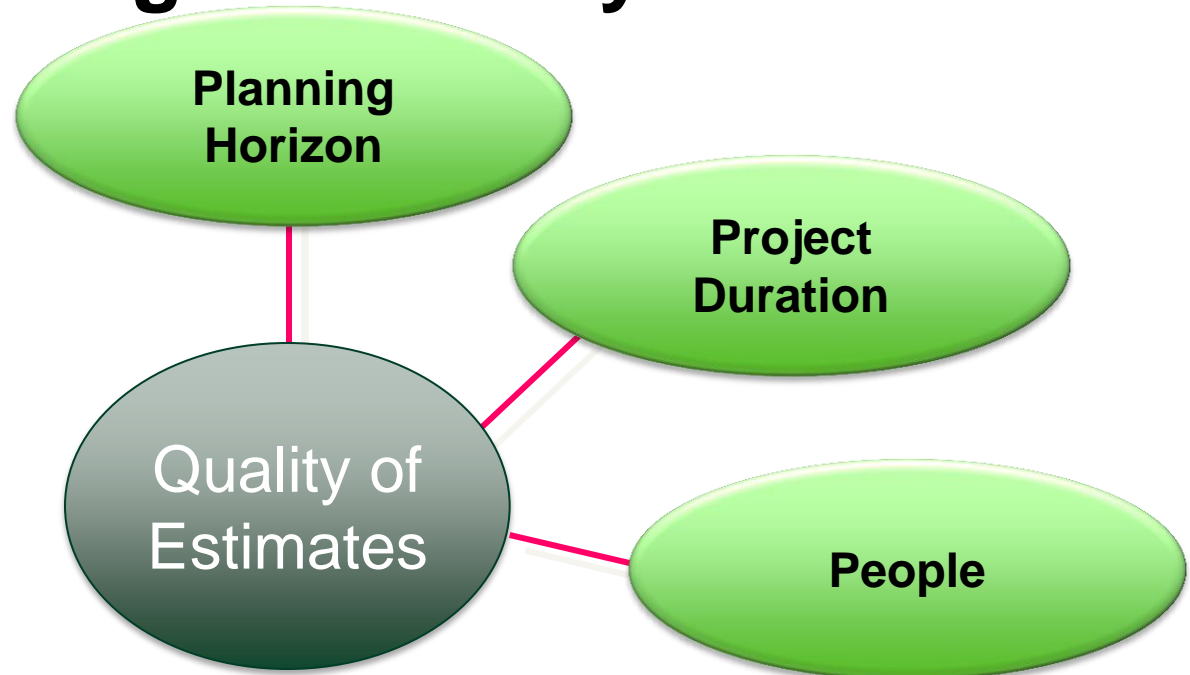
This refers to the accuracy of time and cost estimates. They should improve as the project moves from the conceptual phase to the point where individual work packages are defined.

# Factors Influencing the Quality of Estimates





# Factors Influencing the Quality of Estimates



The “people” factor can introduce challenges in the estimating process. A close match of skills to the task will influence productivity and learning time and, conversely, the opposite is also true. Staff turnover and whether people have worked on projects together in the past also influences accurate estimating.

# Factors Influencing the Quality of Estimates

Project structure refers to matrix, functional, and projectized. The “speed” advantage of a focused dedicated team comes at a higher cost than a matrix team; however the matrix team will not deliver as quickly due to competing demands and divided focus.





