

# Cost Estimating in PMBoK vs. CEBoK

*Remember That. Then, Forget It !*



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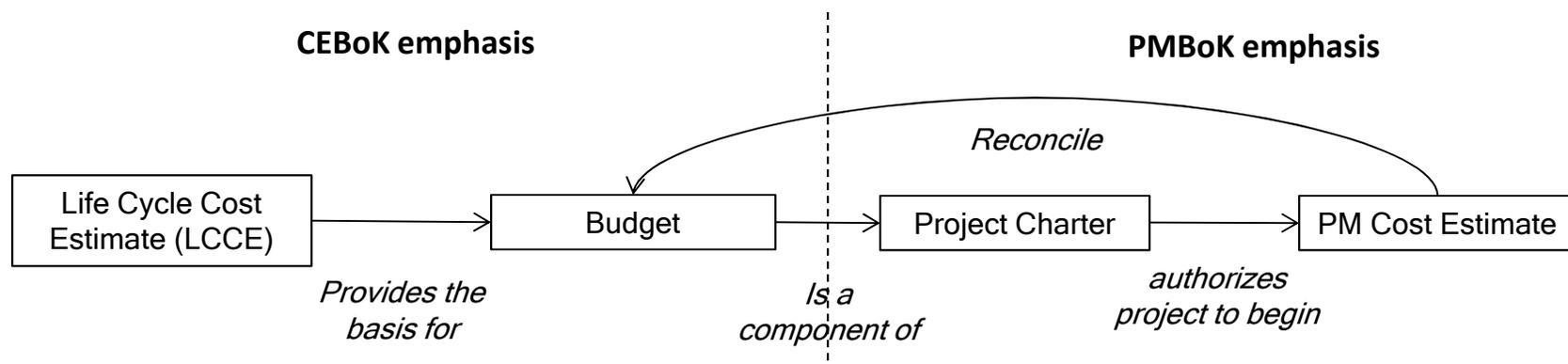
# Course Description

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- **The Project Management Body of Knowledge (PMBok) and Cost Estimating Body of Knowledge (CEBoK)** each give guidance on effective cost estimating for successful project execution. While there is a good deal of overlap between the two curricula, there are also significant differences. More importantly, in many instances, the same terms are used to mean different things. Mastering cost estimating as it exists in both curricula requires you to *remember* everything you learned as you study these bodies of knowledge. And then *forget* it.

# Learning Objectives

- Understand cost estimator's role in PMBoK world versus CEBoK world<sup>1</sup>
  - CEBoK – Independent organization prepares *Life Cycle Cost Estimate (LCCE)* in order to determine budget requirements and program viability
  - PMBoK – Project Manager (PM) prepares project-level cost estimate (project = temporary endeavor with definite beginning and end) in order to direct, manage, and monitor/control the project
- Actively get involved to help both communities become cognizant of each other
- Leverage best practices from both



1. Presentation is intended for audience possessing a CEBoK foundation with less understanding of PMBoK guidance.

# Agenda

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- High-Level Comparison of Cost Estimating in CEBoK vs. PMBoK
- Notable Similarities
  - *same or similar terms, same or similar meaning*
- Notable Differences
  - *new, different, or unique terms*
- Confusions
  - *same terms, different meanings*
- Conclusion

# Actual PMP Exam Practice Question <sup>1</sup>

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1. What is the most accurate cost estimating technique?

- A. Analogous
- B. Parametric
- C. Bottom-Up
- D. Three Point
- E. Group Decision-Making

1. For this and all subsequent questions, we will accept the PMBoK Guide (and related study materials') answer as the correct one, unless otherwise specified.

# Actual PMP Exam Practice Answer

1. What is the most accurate cost estimating technique?

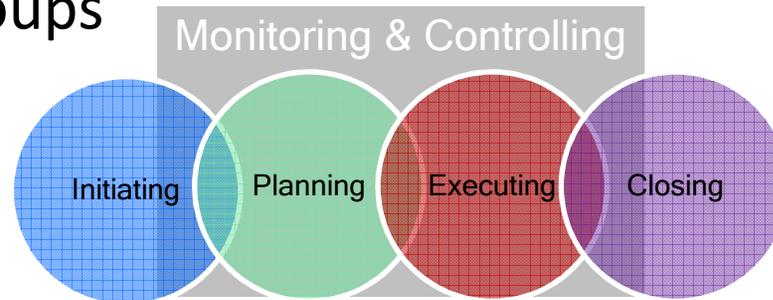
- A. Analogous
- B. Parametric
- C. Bottom-Up
- **D. Three Point**
- E. Group Decision-Making



From PMP Study resource 4squarereviews.com (emphasis added): “Analogous and parametric estimates are examples of top-down estimates, the first being on the basis of the entire project and the second being on the basis of some sort of unit measure (dollars per square foot, hours per line of code, etc.). **They both use historical data, with parametric estimates taking longer, but being more accurate than, analogous estimates. Bottom-up estimates take more time to complete, but they also are more accurate than either analogous or parametric estimates. Three-point estimates are examples of bottom-up estimates,** which are obtained from analyzing individual work packages, that are refined through risk analysis. The single-point estimates are enhanced using risk analysis by figuring out how much each estimate would take in a best-case (optimistic) and worst-case basis (pessimistic). **They are even more accurate than bottom-up estimates,** because they take into account the various risk factors which may effect the cost of the project. It is entirely possible that you could use all four techniques in different stages of planning, the analogous and then parametric estimates to get a preliminary estimate, and then the bottom-up estimate to get a more refined estimate, with **the final estimate coming from the three-point estimates.**”

