



# Incorporating Function Points Into Earned Value Management

By William Roetzheim



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# Introduction

- Introductions
- About the Speaker
  - During his career Mr. Roetzheim founded and then sold two software companies (one services, one product); was a regional manager for an international business consulting company; worked as a practice lead for a major military software practice, and was personally involved in many high-visibility government and military projects. His area of expertise is on model based cost analysis and benchmarking. He has applied this expertise to a wide range of technical and business disciplines.
  - Mr. Roetzheim has written 27 published books, over 100 articles, and three columns dealing with a variety of management and technology issues. He is an experienced project manager, managing over 50 projects during his career. Mr. Roetzheim personally provided management oversight assistance for government projects (mostly in California and Texas) totaling over \$2.5 billion in value. He has provided expert witness services in the areas of cost, standards, and quality. Mr. Roetzheim has been a frequent lecturer and instructor at multiple technology conferences and two California universities. He holds two patents.

Mr. Roetzheim has an MBA, is an IFPUG certified function point specialist, and has both a PMP and RMP designation by the Project Management Institute.



# Intro to EVM

## Traditional Project Tracking

- Develop a project plan, including planned expenditures over time.
- Track actual expenditures
- Measure actual expenditures versus planned expenditures

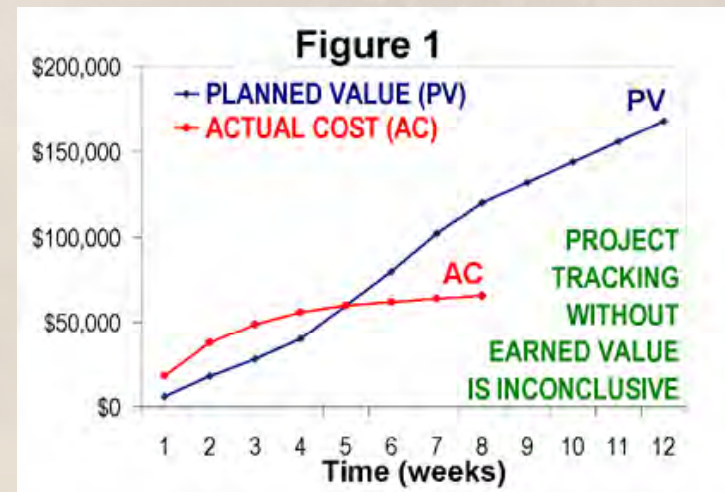


Figure from Wikipedia.com



# Intro to EVM

## With EVM

- We now see that the project is under budget, but falling behind schedule.

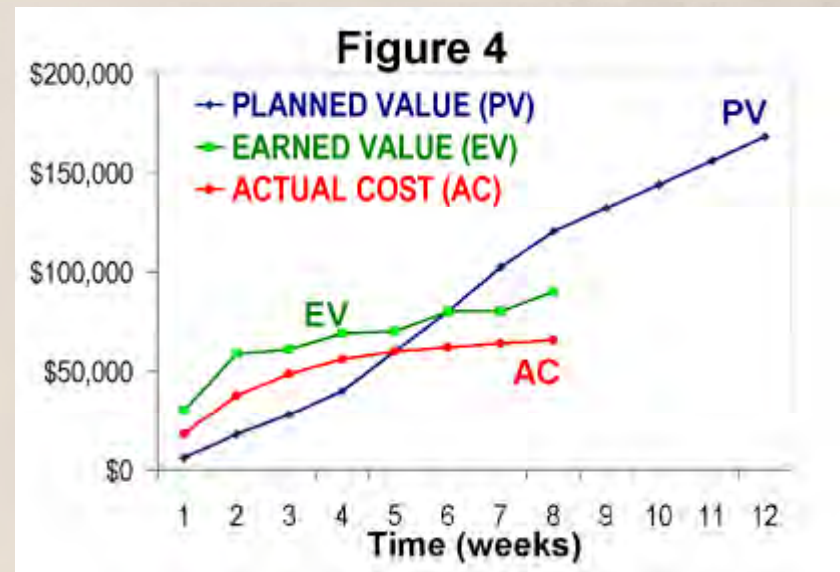


Figure from Wikipedia.com



# Intro to EVM

- Governed by ANSI/EIA-748A
- DoD required by DoD Instruction 5000.02
  - Earned Value Management System (EVMS) in compliance with guidelines in ANSI/EIA-748\* is required on all cost or incentive contracts equal to or greater than \$20M.
  - A formally validated and accepted EVMS is required for cost or incentive contracts equal to or greater than \$50M.
  - EVM may be imposed on contracts less than \$20M as a risk-based decision of the program manager based on a cost/benefit analysis.
- **DFARS CLAUSES**
  - Notice of Earned Value Management System (Apr 2008), DFARS 252.234-7001.
  - Earned Value Management System (Apr 2008), DFARS 252.234-7002.