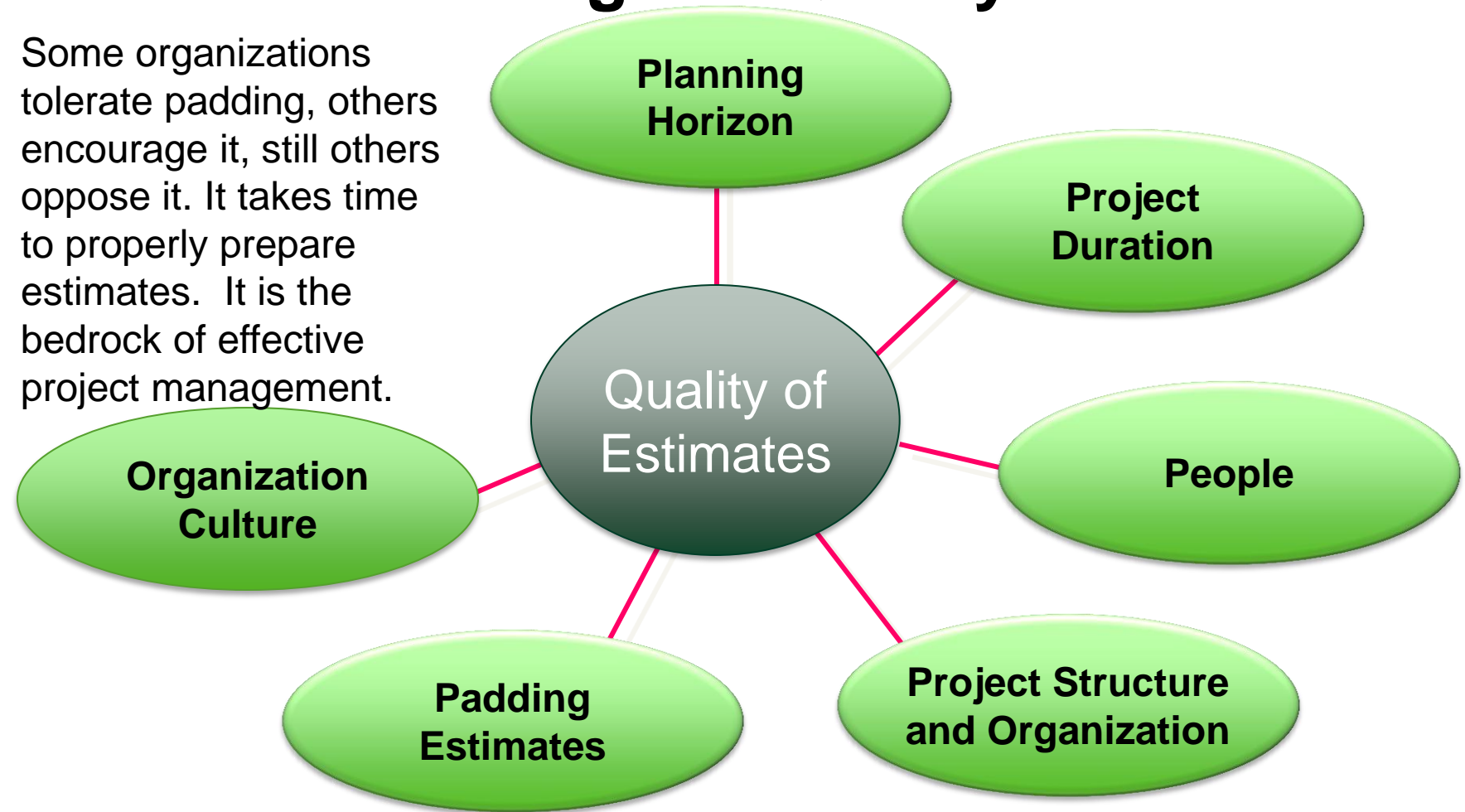
# Factors Influencing the Quality of Estimates

When asked to estimate, most are inclined to “pad” estimates in order to increase the probability of being on budget and reducing the risk of being late. Padding, however, defeats the chance of truly arriving at realistic estimates, which is greatly needed in order to be competitive.



# Factors Influencing the Quality of Estimates

Some organizations tolerate padding, others encourage it, still others oppose it. It takes time to properly prepare estimates. It is the bedrock of effective project management.



Equipment downtime, holidays, vacations, staff reduction, strikes, and legal limits influence project estimates.



# Estimating Guidelines for Time, Cost, and Resources

- **Responsibility:** Those who are the most familiar with the tasks should make the estimates. If others are consulted instead, it will be difficult to hold those doing the work responsible for not achieving the estimated time.
- **Use several people to participate.** Estimates have a better chance of being reasonable and realistic when several people with relevant experience and knowledge of the task are used.
- **Normal conditions:** Base estimates on normal conditions, efficient methods and processes, and a normal level of resources.

# Estimating Guidelines for Time, Cost, and Resources

- **Time Units:** Use consistent time units (hours, days, weeks, etc.) whenever possible when estimating task time.
- **Independence:** Treat each task independently. Do not aggregate time or cost upward. Each task is to have its own values.
- **Contingencies:** Work package estimates should not include allowances for contingencies. Remember, the estimate should assume normal conditions but expect that not all work packages will materialize as planned.