# PMBok Guide Quick Overview

- 5 Process Groups



- 10 Knowledge Areas

- 4.0 Project Integration Management

- 5.0 Project Scope Management

- 6.0 Project Time Management

- 7.0 Project Cost Management

- 8.0 Project Quality Management

- 9.0 Project Human Resource Management

- 10.0 Project Communications Management

- 11.0 Project Risk Management

- 12.0 Project Procurement Management

- 13.0 Project Stakeholder Management

5.4 Create WBS

6.2 Define Activities  
6.4 Estimate Activity Resources  
6.6. Develop Schedule

7.1 Plan Cost Management  
7.2 Estimate Costs  
7.3 Determine Budget  
7.4 Control Costs

11.4 Perform Quantitative Risk Analysis

# High-Level Comparison

Attribute	PMBok Guide	CEBoK
Accrediting organization	Project Management Institute (PMI) ( <a href="http://www.pmi.org">www.pmi.org</a> )	International Cost Estimating and Analysis Association ( <a href="http://www.iceaaonline.org">www.iceaaonline.org</a> )
Primary Certification	Project Management Professional (PMP)	Certified Cost Estimator/Analyst (CCE/A)
Exam Format	200 Multiple-Choice Questions	Part I: 60 Multiple Choice Questions Part II: 50 Multiple Choice, 2 BCR
Major Units and Number	Process Groups (5)	Sections (5)
Minor Units (Vertical)	Processes (47)	Modules (16)
Minor Units (Horizontal)	Knowledge Areas (10)	--
Orientation <sup>1</sup>	Process and Topic	Topic
Role of Estimator	Project Manager = Estimator	Independent Estimator

1. In the PMBoK Guide, each process has *inputs, tools and techniques*, and *outputs*. In CEBoK, each module has core and advanced *topics*.

# High-Level Comparison (Continued)

Attribute	PMBok Guide	CEBoK
Number and Names of Primary Cost Estimating Techniques	10 (Expert Judgment, Analogous, Parametric, Bottom-Up, Three-Point, Reserve Analysis, CoQ, Project Management Software, Vendor Bid Analysis, Group Decision-Making)	4 (Analogy, Parametric, Engineering Build-Up, Extrapolation from Actuals)
Number & Names of Subordinate Cost Estimating Techniques	None	One (Expert Opinion)
Ways of Structuring Estimates	Not discussed (See SN)	Top-Down, Bottom-Up
Role of Work Breakdown Structure (WBS)	Is a necessary foundation for estimating costs but the estimate is conducted at the activity level (below the lowest level in the WBS)	Primary estimating structure. Cites MIL-STD-881C WBSs as guidance <sup>1</sup> for structuring estimates
Role of Cost Element Structure (CES)	Not discussed	Sometimes used interchangeably with WBS <sup>2</sup>
Orientation of Estimates in Their Native Estimating Structure	Activity <sup>3</sup>	Product <sup>4</sup>

1. "MIL-STD-881C is the standard guidance [regarding Work Breakdown Structures]." (CEBoK, Module 1 (45))
2. "In some cost estimating circles, WBS is also known as the Cost Element Structure (CES). These terms can be interchangeable..." (CEBoK, Module 1 (45 SN)).
3. "*Estimate Costs* is the process of developing an approximation of the monetary resources needed to complete project **activities**" (emphasis added, PMBoK Guide, p. 200). In addition, the primary output of this process is *Activity Cost Estimates*.
4. "[The WBS] displays and defines the system/program to be developed as a **product-oriented** family tree...necessary to capture all elements of cost "(emphasis added, CEBoK, Module 1 (46 SN))

# High-Level Comparison (Continued)

Attribute	PMBok Guide	CEBoK
Typical Scope of Estimate	Project-specific. Limited to monetary resources expended by the project.	Life Cycle Cost Estimate (LCCE). Potentially includes many projects; captures all costs, regardless of funding source.
When the Prototypical Estimate is Done	<i>After</i> we have decided to perform the project (Planning Process Group)	<i>Before</i> we have decided to perform the project (pre-Milestone A in DoD)
Prototypical Project Type	Construction or Software Development on behalf of a private company	Weapon or IT System Acquisition on behalf of DoD
Primary Recognized Probability Distributions	Normal, Triangular, Program Evaluation and Review Technique (PERT) Beta <sup>1</sup>	Normal, Lognormal, Triangular, Binomial <sup>2</sup> , Weibull <sup>3</sup> , Poisson, Beta <sup>4</sup> , Uniform, Chi Square, F, t
Primary Use of Three Point Estimates	<i>Cost and Schedule</i> Risk Analysis. This content resides in processes 6.5 “Estimate Activity Durations” and 7.2 “Estimate Costs” of the PMBoK Guide.	<i>Cost</i> Risk Analysis. Triangular distributions are cited as a typical way to capture expert opinion in input and output-based cost risk analysis in CEBoK Module 9.