# From ANSI/EIA-748A

- The principles of an EVMS are:
  - Plan all work scope for the program from inception to completion.
  - Break down the program work scope into finite pieces that can be assigned to a responsible person or organization for control of technical, schedule, and cost objectives.
  - Integrate program work scope, schedule, and cost objectives into a performance measurement baseline plan against which accomplishments may be measured.
  - Control changes to the baseline.
  - Use actual costs incurred and recorded in accomplishing the work performed.
  - Objectively assess accomplishments at the work performance level.
  - Analyze significant variances from the plan, forecast impacts, and prepare an estimate at completion based on performance to date and work to be performed.
  - Use EVMS information in the organization's management processes.



# From ANSI/EIA-748A

- **2.2 Planning, Scheduling, and Budgeting**
  - B. Identify physical products, milestones, technical performance goals, **or other indicators** that will be used to measure progress.
  - C. ...Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefinitized work. **Budget for far-term efforts may be held in higher level accounts until an appropriate time for allocation at the control account level....**
  - E. To the extent it is practicable to identify the authorized work in discrete work packages, establish budgets for this work in terms of dollars, hours, or **other measurable units....**



# From ANSI/EIA-748A

- **3.7 Earned Value Methodology**

- 3.7.1 Discrete Effort (extracts, emphasis added)

- There are three basic earned value techniques applicable to discrete/work package efforts (efforts with definable scope and objectives that can be scheduled and on which progress can be measured). The basic techniques are valued milestones, standard hours, and **management assessment**.
    - Management assessment may be used to determine the percentage of work completed for a task or group of tasks. Earned value is then calculated by applying that percentage to the total budget for the work. **Management assessment may include the use of metrics for work measurement.**
    - Generally, **the objective earned value techniques (valued milestone or standard hours) are preferred**, but each has its own merits and an organization should use those that best suit its management needs.

- 3.7.2 Apportioned Effort

- Apportioned effort is work for which the planning and progress are tied to other efforts. The budget for the apportioned account will be time-phased in relation to the resource plans for the base account(s). Status and the taking of earned value are driven by the status on the base account(s).



# EVM Challenges

- EVM has no provision to measure quality
- EVM does not directly address risk.
- EVM has difficulties with respect to scope.
  - Because EVM requires a quantified project plan, it is difficult to apply to projects where the scope is not clearly defined up-front.
  - EVM focuses on the project scope and ignores the product scope.



# EVM and Quality

- Traditional EVM ignores quality
  - If you measure speed and without also measuring quality, you can end up with a lot of cheap junk in a hurry.



# For a 500 FP Project Developed Carelessly

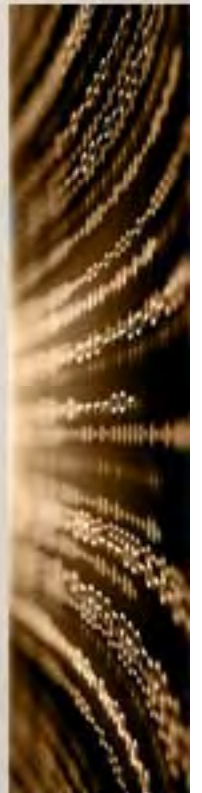
- Development costs will be about \$600K
- Approximately 5 bugs per function point will be introduced
- The direct costs of bug detection and removal will be about \$500K
- This process will detect 75% of the bugs, leaving 1.25 bugs per function point
- The cost to repair these during the first two years of product life will be \$750K plus lost market share



# What does this tell you?

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Module	Defects
Module A	2
Module B	4
Module C	2
Module D	9
Module E	23
Module F	6
Module G	1
Module H	6
Module I	8
Module J	6
Module K	0
Module L	1
Module M	0
Module N	1
Module O	0
Module P	9



# How about now?

Module	Defects	FP	Ratio
Module A	2	4	50%
Module B	4	4	100%
Module C	2	3	67%
Module D	9	32	28%
Module E	23	1500	2%
Module F	6	22	27%
Module G	1	3	33%
Module H	6	24	25%
Module I	8	4	200%
Module J	6	23	26%
Module K	0	3	0%
Module L	1	4	25%
Module M	0	3	0%
Module N	1	4	25%
Module O	0	3	0%
Module P	9	555	2%