# Estimating Guidelines for Time, Cost, and Resources

- **Adding risk assessment to the estimate:** This helps avoid surprises to the stakeholders. Unexpected time delays or cost increases should be identified as possible risks to the project. Use a PERT time estimates for optimistic, most likely, and worse case scenario for tasks that are vulnerable.

*PERT: Program (or Project) Evaluation and Review Technique*

**E.g.** Your project goal is to install new technology and because this is not a proven process it carries more risk when determining how long it will take.

Optimistic = 5 days. Most likely = 8 days. Pessimistic = 15 days.

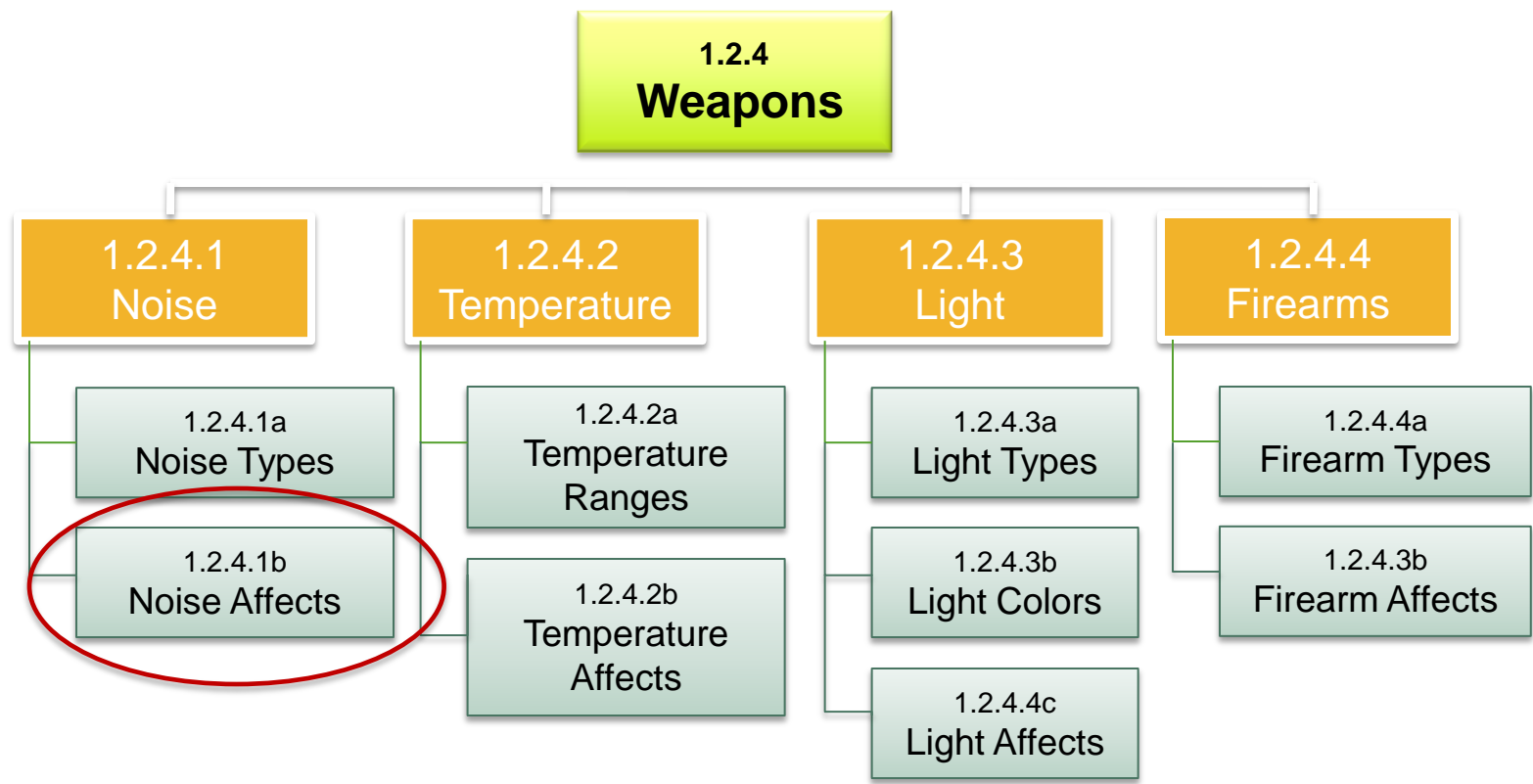
$$T_E = (O + 4M + P) \div 6 \quad \text{-or-} \quad (5 + 32 + 15) \div 6 = 8.6 \text{ days}$$