1. Erroneously referred to in the PMBoK Guide as the “Beta Distribution” (p. 171), although it is acknowledged to be “from the traditional PERT technique” (p. 171) and “from a traditional PERT analysis” (p. 206). The PMBoK formulas are more commonly known as following the PERT Beta distribution, which is a special case of the Beta distribution.
2. Includes Bernoulli distribution (a Binomial distribution includes n Bernoulli trials).
3. Includes Rayleigh distribution (special case of Weibull).
4. Includes PERT Beta distribution (special case of Beta).

# High-Level Comparison (Continued)

Attribute	PMBok Guide	CEBoK
Formula for an Element-Level Point Estimate (Triangular Distribution) (a = lower bound (0 <sup>th</sup> percentile), b = most likely, c = upper bound (100 <sup>th</sup> percentile))	$(a+b+c)/3$	$(a+b+c)/3$
Formula for an Element-Level Point Estimate (PERT Beta Distribution) (a = lower bound (0 <sup>th</sup> percentile), b = most likely, c = upper bound (100 <sup>th</sup> percentile))	$(a+4b+c)/6$	Not addressed. PERT Beta is not mentioned as a recognized probability distribution, but is implicitly included as a special case of the Beta distribution.
Formula for Standard Deviation (a = minimum of data, b = maximum of data)	$(b-a)/6$	$\sqrt{\frac{1}{(n-1)} \sum (x_i - \bar{x})^2}$
Treatment of Inflation	None. All estimates in nominal dollars (then-year or same year).	Entire Module. Base Year Estimating Paradigm (real dollars).

# High-Level Comparison (Concluded)

Attribute	PMBok Guide	CEBoK
<i>What</i> is Time-Phased?	The then-year-denominated (nominal dollar) estimate.	The constant year-denominated (real dollar) estimate
<i>Why</i> are we doing this?	Because as project managers, we want to know how much the project will cost, or what our cost baseline is. This allows us to manage and control performance of the project.	Because as cost estimators, we want to know how much the program will cost. Knowing that gives the program and/or acquisition outcomes in general the best chance to succeed.
If everything goes perfectly (i.e., we do a perfect job), the project/program will come in...	At the <i>0<sup>th</sup></i> percentile of the total cost distribution (underrun) and ahead of schedule	At the <i>mean</i> of the total cost distribution (on time and on budget)
...And our entire frame of reference is...	One project, and is limited to things for which the project pays	The entire program life cycle, regardless of funding source

# Font Convention for Brief

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- For each comparison slide, we use the convention of placing common themes in black, PMBoK Guide <sup>1</sup>-unique content in red <sup>2</sup>, CEBoK<sup>1</sup> -unique content in blue <sup>3</sup>

1. All comparisons are based on PMBoK version 5 and CEBoK version 1.2.

2. This is the MS Office color “red.” (R,G,B) = (255,0,0).

3. This is the MS Office color “blue, accent 2.” (R,G,B) = (0,102,255).

# Notable Similarities: Overview

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- Inputs
  - Technical Baseline Document (**Scope Baseline/CARD**) as key input to cost estimating process<sup>1</sup>
- Cost Estimating Techniques
  - Analogous/Analogy Estimating
  - Expert Judgment/Expert Opinion
- Cost Estimating Tools
  - Earned Value Management (EVM)
  - **Monte Carlo Simulation for Quantitative Risk Analysis**
  - **Vendor Bid Analysis/Independent Government Cost Estimate (IGCE)**
- Outputs
  - Basis of Estimate/Estimate Documentation
  - **Time-Phased Estimate**

1. Bold font designates that subject will be further discussed in a later slide.

# Similarities:

## Technical Baseline Document

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- Both curricula recognize the importance of having a standalone document that tells you what *it* (the thing to be estimated) is:
  - “Scope [is] the sum of products, services, and results to be provided as a project...[the] Scope Baseline [is] the approved version of a scope statement, WBS, and its associated WBS dictionary.” <sup>1</sup>
  - The Cost Analysis Requirements Description (CARD) is a detailed technical and high-level schedule description of a program/system to be estimated.
    - The CARD is intended to be comprehensive enough to facilitate identification of any area or issue that could have a significant cost impact and that therefore must be addressed by the cost estimator...
    - You will see other terms for CARDS in other organizations, including...ICBD... CADRe...and CEBD.” <sup>2</sup>

1. Glossary (p. 538)

2. Module 1 Cost Estimating Basics (slide 28)

# Similarities:

## Monte Carlo Simulation

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- Both curricula identify Monte Carlo Simulation and the resulting cost distributions as a key component of quantitative risk analysis.
  - “A project simulation uses a model that translates the specified detailed uncertainties of the project into their potential impact on project objectives. Simulations are typically performed using the Monte Carlo technique ”<sup>1</sup>
  - “Monte Carlo simulations allow the analyst to understand the combined effects of multiple risks. The traditional output of a Monte Carlo model is a probabilistic cost distribution...This distribution allows the analyst to decipher the cost estimate at various confidence levels.”<sup>2</sup>

1. 11.4.2.2 Quantitative Risk Analysis and Modeling Techniques (p. 340). The graphic shows budgeting at the 75<sup>th</sup> percentile as a 75% “likelihood of success.” The point estimate, which is identified as “the most likely cost estimate,” lies at the 12<sup>th</sup> percentile.