# Total Test Cases Over Time

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Test Cases

50

100

140

200

250

350

375

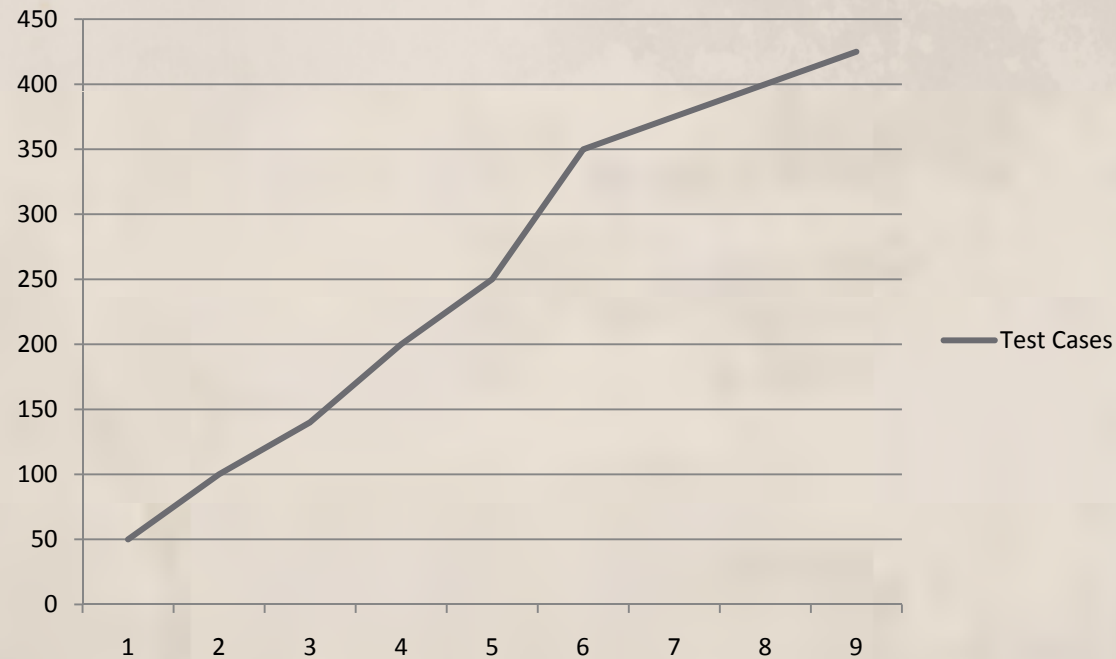
400

425



# Let's Make It a Graph

Test Cases



# Let's Apply What We've Learned

Test Cases	FP	TC/100FP
50	61	82
100	119	84
140	170	82
200	235	85
250	265	94
350	337	104
375	372	101
400	382	105
425	412	103

How is this contractor's performance?