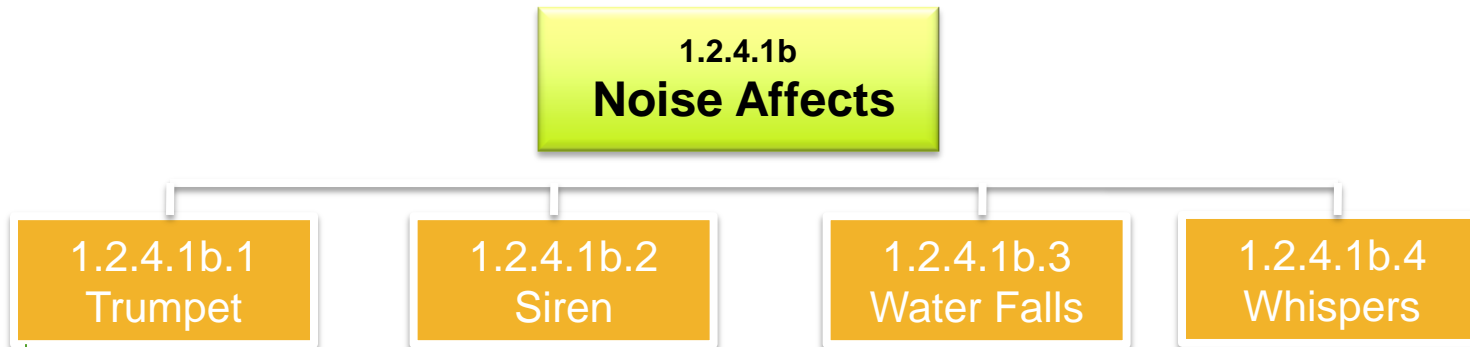


# Top-Down versus Bottom-Up Estimating

- **Top-Down Estimates** are usually derived from a resource or group of resources who use prior experience and information to determine the estimated duration and cost.
- **Top-Down Estimates** are also made by top managers who have little knowledge of the processes used to complete the project. See *“Council Fumes as Tram Tale Unfolds”* on pg. 133.
- **Bottom-Up Approach** can serve as a check on cost elements in the WBS by rolling up the work package associated cost accounts to major deliverables at the work package level.

*Let's look at a work package and some of its details...*





### WP 1.2.4.1b.1.1 Trumpet Development

- Adults gather babies
- Babies cry
- Army assembles at front castle gates
- Army closes front castle gates
- King is alerted that the Vrembers are on their way
- Castle people all start talking at the same time
- Castle guards check that all babies are with the adult parents
- Missing babies are adopted when found by a childless adult

**WP 1.2.4.1b.1.1**

- Trumpet Development: Adults gather babies
- Trumpet Development: Army assembles at front castle gates
- Trumpet Development: Army closes front castle gates

**Adults gather babies**

John Sheridan (motion)	25 hrs	611-205	56.25	1,406.25	6/01/2013
Nicki Greer (acceleration)	10 hrs	611-205	56.25	562.50	5/15/2013
<b>TOTAL:</b>	<b>35 hrs</b>	611-205		<b>\$1,968.75</b>	

**Army assembles at front castle gates**

John Unger (motion)	30 hrs	611-205	56.25	1,687.50	6/10/2013
Nicki Greer (acceleration)	12 hrs	611-205	56.25	675.00	6/10/2013
<b>TOTAL</b>	<b>42 hrs</b>	611.205		<b>\$2,362.50</b>	

**Army closes front castle gates**

John Sheridan (motion)	24 hrs	611-205	56.25	1,350.00	6/18/2013
Nicki Greer (acceleration)	10 hrs	611-205	56.25	562.50	6/20/2013
<b>TOTAL</b>	<b>34 hrs</b>	611-205		<b>\$1,912.50</b>	