2. Module 9 Cost and Schedule Risk Analysis (SN, slide 45). Also presented as a Related Topic later in the module.

# Similarities:

## Vendor Bid Analysis/IGCE

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- Both curricula recognize the importance of cross-checking vendor cost estimates, or bids, independently.
- Incredibly, neither curriculum acknowledges an Independent Government Cost Estimate (IGCE) as a cost product <sup>1</sup>.
  - “When projects are awarded to a vendor under competitive processes, additional cost estimating work may be required...to examine the price of individual deliverables and to derive...the [estimated] final total project cost.” <sup>2</sup>
  - “Government estimators should participate in all stages of acquisition planning, including developing independent cost estimates (ICEs)” <sup>3</sup>

1. In the PMBoK Guide paradigm, the government is not necessarily the customer, so this is unsurprising. In CEBoK, “IGCE” is not listed among the many cost products of Module 1 Cost Estimating Basics. Module 14 Contract Pricing refers to “independent cost estimates,” which are not to be confused with the Independent Cost Estimates (ICEs) of Module 1.

2. 7.2.2.9 Vendor Bid Analysis (p. 207)

3. Module 14 Contract Pricing (slide 4)

# Similarities:

## Time-Phased Estimate

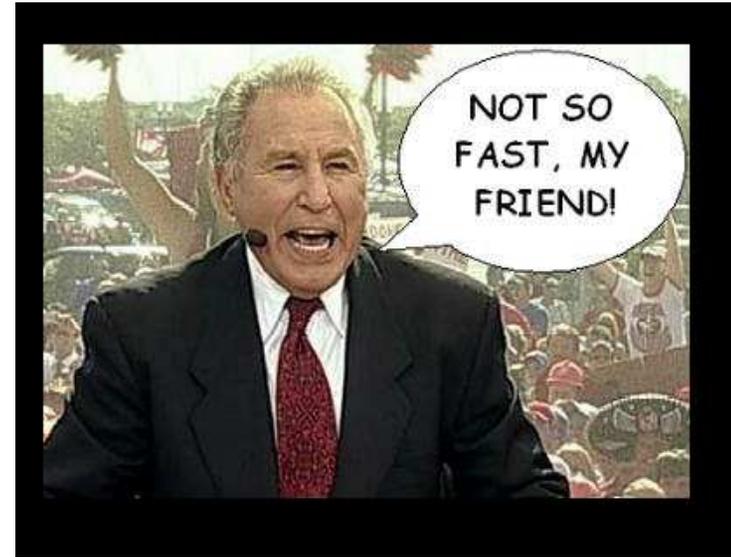
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- Both curricula guide us to time-phase the estimate, but at different points.
  - Cost estimates are directly tied to schedule activities. “This enables a time-phased view of the cost baseline.”
    - Additionally, there is no treatment of inflation in PMBoK. A time-phased view of the cost baseline paired with the fact that inflation is not discussed in PMBoK results in all estimates being conducted in then-year (or nominal) dollars.<sup>1</sup>
  - “Base Year Estimating Paradigm”<sup>2</sup> refers to adjusting all costs into one Base Year, estimating in that same Base Year, and then spreading the estimate into the years they are expected to occur (time-phasing).

1. 7.3.3.1 Cost Baseline (p. 212). The term “Inflation” appears only in the context of “Inflation Allowance.” The term “escalation” applies to elevating an item within the project team or organizational chain of command, and is not used in the context of price increases.  
2. Module 5 Inflation (slide 12)

# Notable Differences: Overview

- PMBoK Guide - Unique Inputs to Cost Estimating Process
  - **Cost Management Plan**<sup>1</sup>
  - **Human Resource Management Plan**
  - **Project Schedule**
  - Enterprise Environmental Factors (EEFs) and Organizational Process Assets (OPAs)
- PMBoK Guide - Unique Cost Estimating Tools and Techniques
  - **Reserve Analysis**
  - **Cost of Quality**
  - Project Management Software



1. Bold font designates that subject will be further discussed in a later slide.

# Inputs:

## Cost Management Plan

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- Describes how the project costs will be planned, structured, and controlled
  - Units of Measure
  - Level of precision (rounding)
  - Level of accuracy (+/- percentage range)
  - EVM rules of performance measurement
  - Variance thresholds
- Sometimes addressed in ground rules and assumptions of cost estimate but generally not addressed.

