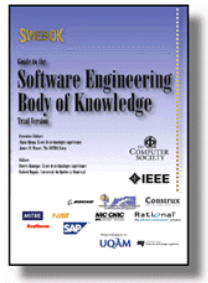

# EARNED SCOPE MANAGEMENT

Alain Abran &
Francisco Valdés

# Agenda



- Planning & Monitoring in SWEBOK
- Earned Value & Scope Management
- Example
- Extensibility to early phases - Lifecycle




# Project Constraints

## Wishes

Unlimited facilities

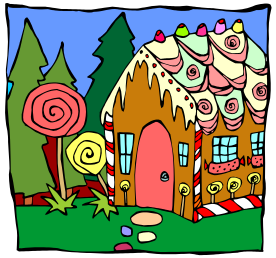
No budget & time constraints

## Agreed Constraints



# Project Scope

## Stakeholders initial wishes



The dreamer

Marketing

The visionnary

Accounting

## Agreed Project Scope!

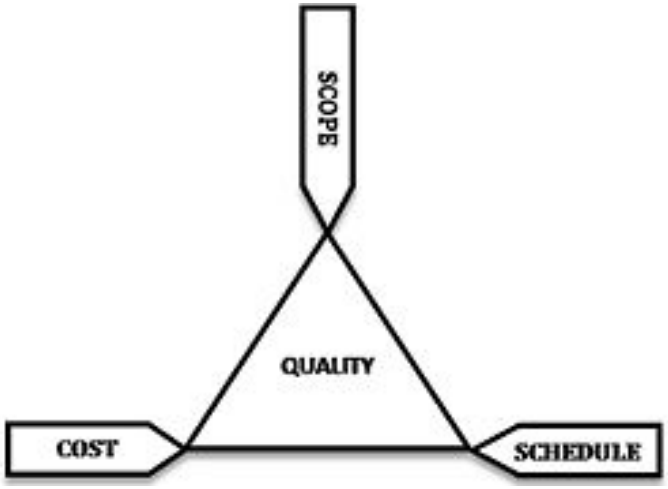
# Project Triple Constraint

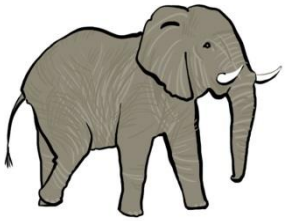




# Triple constraints

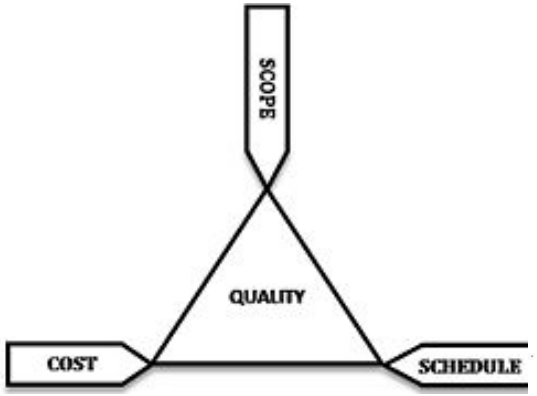





- Equilibrium needed across the triple constraint
- The  in the room = QUALITY!

# Triple constraints






**Lower Budget**

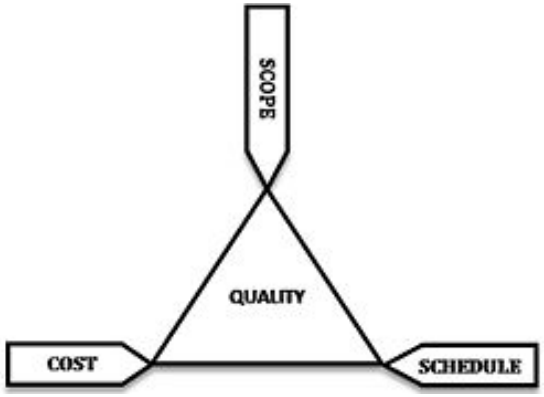
**or**

**Shorter Schedule**

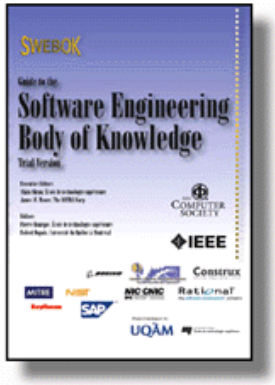


# Triple constraints






**Higher Budget**




**Software Engineering Management**

- Initiation and Scope Definition
- Software Project Planning
- **Software Project Enactment**
  - Implementation of Plans
  - Software Acquisition and Supplier Contract Management
  - Implementation of Measurement Process
  - Monitor Process
  - Control Process
  - Reporting
- Review and Evaluation
- Closure
- Software Engineering Measurement
- Software Engineering Management Tools