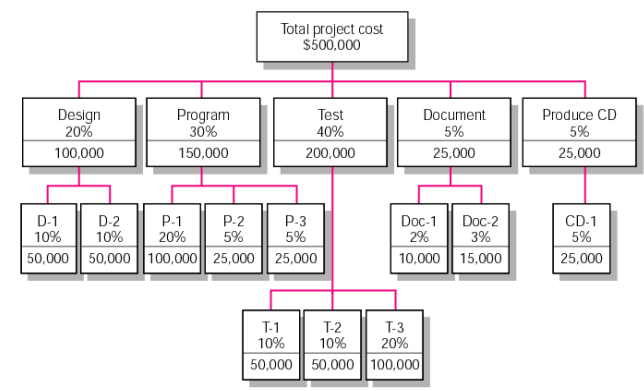
**111 hrs 611-205 \$6,243.75**

## Top-Down Approaches

- **Consensus Methods:** uses the pooled experience of senior and/or middle managers to estimate the total durations and cost. These initial top-down estimates are only a rough cut and normally occur in the “conceptual” stage of the project. PM’s are to be sure that these estimates are not dictated to lower level managers.
- **Ratio Methods:** these are parametric or ratio methods that are used in the “concept or need” phase of the project to get an initial duration and cost. E.g. a house is 2,700 sq. ft. at a cost of \$160 per sq. ft. Therefore, the parametric cost is approximately \$432,000. Based on prior experience, a house of this size normally takes 100 days to complete.