# Inputs:

## HR Management Plan

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- Describes how the human resources will be staffed, managed, and released at project conclusion
  - Roles
  - Responsibilities
  - Org Charts
  - Resource Calendars
  - Staff Acquisition
- Defining resources at the individual level is impossible in a pre-award LCCE

# Inputs:

## Project Schedule

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- Schedule has high degree of influence in developing the cost estimate; a key input is an integrated schedule model with linked tasks/milestones with associated planned dates, durations, and assigned resources
  - Project Gantt chart
  - Project Schedule Network Diagrams
  - Project Calendar
  - Activity Resource Requirements
- Schedule has much lower degree of influence on the estimate since, in the case of an LCCE, it is not fully flushed out; CARD may provide some high level schedule information

# Tools and Techniques: Reserve Analysis

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- Uncertainty in cost point estimate is handled through reserves. Quantitative risk analysis (including the use of a probability distribution of cost) is used to estimate the amount of reserve needed.
  - *Contingency* reserves are added to cost estimate to account for known-unknowns
  - *Management* reserves are added to cost estimate to account for unknown-unknowns
- Quantitative risk analysis also used, but “Reserve Analysis” not admitted as a *cost estimating technique*. Less prominent distinction between contingency and management reserve. <sup>1</sup>

1. In the Risk Cube section of Module 9 (slide 80 SN), the distinction is made: “The above charts show Management Reserve as a percent of contract value for various contract types. This MR is probably “hold-back” meaning money estimated to be needed, but held in reserve to act as a challenge, or goal, to the Account Managers and not contingency (meant to cover risk) which means extra funds above and beyond the initial cost estimate, meant to cover risk ‘maybes’ and ‘unknown-unknowns.’” In the PMBoK Guide, the distinction is more prominent, and is an intrinsic part of a cost estimating tool and technique.

# Tools and Techniques: Cost of Quality

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- Cost of Quality is a major consideration when developing the cost estimate
  - Cost of Conformance
    - Prevention (build a quality product)
      - Training, Document processes, Equipment, Time to do it right
    - Appraisal (assess the quality of the product)
      - Testing, Inspection
  - Cost of Nonconformance
    - Internal Failure Costs (failures found internally)
      - Rework, scrap
    - External Failure Costs (failures found externally)
      - Liabilities, warranty work, lost business
- Cost of Quality is not a tool/technique for estimating costs in an LCCE
  - May be distributed to products that require the quality
  - No explicit distinction among these four types of costs

# Confusions: Overview

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- S-Curve
- Definition of Parametric Technique
- Mean of Three Point Estimates
- Formulas for Variance and Standard Deviation
- Relationship among Cost, Schedule, Time-Phasing, and Inflation



# Actual PMP Exam Practice Question

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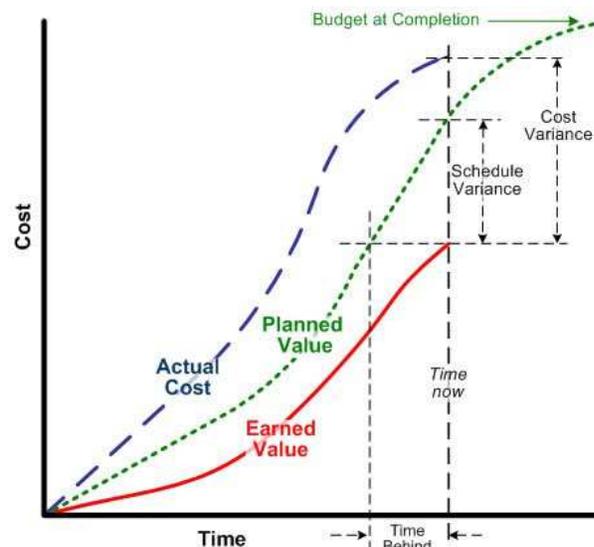
2. Which of the following can be displayed as an S-Curve?

- A. Estimate at completion
- B. TCPI
- C. CPI and SPI
- D. Cost performance baseline

# Actual PMP Exam Practice Question

2. Which of the following can be displayed as an S-Curve?

- A. Estimate at completion
- B. TCPI
- C. CPI and SPI
- D. **Cost performance baseline**



An S-Curve according to PMBoK

Source: <http://www.thinkforachange.com/blog/evmtolerancelimits/>

# Confusions: The Term “S-Curve”

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- Used in an EVM context to show cumulative earned value, planned value, and actual costs over time; S-Curves used “...to display EV data...” <sup>1</sup>
- Used in the context of risk analysis: “The traditional output of a Monte Carlo model is a probabilistic cost distribution (commonly referred to as an S-Curve). This distribution allows the analyst to decipher the cost estimate at various confidence levels.” <sup>2</sup>

# Confusions:

## Definition of Parametric Technique: The Same...

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- “An estimating technique in which an algorithm is used to calculate cost or duration based on historical data and project parameters.” <sup>1</sup>
- “A technique that develops cost estimates based upon the examination and validation of the relationships which exist between a project's technical, programmatic, and cost characteristics as well as the resources consumed during its development, manufacture, maintenance, and/or modification.” <sup>2</sup>

1. Glossary (p. 548)

2. Module 3 Parametrics (slide 1), citing *Parametric Cost Estimating Handbook*

# Actual PMP Exam Practice Question

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3. You are the project manager for the JKH Project. You have elected to use parametric estimating in your cost estimating for the project. Which of the following is an example of parametric estimating?