# Monitor Process

- Adherence to project plan should be assessed:
  - Continually
  - At predetermined intervals
- For each task, this refers to the assessment of:
  - Outputs
  - Completion criteria

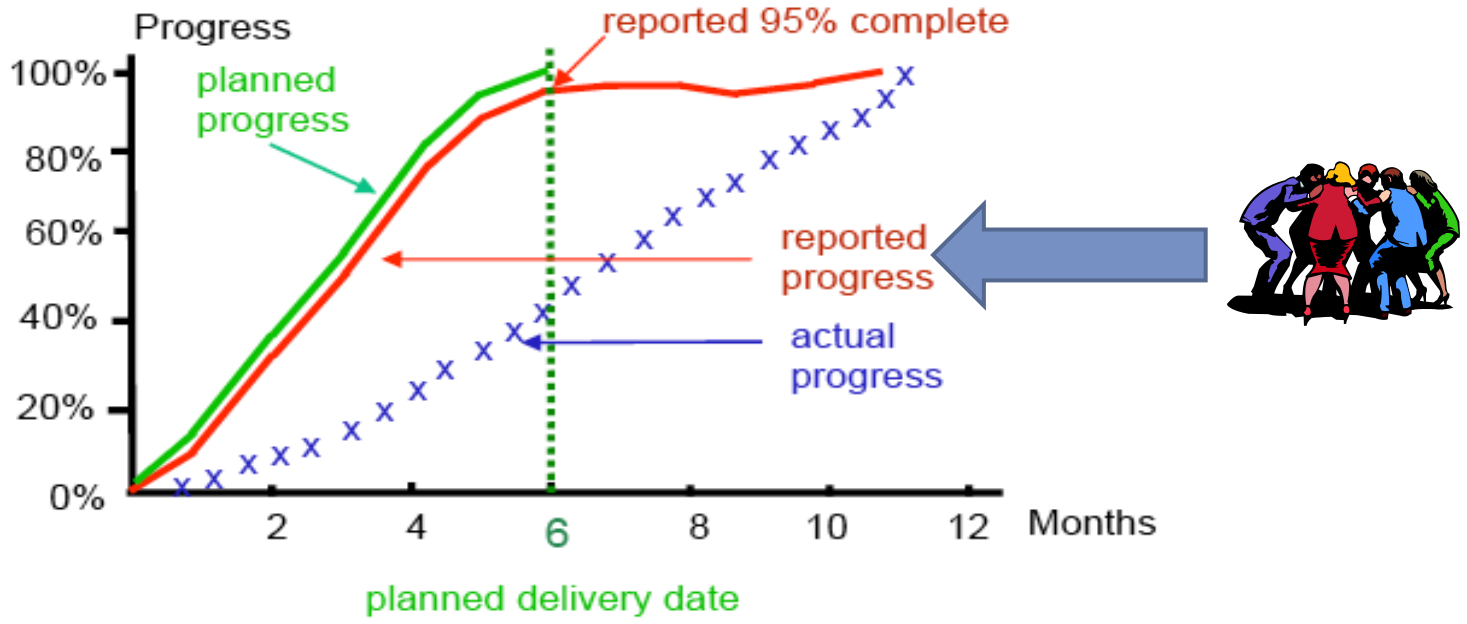
# Monitor Process

Analysis of measurement data:

- Variance analysis based on the deviation of actual from expected outcomes:
  - Costs-Effort overuns
  - Schedule slippage,
  - Outliers identification
  - Etc .