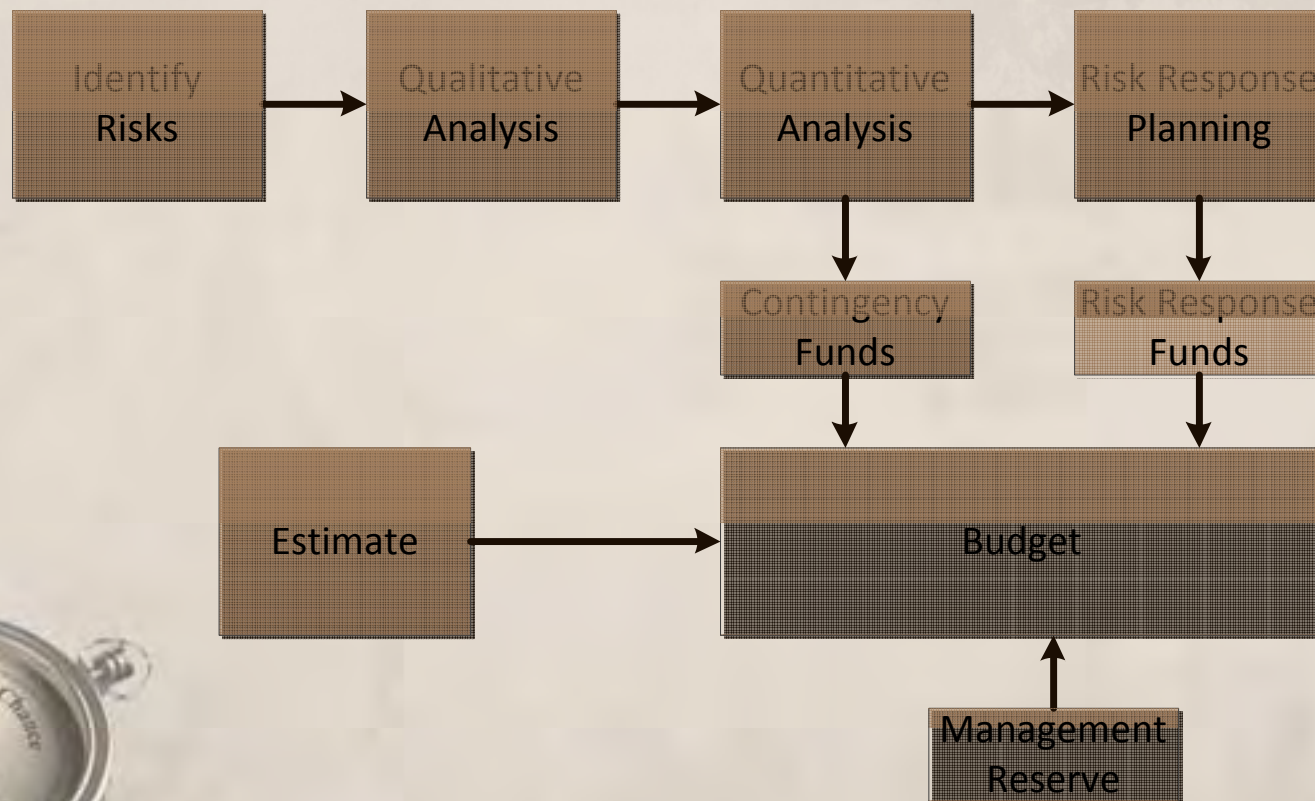
# Let's Benchmark

- Suppose I told you that for projects equivalent to this one, we would expect to see 251 test cases per 100 function points? Does that change your opinion?



# EVM and Risk

- Measurement Using the Right Baseline



# EVM Scope Challenges

- Because EVM requires a quantified project plan, it is difficult to apply to projects where the scope is not clearly defined up-front.
- EVM focuses on the project scope and ignores the product scope.



# Some Definitions

- **Scope** The sum of the products and services to be provided in a project.
- **Product Scope** The features and functions that are to be included in a product or service.
- **Project Scope** The work that must be done in order to deliver a product with the specified features and functions.