- A. \$750 per ton
- B. Historical information from a similar project
- C. Estimates built bottom up based on the WBS
- D. Estimates based on top-down budgeting

# Actual PMP Exam Practice Answer

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3. You are the project manager for the JKH Project. You have elected to use parametric estimating in your cost estimating for the project. Which of the following is an example of parametric estimating?

- **A. \$750 per ton**
- B. Historical information from a similar project
- C. Estimates built bottom up based on the WBS
- D. Estimates based on top-down budgeting

# Confusions:

## Definition of Parametric Technique: Yet Different!

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- While not explicitly mentioned in the PMBoK Guide, the parametric technique is thought of by the PMP exam (and preparation material) authors in a specific way. The following text is representative of core study material (emphasis added):
  - “Analogous and parametric estimates are examples of top-down estimates, the first being on the basis of the entire project and the second being on the basis of some sort of unit measure (dollars **per** square foot, hours **per** line of code, etc.). They both use historical data, with parametric estimates taking longer, but being more accurate than, analogous estimates.”<sup>1</sup>
    - The algorithms used are generally tautological, do not involve regression analysis, have no associated measures of uncertainty, and are actually more closely associated with the CEBoK Engineering Build-Up Technique!
  - In CEBoK and the Parametric Estimating Handbook, parametric estimating is generally akin to regression analysis, and the resultant Cost Estimating Relationships (CERs) are generally *not* tautological.

1. <http://4squareviews.com/2013/04/12/5th-edition-pmbok-guide-chapter-6-comparison-of-estimating-techniques>

# Confusions: Question:

## Mean of Three Point Distribution

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4. You are creating a cost (or duration) estimate and are given the following three point estimating parameters: Optimistic = 1, Most Likely = 2, Pessimistic = 4. Absent any other information, what is your point estimate, to two decimal places?

- A. 2.00
- B. 2.17
- C. 2.33

# Confusions: Answer:

## Mean of Three Point Distribution

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4. You are creating a cost (or duration) estimate and are given the following three point estimating parameters: Optimistic = 1, Most Likely = 2, Pessimistic = 4. You would like your point estimate to be at the mean. Absent any other information, what is your point estimate?

- A. 2.00
- **B. 2.17**
- C. 2.33

In CEBok, we would assume a triangular distribution. The mean of this distribution is  $(a+b+c)/3$ , i.e. the average of the three parameters. This is  $(1+2+4)/3 = 7/3 = 2.33$ . However, in the PMBoK Guide, the “default” distribution is the PERT Beta distribution (sometimes erroneously referred to as the Beta distribution), for which the mean  $(a+4b+c)/6 = (1+4*2+4)/6 = 13/6 = 2.17$ . Choice A, 2.00, represents the mode, rather than the mean of either distribution.

# Confusions:

## Mean of Three Point Distribution

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- Three-point estimating uses a triangular distribution *or* PERT Beta distribution (typically, PERT Beta)
- Any estimating using a three point distribution is **associated with triangular distribution only**

# Confusions: Question:

## Formulas for Variance & Standard Deviation

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5. What is the (sample) standard deviation of the same set of numbers (1,2,4), to two decimals?

- A. 0.50
- B. 1.11
- C. 1.25
- D. 1.53

# Confusions: Answer:

## Formulas for Variance & Standard Deviation

---

5. What is the (sample) standard deviation of the same set of numbers (1,2,4), to two decimals?

- **A. 0.50**
- B. 1.11
- C. 1.25
- D. 1.53

PMBok relies upon on the older (pre-calculator) formula for standard deviation, which is used in the PERT technique. This technique assumes that (nearly) all of the data lie within three standard deviations of the mean, based on the fact that in a normal distribution, 99.7% of the data meet this criterion in a normal distribution. From this it follows that the “entire” distribution is six standard deviations, so one standard deviation can be calculated as the range of the distribution, divided by six. Here,  $(4-1)/6 = 3/6 = 0.50$ . Incredibly, with  $n$  data points, we can change  $(n-2)$  of them arbitrarily (as long as we don't go above the maximum or below the minimum) *without changing the standard deviation*. For example, the data set (1, 2.33, 4), in which one of the three points has no deviation from the mean, has the same (PMBok Guide-defined) standard deviation. The PMBok Guide formula for variance is the square of the standard deviation (here, 0.25). Choice B, 1.11, is the mean absolute deviation. Choice C, 1.25, is the population, not sample, standard deviation, as defined in classical statistics. Choice D, 1.53, is the (classically defined) sample standard deviation.

# Confusions: Bonus Question

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6. To be fair, the previous formula was originally intended only as an approximation. In the previous problem (data set: 1,2,4), what is the percentage error between the (classically defined) and (PMBok Guide-based) sample variance?

- A. Less than 10%
- B. More than 10%, but less than 50%
- C. More than 50%, but less than 100%
- D. More than 100%, but less than 1,000%
- E. More than 1,000%

# Confusions: Bonus Answer

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6. To be fair, the previous formula was originally intended only as an approximation. In the previous problem (data set: 1,2,4), what is the percentage error between the (classically defined) and (PMBok Guide-based) sample variance?