# Traditional Monitor Process

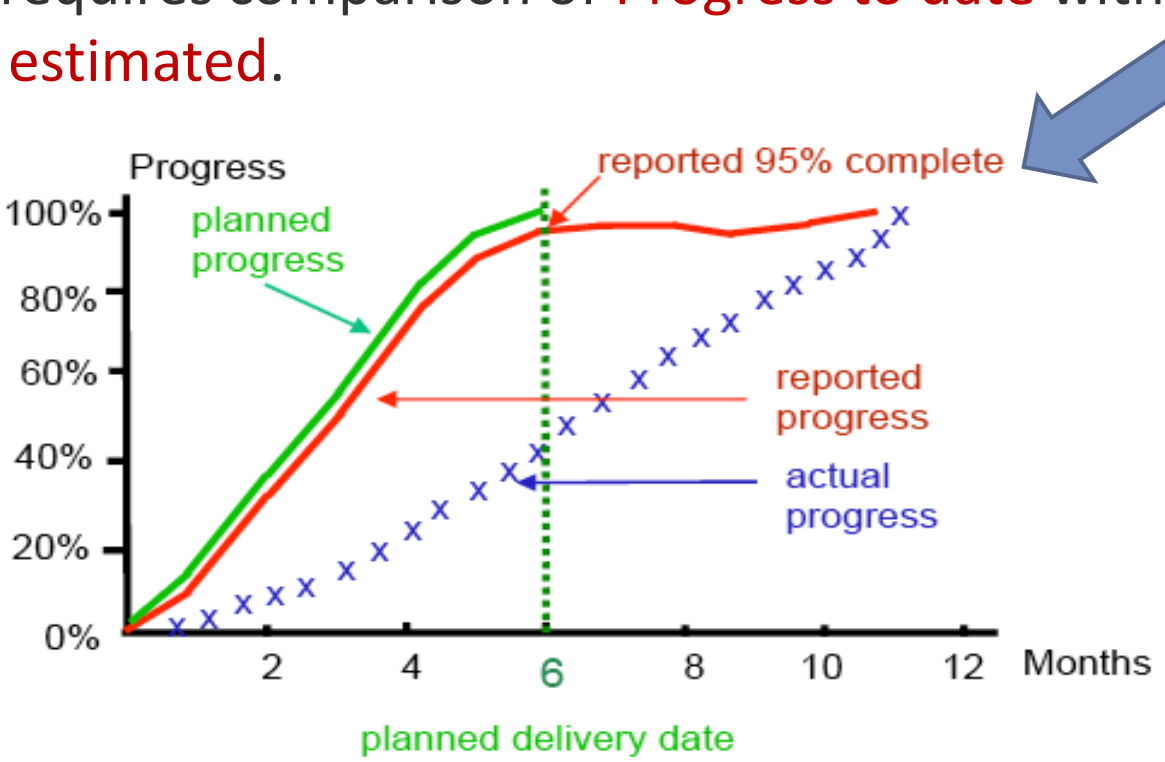
- Monitoring *progress* is tracking the achievement of Project Goals. It requires comparison of Progress to date with Progress estimated.




(Fairley, 2009)

# Traditional Monitor Process

- Monitoring *progress* is tracking the achievement of Project Goals. It requires comparison of Progress to date with Progress estimated.




(Fairley, 2009)

# Traditional Monitor Process

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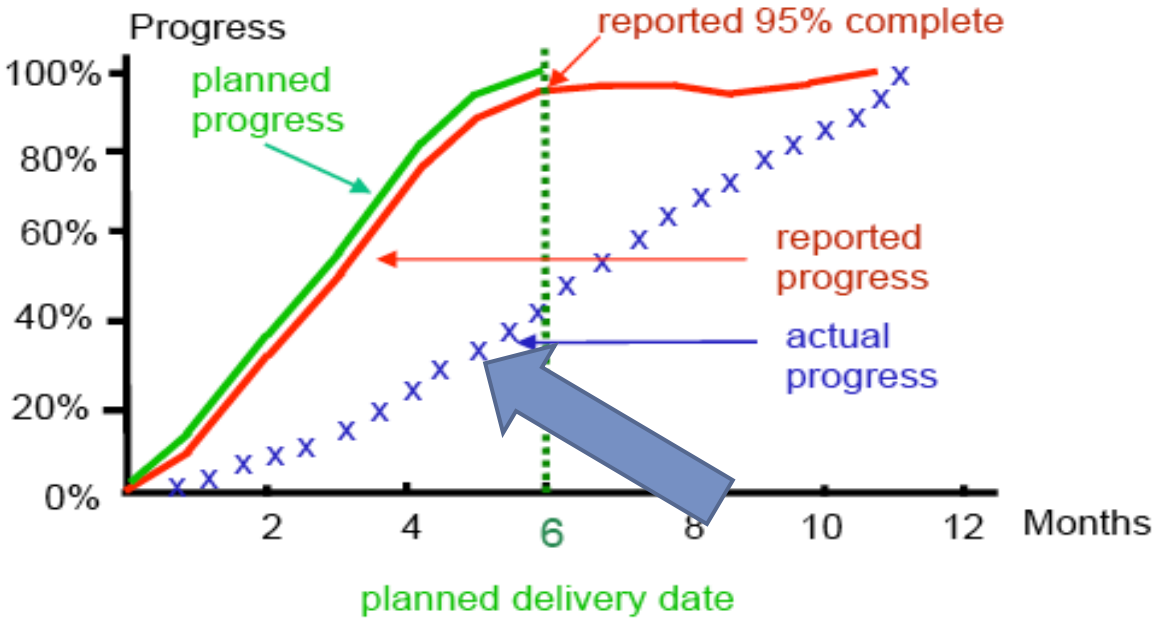