# PM-BOK versus Real World

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- PM-BOK scope management processes sound good in theory, but...
  - Our dirty little secret



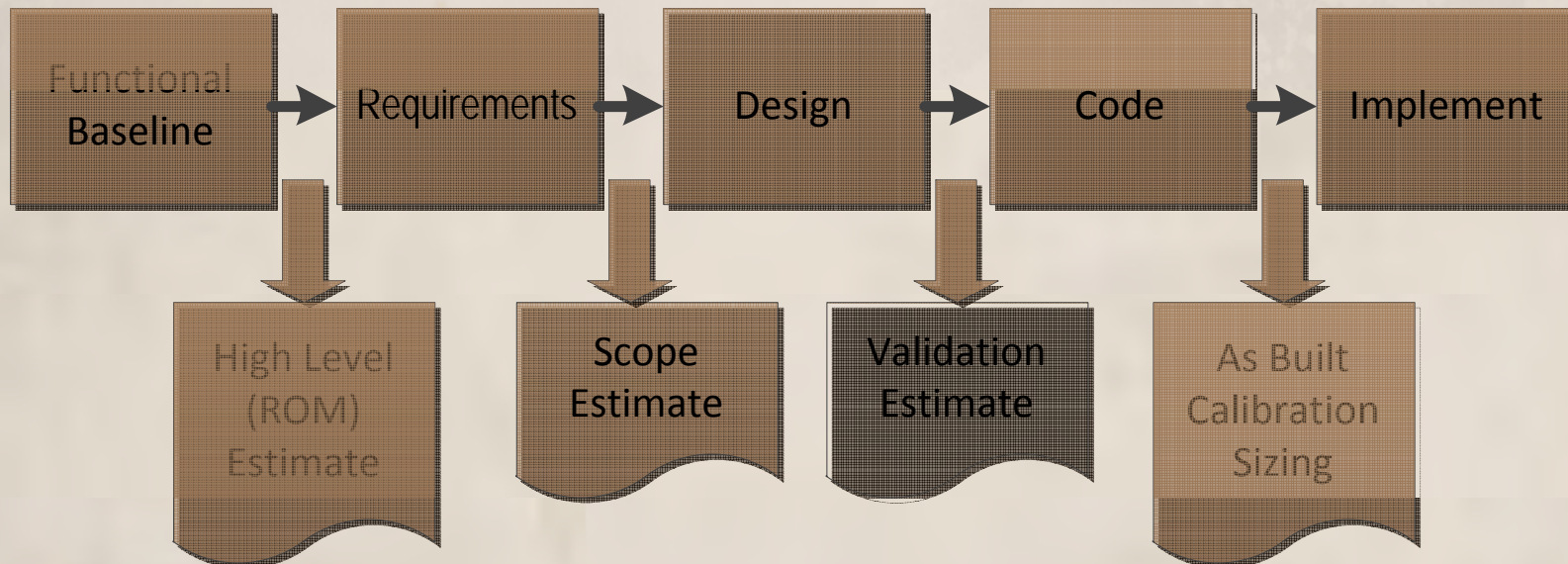
# Scope Ambiguity

- There is a limit to how well defined the scope of a project can be no matter how hard you work at it.
- Low Ambiguity Projects
  - Comparable products exist
    - Tract Home
    - Shrink wrap software installation
    - Hardware installation
- Moderate Ambiguity Projects
  - Comparable product components exist, but composition is unique
    - Most custom built homes
    - Some COTS Software Installations
    - May be strong for builder familiar with blueprints, but weak for homeowner unfamiliar with blueprints
- High Ambiguity Projects
  - There are no directly comparable products
    - Custom software
    - Mission to Mars