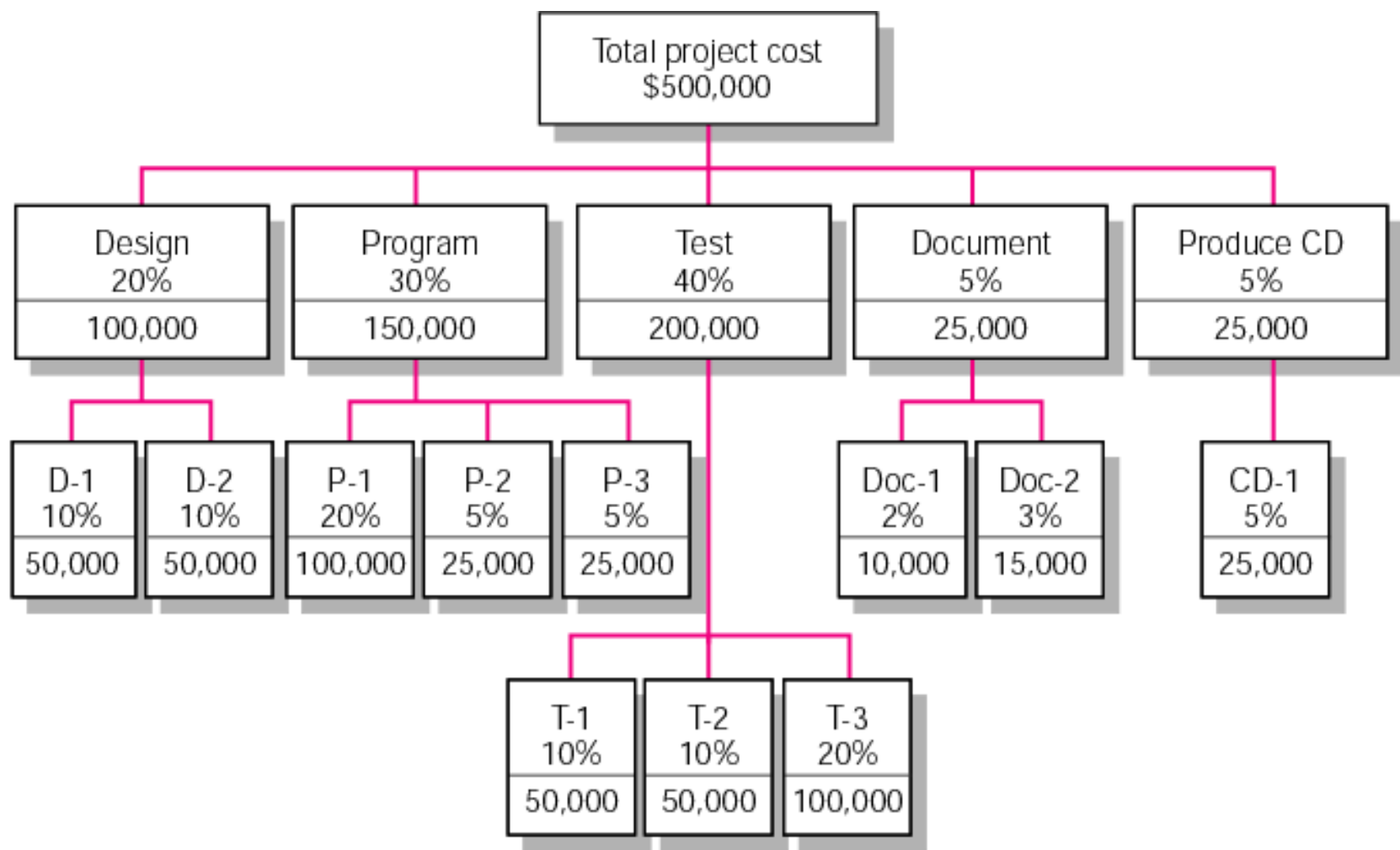
# Top-Down Approaches

- **Apportion Methods:** similar to the ratio or parametric method and is used when projects are very similar to previous projects in terms of features and cost. These are used for standard projects having small variations or customizations.
- On the next slide, you will see that each element of the project is assigned a percentage or apportion of the total estimated cost of the project.





# Top-Down Approaches – The Apportionment Method



## Top-Down Approaches

- **Function Point Method for Software & System Projects:** software development projects are frequently estimated using weighted variables called “function points.” These function points are identified as number of inputs, number of outputs, number of inquiries, number of data files, and number of interfaces. The total adjusted count provides the basis for estimating labor effort and cost for a project and may use factors derived from historical data.
- Function point metrics are useful, however their accuracy depends on adequate historical data and the relevancy of the current project deliverables when lined up with the past project averages.

# Top-Down Approaches

- Function Point Method for Software & System Projects:**

## 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
				<b>Total</b>	<b>660</b>

## Top-Down Approaches

- **Learning Curves** require that the same task or group of tasks be repeated several times, thus improving performance over time due to this repetition. The pattern of improvement can be used to predict the reduction of time it takes to perform the task.
- Each time the output quantity doubles the unit of labor hours are reduced at a constant rate.

---

The main **disadvantage of top-down** approaches is simply that time and cost for a specific task are not considered.

## Bottom-Up Approaches

- **Template Method** is the use of similar previous projects as a good starting point. E.g. A collision shops consults published labor rates and labor time to perform a collision repair. This method enables the performing organization to develop a potential schedule, estimate costs, and develop a budget in very short order.

## Bottom-Up Approaches

- **Parametric Procedure Applied to Specific Tasks** such as cost per sq. ft. can be the source of top-down estimates as well as estimating work package tasks. E.g. Converting 36 workstations to the latest version of Office 2010: it has been determined that one desktop technician could convert 3 workstations per day; thus 12 days to convert all 36.

What if you add 2 more desktop technicians?  $(36/3)/3=4$  This equation now states that if you use 3 technicians and each are able to convert 3 workstations per day, then it will take 4 days to convert all 36 workstations.

---

Wallpaper is \$5 per sq. yd. plus \$2 per sq. yd. for installation, i.e. \$7 per sq. yd. Multiplying length and height of all the walls to be wallpapered is the total sq. yardage of the job, times \$7.



# Bottom-Up Approaches

- **Range Estimating** is used when a work package has significant uncertainty about the total time and cost in which to complete. This gets back to PERT estimating. Figure 5.2

Excel formula for PERT =  $(A1+(4*B1)+C1)/6$

		Range Estimates				
WBS		Low Estimate	Average Estimate	High Estimate	Range of	Risk Level
ID	Description	Days	Days	Days	Days	
102	Approval	1	1	3	2	Low
103	Design packaging	4	7	12	8	Medium
104	ID potential customers	14	21	35	21	High
105	Design bottle logo	5	7	10	5	Low
106	Contract kiosk space	8	10	15	7	Medium
107	Construct kiosk	4	4	8	4	Medium
108	Design fair brochure	6	7	12	6	High
109	Trade journal advertising	10	12	15	5	Medium
110	Production test	10	14	20	10	High
111	Produce to inventory	5	5	10	5	High
112	Business card scanner hookup	1	2	3	2	Low
113	Video hookup	2	2	4	2	Medium
114	Event rehearsal	2	2	5	3	High

## Hybrid: Phase Estimating

- **Hybrid** begins with a top-down estimate. It is then refined as the each phase of the project is implemented.
- **Phase estimating** is used when there is great uncertainty and impractical to estimate time and cost for the entire project.
- **Phase estimating** uses a two-estimate system over the life of a project. A detailed estimate is developed during the current phase and a macro estimate is determined for the remaining phases.