- A. Less than 10%
- B. More than 10%, but less than 50%
- C. More than 50%, but less than 100%
- **D. More than 100%, but less than 1,000%**
- E. More than 1,000%

The PMBoK Guide-based variance is 0.25 (square of 0.50). The classical variance is the sum of squared deviations from the mean, divided by (n-1):  $(1-2.33)^2 + (2-2.33)^2 + (4-2.33)^2 / 2 = (1.33+0.33+1.67)/2 = 2.33$ . The percentage difference between these numbers is  $(2.33-0.25)/0.25 = 2.33/0.25 - 1 = 833\%$ .

# Confusions:

## Cost, Schedule, Time Phasing, and Inflation: Question

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6. Place the following steps in the **correct** order. Then, place them in the **correct** order.

Create WBS/CES

Develop Schedule

Determine Budget

Estimate Costs

Time-Phase Activities

Time-Phase Costs

Inflate/Escalate the Costs

Reconcile with Funding Limits

# Confusions:

## Cost, Schedule, Time Phasing, and Inflation: **Answer**

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1. Create WBS/~~CES~~ (5.4)
2. Time-Phase Activities (6.3 Sequence Activities)
3. Develop Schedule (6.6)
4. Estimate Costs (7.2)
5. Reconcile with Funding Limits
6. Determine Budget (7.3)

~~Inflate/Escalate the Costs~~

~~Time-Phase Costs~~ (this is already implied by the time-phased activities)

Understanding that some of these are judgment calls, because certain steps are performed iteratively, here is our best effort at putting the steps in their correct order, based on the PMBoK Guide. Numbers in parentheses refer to PMBoK Guide process numbers. First, we create the WBS (5.4). The term “CES” is not used. Next, we sequence the activities (time-phasing), which is process 6.3 Next, we develop the schedule (6.6). Next, we estimate costs (7.2), and determine the budget (7.3). Funding Limit Reconciliation is a tool and technique of 7.3 Determine Budget, which means that it happens prior to the final determination of the budget. Because all costs are estimated in nominal dollars, we never inflate, or escalate them. To the obvious question (how can we time-phase costs that we don't yet have), recall that we have activity resource requirements, but they are part of the schedule, not the cost estimate. In the PMBoK Guide, it is intentional that Project Scope Management (Chapter 5) precedes Project Time Management (chapter 6), which precedes Project Cost Management (Chapter 7). In fact, as noted earlier, the schedule is actually an *input* to the cost estimating process.

# Confusions:

## Cost, Schedule, Time Phasing, and Inflation: [Answer](#)

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1. Create WBS/CES
2. Estimate Costs
3. Time-Phase Costs
4. Inflate/Escalate the Costs
5. Determine Budget

~~Time-Phase Activities~~

~~Develop Schedule~~

~~Reconcile with Funding Limits~~

CEBoK is generally topic, rather than process-oriented, but one can infer a process. There is no module on WBS/CES development, but it is presented as a foundational topic in Module 1 Cost Estimating Basics. There is similarly no module called “Estimate Costs,” but most of the topics are geared toward creating a cost estimate. Importantly, we time-phase the base year-denominated cost estimate. Why? Inflation indices are published by year. If we didn’t have costs by year prior to inflation adjustment, how would we know which indices to use? Module 5 Inflation covers step 4, Inflate/Escalate the Costs. The cost estimate then becomes the basis for the budget. Schedule development isn’t addressed in CEBoK. Reconciliation of the budget with funding limits is not part of the cost estimating process, and is also not recognized as a step in the GAO Cost Estimating and Assessment Guide.

# Confusions:

## Cost, Schedule, Time Phasing, and Inflation

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### Answer

1. Create WBS/~~CES~~(5.4)
2. Time-Phase Activities (6.3  
Sequence Activities)
3. Develop Schedule (6.6)
4. Estimate Costs (7.2)
5. Reconcile with Funding Limits
6. Determine Budget (7.3)

~~Inflate/Escalate the Costs~~

~~Time-Phase Costs~~ (this is already implied by the time-phased activities)

### Answer

1. Create WBS/CES
2. Estimate Costs
3. Time-Phase Costs
4. Inflate/Escalate the Costs
5. Determine Budget

~~Time-Phase Activities~~

~~Develop Schedule~~

~~Reconcile with Funding Limits~~

# Conclusion

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- Speak the language of the country you're in
  - Use the jargon of your community of practice
- Actively get involved to help both communities become cognizant of each other
- Leverage best practices from both
- Understand your role
  - The aims of a true program LCCE conducted by an independent organization in order to determine budget requirements and program viability are different than the aims of a project-level cost estimate prepared by a Project Manager directing, managing, and monitoring project work

# Conclusion (continued)

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- But try not to introduce 833% errors in variance estimates!