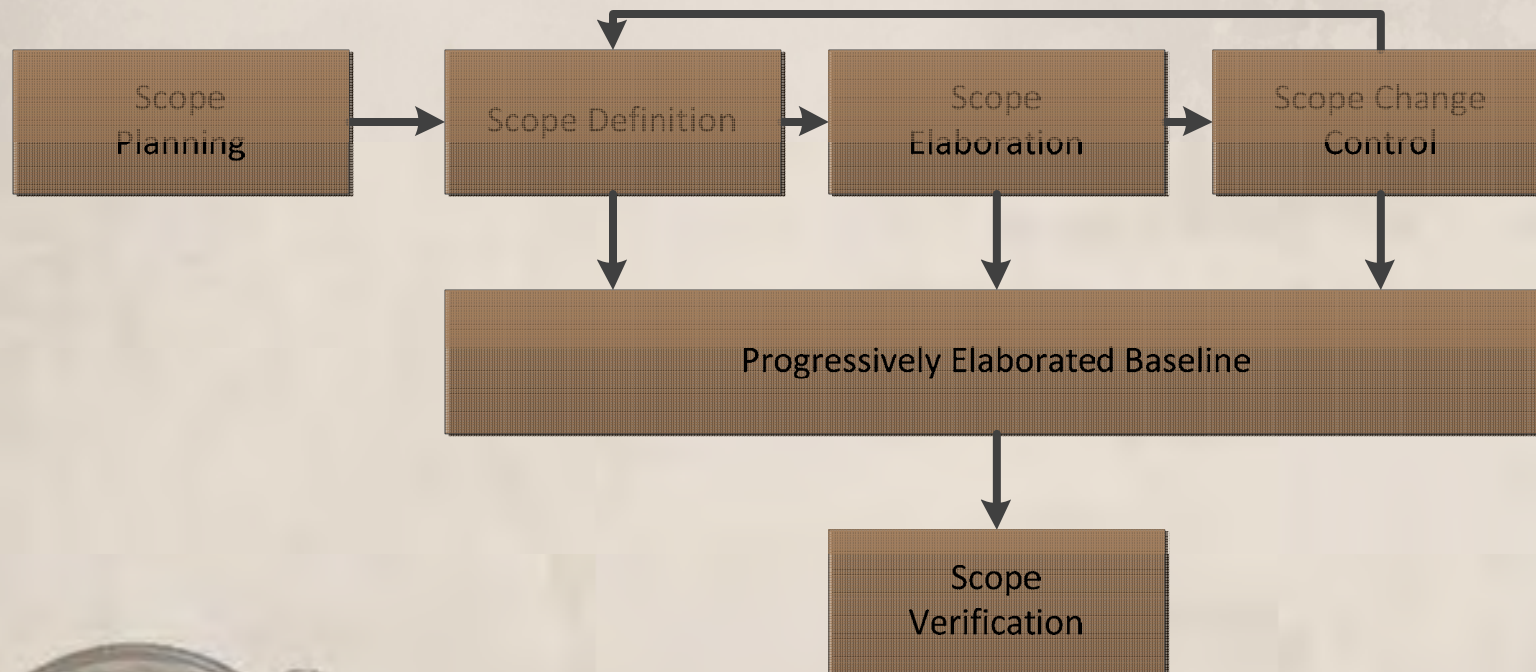


# Estimation Framework

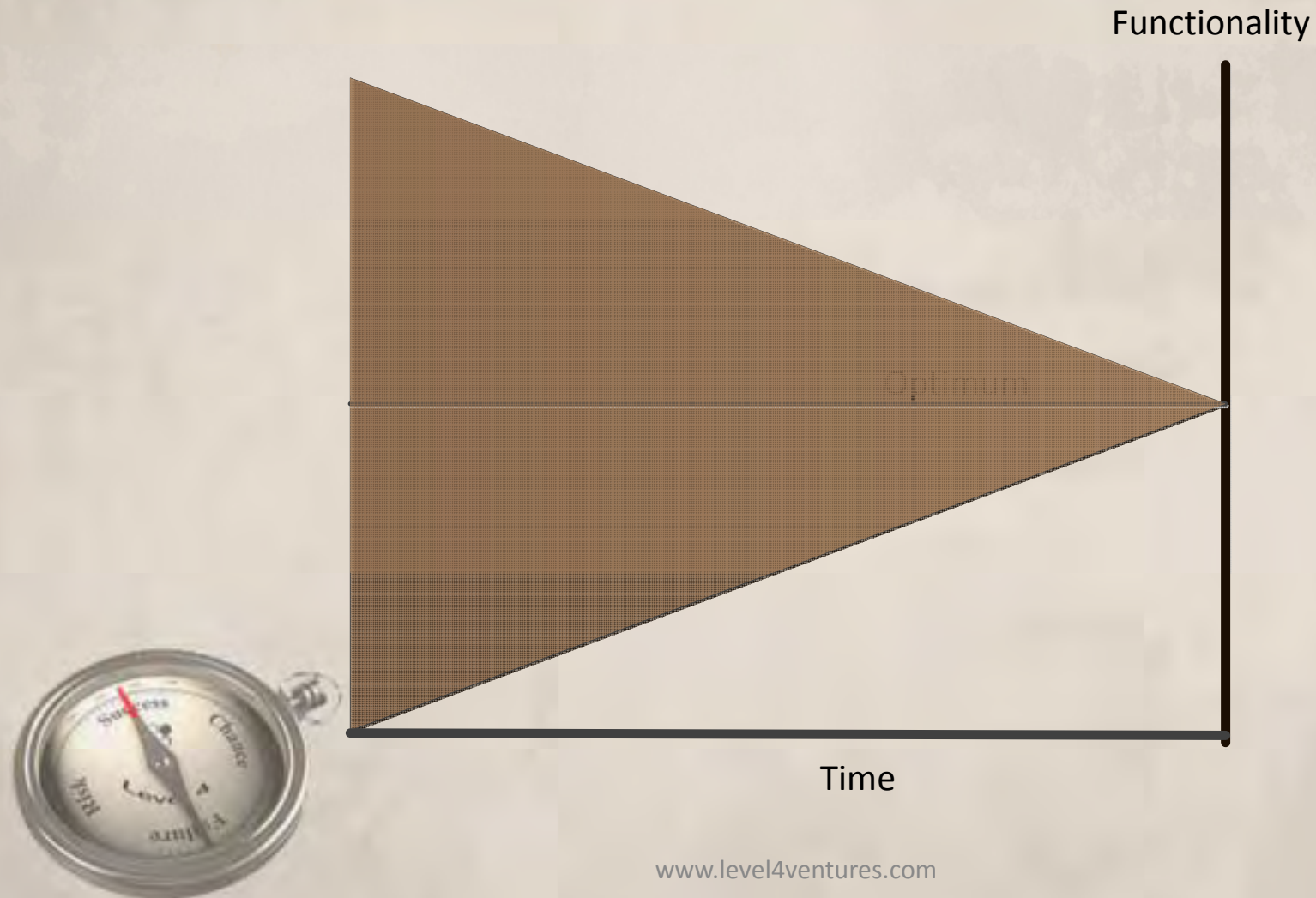
- Why do we need this?