# Hybrid: Phase Estimating

- Phase Estimating

Phase	Need 1	Specifications 2	Design 3	Produce 4	Deliver 5
1		Macro estimate			
2		Detailed estimate	Macro estimate		
3			Detailed estimate	Macro estimate	
4				Detailed estimate	Macro estimate
5					Detailed estimate

## Note About Project Estimates

- Unfortunately, your customer will want an accurate estimate of the project schedule and cost the moment the decision is made to move forward with the project. Remember, the only possible estimate at that time is the Top-Down *Consensus* method. More information about the Consensus Method:
  - Involves a meeting where experts discuss, disagree, then ultimately reach a decision as to their best guess estimates.
  - Organizations seeking greater rigor will use the **Delphi Method** to determine macro estimates.
  - **Delphi Method** is an anonymous method of gathering opinions or data. It removes “group think” and neutralizes influence from strongly opinionated participants.  
See “*The Delphi Method*” pg. 134.

## Level of Detail

- Top management may center on the total project and major project milestones.
- Middle management may center more on one segment of the project or a limited number of milestones as they have a reflection on their area of the organization.
- First-line (or functional) managers may only be interested in the individual work package tasks that must be performed in their down line.
- The beauty of the WBS is the ability to aggregate information so that each level of management can obtain the kind of information they want and need in order to make decisions.



## Level of Detail

- **Excessive detail** is unproductive paperwork and may foster a focus on departmental outcomes rather than the team work required across all departments.
- **Insufficient detail** generates a lack of focus on the project goals and commits a wasted effort on non-essential activities.
- Fortunately, the **WBS is very flexible** in that functional units may expand their portion of the structure to meet their special needs. E.g. the marketing department may want to further break down (or decompose) their new product promotion into TV, radio, billboards, Internet, periodicals, and newspapers. Work packages for each would then be developed so that each promotion medium can be assigned to individuals and easily estimated for time and cost. Aggregated up, the marketing department would then obtain the estimated time and cost for the entire promotion effort.



# Types of Costs

- **Direct Costs** are clearly chargeable to a specific work package and include labor, materials, equipment, and any other resources defined by the project.
- **Direct Project Overhead Costs** are those incurred costs that are directly tied to a specific project deliverable or work package. These include salary, rents, supplies, specialized machinery, etc. Using certain direct overhead costs provides a more accurate project cost rather than using a blanket overhead rate (sometime called a “loaded labor rate”) for the entire project.
- **General and Administrative Overhead Costs** represent costs not directly linked to the project but are carried for the duration of the project. These include organization costs across all products and projects such as advertising, accounting, and management above the project level. A specific percentage of these costs are allocated to the project.

## Types of Costs

***Note from Instructor:** Figure 5.5 is difficult to understand because the text does not provide the actual costs of labor, materials, equipment, or others. It is simply shown as \$80,000 and we do not know what is included in that cost. Therefore the \$20,000 direct overhead costs cannot be calculated. You just have to take it on face value. The same applies to the values shown for G&A and Profit.*

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

# Estimating Projects: Preferred Approach

- Make rough top-down estimates
- Develop the WBS with an OBS
- Use bottom-up estimates
- Develop schedule and budget
- Reconcile the difference between the top-down and bottom-up estimates

## Refining Estimates

- **Work Packages**, as described in Chapter-4 are aggregated (or rolled up) to estimate the total direct costs of the project, thus determining the project budget.
- A **Network** diagrams, described in Chapter-6, will provide additional information to the project team for determining the project schedule.

# Refining Estimates

- **So why, after investing so much time on detailed estimates could the numbers still be so far off?**
  - **Interaction costs are hidden in estimates.** Tasks are to be estimated independent from other tasks. However work on one task may have a dependency on one or more prior tasks. The hand-off between tasks requires time and attention.

*E.g. The development of a prototype requires the prototype team to interact with design engineers, asking clarifying questions and making adjustments; time for meetings and other coordination of activities are not reflected in these independent estimates. They are hidden.*

## Refining Estimates

- **So why, after investing so much time on detailed estimates could the numbers still be so far off?**
  - **Normal conditions do not apply.** Earlier it was stated that estimates are supposed to be based on normal conditions, as a good starting point, but is rarely realistic in real life. Resource availability, whether people, equipment, materials, or even funding can easily extend original estimates.