# Conclusion (Concluded)

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*Remember everything I said. Then, forget it.*

# BACKUP

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# Similarities:

## Analogous/Analogy Estimating

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- Both curricula recognize **analogous/analogy** estimating as a valid technique
  - A technique for estimating the duration or cost of an activity or project using historical data from a similar activity or project. Less costly and less time-consuming than other techniques, but also less accurate <sup>4</sup>.
  - Adjust costs of an analogous system to estimate the new system, using a numeric ratio based on an intuitive physical or countable metric. An adjusted analogy is like a regression, but the slope is just a guess <sup>5</sup>.

1. 6.5.2.2 Analogous Estimating (pp. 169-170)
2. Module 2 Cost Estimating Techniques (slides 14-16)

# Similarities:

## Expert Judgment/Expert Opinion

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- Both curricula recognize **Expert Judgment/Expert Opinion** estimating as a (**more** or **less**) valid technique
  - **Expert Judgment, guided by historical information, provides valuable insights about the environment and information from similar projects. Expert judgment can also be used to determine whether to combine methods of estimating and how to reconcile between them.** <sup>1</sup>
  - **Uses an expert or group of experts to estimate the cost of a system. Expert Opinion refers to direct assessment of costs. Expert Judgment is expected to be applied in any of the previously described legitimate <sup>2</sup> cost estimating techniques. Expert Opinion alone is not widely considered to be a valid technique...[it] is the least regarded and most dangerous method, but it is seductively easy. Most lexicons do not even admit it as a technique <sup>3</sup>, but it is included here for completeness.** <sup>4</sup>

1. 7.2.2.1 Expert Judgment (p. 204). The instruction we received certainly suggests that this also includes direct assessment of cost or effort.

2. Implying that we needn't use Expert Judgment when using an illegitimate cost estimating technique. Note that Expert Judgment in the PMBoK Guide corresponds to Expert Opinion in CEBoK. Expert Judgment in CEBoK does not have an apparent PMBoK Guide counterpart.

3. But the PMBoK Guide does!

4. Module 2 Cost Estimating Techniques (slides 39-40)

# Similarities:

## Basis of Estimate/Estimate Documentation

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- Both curricula recognize the importance of a Basis of Estimate, but in different contexts.
  - Output of *Estimate Costs* and Input to *Determine Budget*. “Supporting documentation outlining the details used in establishing project estimates such as assumptions, constraints, level of detail, ranges, and confidence levels... <sup>1</sup>The amount and type of additional details supporting the cost estimate vary by application area. Regardless...the supporting documentation should provide a clear and complete understanding of how the estimate was derived.” <sup>2</sup>
  - Introduced in context of *vendor cost proposals* in Contract Pricing module. “The description of the resources and the methodology used to estimate the quantity (hours, materials, etc.) is called the Basis of Estimate (BOE)...BOEs must be written for the work proposed to a level of detail determined by the SOW.” <sup>2</sup> The non-Contract Pricing analog is called Estimate Documentation, and is separately treated. <sup>3</sup>

1. 7.2.3.2 Basis of Estimates (pp. 208, 210).
2. Module 14 Contract Pricing (slide 38).
3. Module 1 Cost Estimating Basics (slide 41)

# Similarities: Use of EVM

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- The two curricula are consistent in their treatment of Earned Value Management (EVM), but one is *project-specific*, while the other relies upon the award *and definitization* of a contract.
  - A methodology that combines scope, schedule, and resource measurements to assess project performance and progress. <sup>1</sup>
  - Earned Value Management (EVM) integrates Technical Scope, Schedule, and Cost for definitized contract work <sup>2</sup>
  - Formulas match!

1. Glossary (p. 538)  
2. Module 15 Earned Value Management (slide 9)

# Differences: Inputs - EEFs & OPAs

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- Directly identifies the enterprise environmental factors (EEFs) and organizational process assets (OPAs), which can influence estimate
  - EEF Examples:
    - Organizational culture/structure
    - Market conditions
    - Currency exchange rates
    - Rate information & published seller price lists
  - OPA Examples:
    - Financial control procedures
    - Historical information/lessons learned
    - Financial databases
    - Policies, procedures, guidelines for cost estimating/budgeting
- EEFs and OPAs are unknown at the time of (pre-award) LCCE

# Differences: Tools and Techniques - Project Management Software

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- Specialized software to help manage the cost and schedule of the project
  - Develop resource pools / resource estimates
  - Assist in resource optimization
  - Monitor EVMS metrics (PV, EV, and AC)
  - Forecast final estimate
- Specialized software includes ACE-IT, COCOMO, @RISK, Crystal Ball, Primavera, SEER, Argo, Polaris, and Microsoft Office suite of products. But these are not admitted as cost estimating techniques.

# Confusions:

## Role of WBS & Orientation of Estimates

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- WBS is a breakdown of deliverables but contains NO activities thus NO cost information
  - Costs are estimated at the activity level
- WBS is used interchangeably with CES, and contains activities such as program management, systems engineering, etc. but cost elements are generally required to be product-oriented

# Confusions:

## Role of Cost Estimators

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- Project Manager = Cost Estimator
  - Thus, cost estimator is fully vested in the project's success
- Cost estimator provides independent, organization-independent, life cycle view