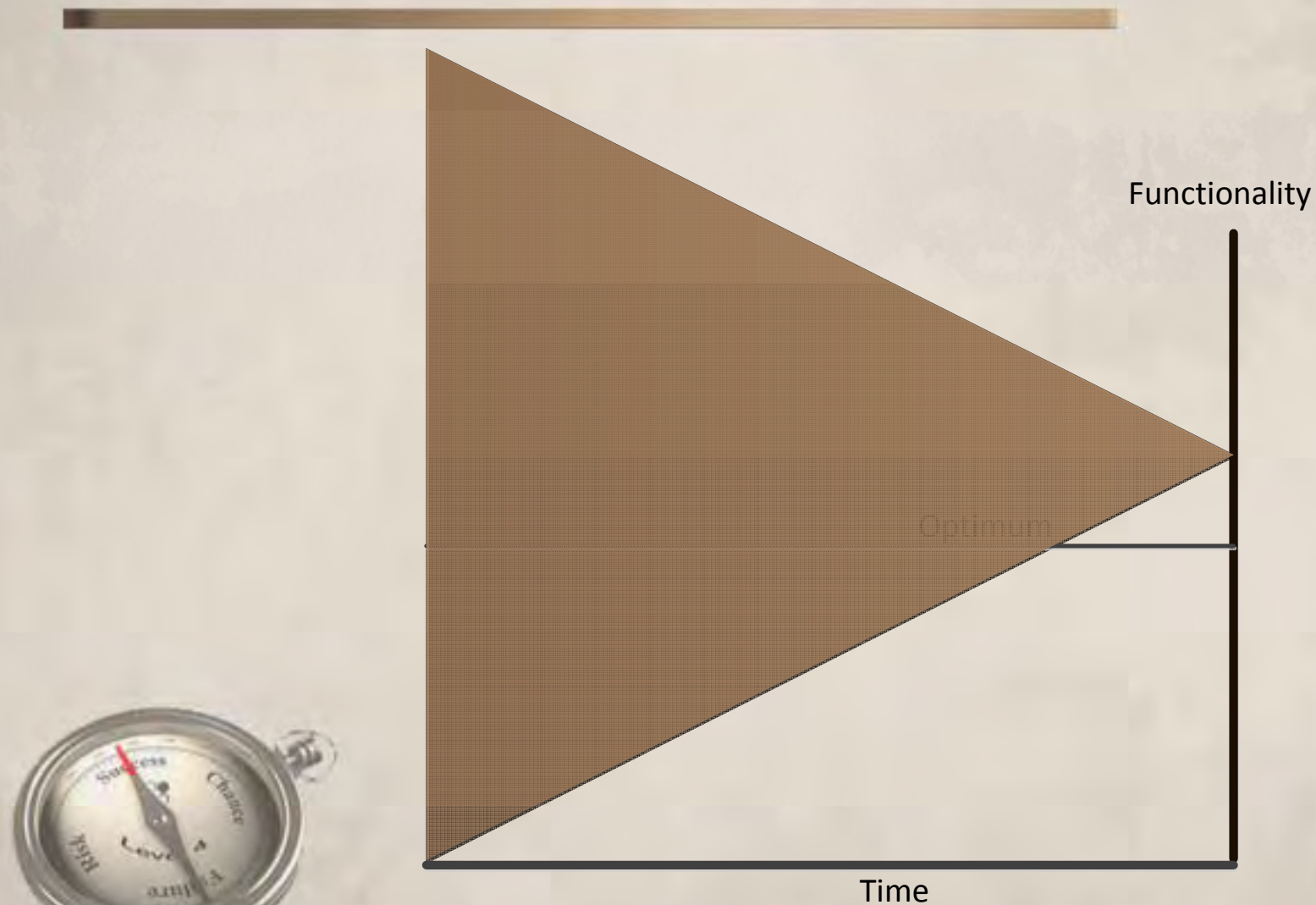
# Managing Scope



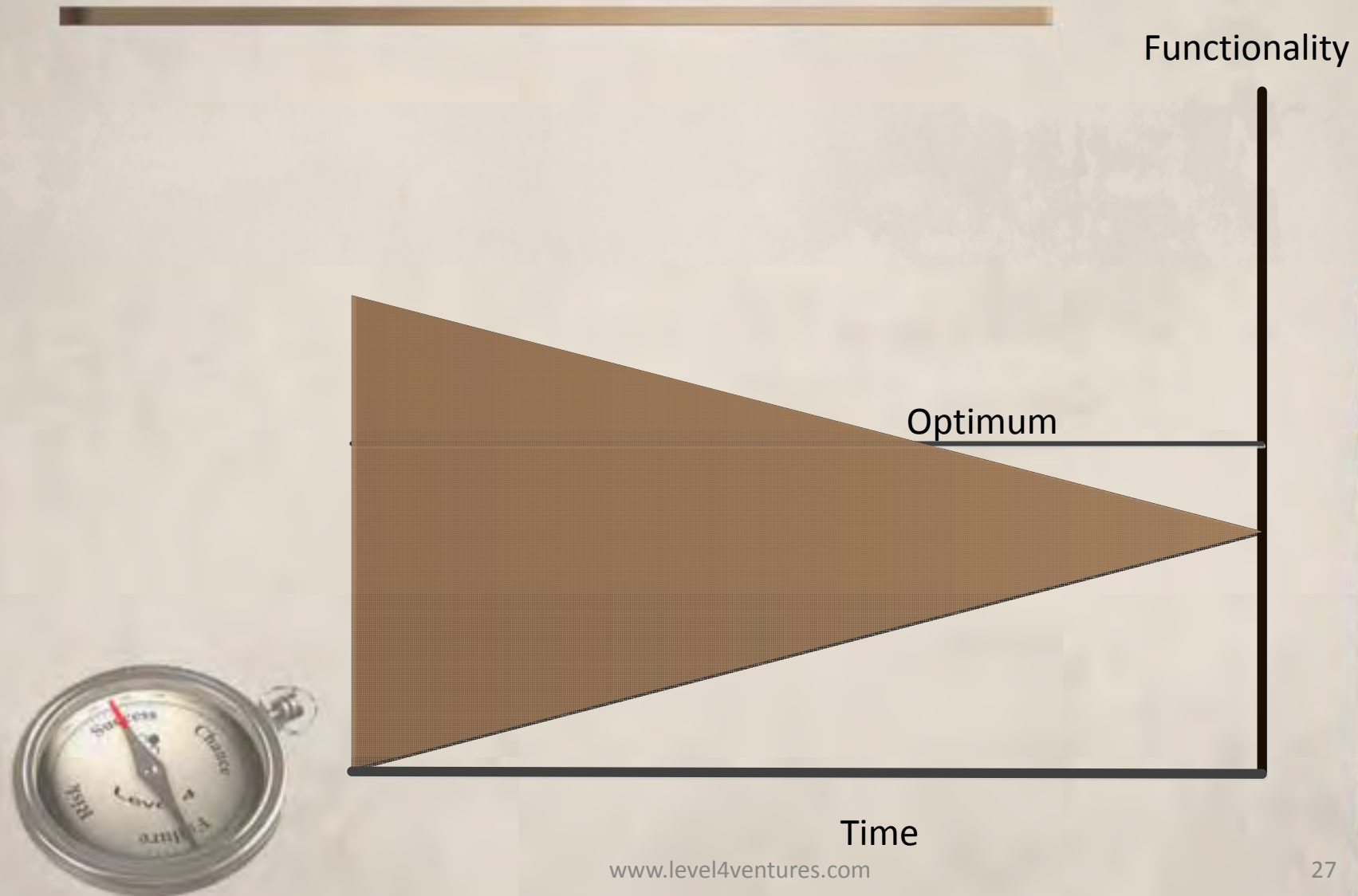
# Properly Managed Project



# Gold Plating



# Under Delivering



# Mid-Course Correction

Functionality

Optimum

Time



# Where Do Changes Come From?

- Scope Ambiguity, the largest source in software
  - Fortunately, shared pain by developer and customer
  - Knowledge is power
- Dynamic Requirements
  - Software requirements typically change between 3% and 15% per year (Capers quotes 1% per month as being typical, I use 7 to 12% per year for most environments)
  - Adaptive changes beyond your control account for roughly half of these.
- PM-BOK scope control is actually focused exclusively on the second category



# So What Should We Do?

- Define the total product scope using a product focused sizing metric (e.g., Function Points)
- Use industry benchmarks to forecast specific intermediate metrics (e.g., number of test cases)
- Use industry benchmark CERs to apportion effort when necessary (e.g., QA/QC is 10% of development).



# More About Function Points

- What are Function Points?
  - A product scope size proxy (HLO)
  - ILF, EIF, EI, EO, EQ
    - Basically: Files, outputs, and inputs
- Other HLO Proxies Are Possible
  - Often easier to count, may better map to problem domain
  - Some can be converted to FP equivalents to support benchmarking and standardization
  - Examples:
    - RICEW
    - Gateways, services, transforms, operations
    - Universes, tables, cubes, reports, interfaces, models



# From ANSI/EIA-748A

- **2.2 Planning, Scheduling, and Budgeting**
  - *B. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress.*
    - Use FP or other size proxy as representing the physical product to be delivered
    - Use industry benchmarks and CERs to convert that into meaningful intermediate engineering artifacts