*E.g. Four bulldozers are normally used to clear a certain sized site in five days, but there are only three bulldozers available during this time period. Now the estimate will be increased to eight days and the crew labor costs will be increased due to the extended task duration.*



# Refining Estimates

- **So why, after investing so much time on detailed estimates could the numbers still be so far off?**
  - **Things go wrong on projects.** Design flaws show up after the fact; weather conditions occur, accidents happen, staff turnover, staff gets ill - all of these affect estimates. The project manager should plan for these risks to occur and the likelihood and impact of such events need to be considered.
  - **Changes in project scope and changes in plans.** As the project proceeds, a much better understanding of what needs to be done may lead to major changes in project plans and costs. Projects in mid-stream may have to be modified due to new demands by the customer and/or competition. Remember, a poorly written scope is another reason for cost overruns.

# Refining Estimates

- The reality is that not all needed information is available when estimating is being done and it is impossible to predict the future. That's why we estimate.
- Even with the best estimating efforts, it may be necessary to revise estimates based on new relevant information before creating a baseline schedule and budget.
- Estimates are adjusted once risks, resources, and other facts have been clearly defined and understood.
- Remember the WBS is only a starting point and does not reveal all the hidden activities that typically occur during a project.

## Refining Estimates

- There will always be some mistakes, omissions, and adjustments that will require additional changes to the project estimates.
- This is why change management is crucial as it accommodates these situations and gets leadership involved.

# Creating a Database for Estimating

- The best way to improve the accuracy of estimates is to collect and archive data from previous projects, both estimates and actuals.
- Historical data provides a knowledge base for improving project time and cost estimates. Creating an estimating database is a “best practice” among leading project management organizations.
- The database approach allows the project estimator to select a specific work package done in the past and glean information for estimating the current project.
- Over time, historical data and the degree of accuracy in the database should improve.

# Chapter-5 Exercises

Mrs. Tolstoy and her husband, Serge, are planning their dream house. The lot for the house sits high on a hill with a beautiful view of the Appalachian Mountains. The plans for the house show the size of the house to be 2,900 square feet. The average price for a lot and house similar to this one has been \$120 per square foot. Fortunately, Serge is a retired plumber and feels he can save money by installing the plumbing himself. Mrs. Tolstoy feels she can take care of the interior decorating.

24 %	Excavation and framing complete
8 %	Roof and fireplace complete
3 %	Wiring roughed in
6 %	Plumbing roughed in
5 %	Siding on
17 %	Windows, insulation, walks, plaster, and garage complete
9 %	Furnace installed
4 %	Plumbing fixtures installed
10 %	Exterior paint, light fixtures installed, finish hardware installed
6 %	Carpet and trim installed
4 %	Interior decorating
4 %	Floors laid and finished

# Chapter-5 Exercises

Firewall Project XT. Using the “complexity weighting” scheme shown in Table 5.2 and the function point complexity weighted table shown below, estimate the total function point count. Assume the historical data suggests five function points that are equal to one person month and six people can work on the project.

**Complexity Weight Table**

Number of inputs	10	Rated complexity low x 2
Number of outputs	20	Rated complexity average x 6
Number of inquiries	10	Rated complexity average x 4
Number of files	30	Rated complexity high x 12
Number of interfaces	50	Rated complexity high x 15



# Chapter-5 Exercises

Complexity Weight Table					
Element	Count	Low	Average	High	Total
Inputs	10	10 x 2			
Outputs	20	20 x 6	20 x 6		= 120
Inquiries	10		10 x 4		= 40
Files	30			30 x 12	= 360
Interfaces	50			50 x 15	= 750
				<b>TOTAL</b>	= <b>1,290</b>

1. Determine the total amount of function points.
2. Now determine how many person months there are in the total function points.
3. We know that 6 resources will be working the project. So how long is the project duration?
4. What if 20 resources work the project? How long now?
5. What if 43 resources work the project? How long now?

# Chapter-5 Key terms:

## Learn These Terms

Apportionment, 135	Learning curves, 137	Ratio methods, 134
Bottom-up estimates, 132	Overhead costs, 142	Template method, 137
Delphi Method, 134	Padding estimates, 129	Time and cost database, 146
Direct costs, 142	Phase Estimating, 139	Top-down estimates, 132
Function points, 135	Range estimating, 138	