    - Factor quality into progress measurements



# From ANSI/EIA-748A

- **2.2 Planning, Scheduling, and Budgeting**
  - C. ...Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefinitized work. **Budget for far-term efforts may be held in higher level accounts until an appropriate time for allocation at the control account level....**
    - For iterative lifecycles (e.g., Agile), the total project scope may be measured and monitored using size proxies, with the progress measured as builds are delivered
    - Factor risk into baselines and on-going status reporting



# From ANSI/EIA-748A

- **2.2 Planning, Scheduling, and Budgeting**
  - *E. To the extent it is practicable to identify the authorized work in discrete work packages, establish budgets for this work in terms of dollars, hours, or **other measurable units**....*
  - Use direct and indirect product scope proxies for work packages
    - Direct: FP or other HLO
    - Indirect: Benchmark data for artifacts (pages, test cases, use-cases, etc.)



# Conclusions

- Function points and other high level object based product scope proxies are a useful tool to make EVM useful on projects with high scope ambiguity early in the project life.





# Thank You

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# Acronyms

- AC: Actual Cost
- CER: Cost Estimating Relationship
- EI: External Input
- EIF: External Interface file
- EO: External Output
- EQ: External Query
- EV: Earned Value
- EVM: Earned Value Management
- EVMS: Earned Value Management System
- FP: Function Points
- HLO: High Level Object
- IFPUG: International Function Point User Group
- ILF: Internal Logical File
- PM-BOK: Project Management Body of Knowledge
- PV: Planned Value
- QA: Quality Assurance
- QC: Quality Control
- RICEW: Reports, Interfaces, Conversions, Extensions, Workflows