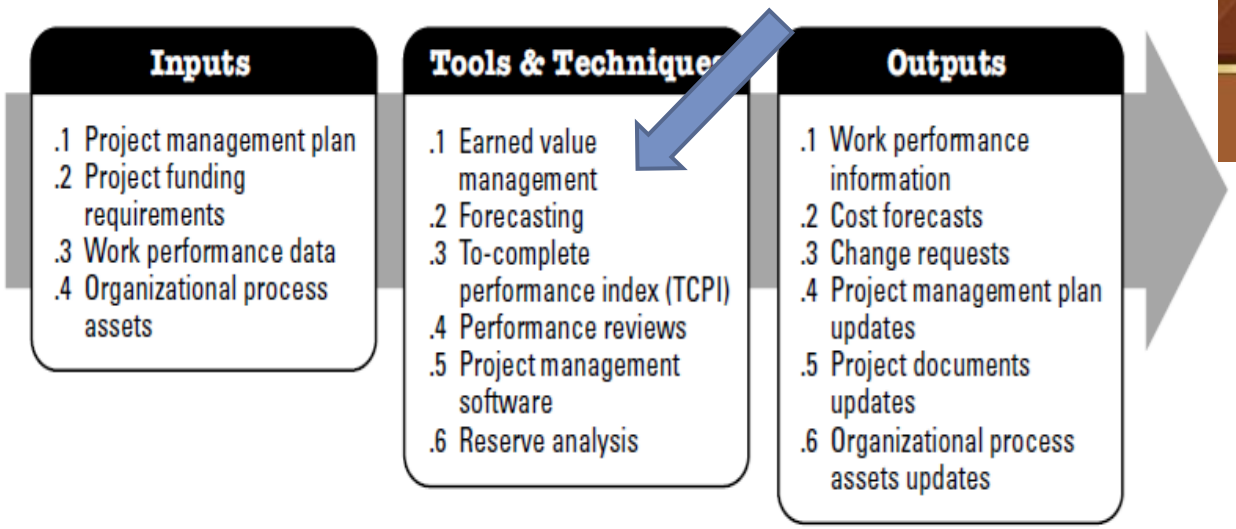

(Fairley, 2009)

# Agenda

- Planning & Monitoring in SWEBOK
- **Earned Value & Scope Management**
- Example
- Lifecycle & Extensibility to early phases

# Monitoring Techniques Available





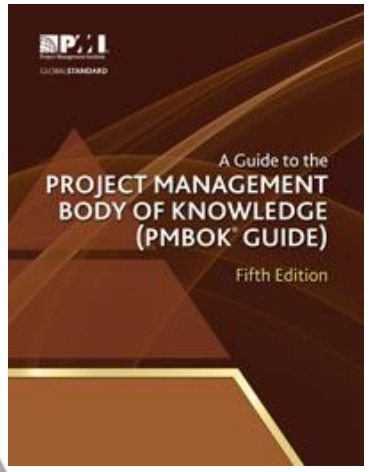




**Figure 1. Control Cost: Inputs, Tools & Techniques, and Outputs**

**(PMI, 2013)**

# Classical Earned Value



Value = $$$ or Estimated Effort for a deliverable

Earned Value =

Deliverable completed

x

Initial estimated Effort

# Earned Value Definitions

COSMIC



| PV = BCWS EV= BCWP AC = ACWP | |
|---|---|
| **Earned Value Terminology & Definition** | Formula |
| **Planned Value (PV) What we had planned on spending according to the schedule** | PV = BCWS |
| **Actual Cost (AC) What money we actually spent (ACWP = Actual Cost of Work Performed)** | AC = ACWP |
| **Budget At Completion (BAC) Original budget for the project** | |
| **Earned Value (EV) What we planned on spending for the work completed today** | EV = BAC (% completed) |
| **Cost Variance (CV) Positive is under budget, Negative is over budget** | EV –AC |
| **Cost Performance Index (CPI) For every dollar spent, we are getting x% of the dollar's value. < 1 is over budget, > 1 is under budget. CPI is sometimes referred to as "forecast to complete"** | EV / AC |
| **Estimate AT Completion (EAC) The current expected total cost is x dollars** | AC / % Completed |
| **Estimate To Complete (ETC) It will cost x dollars to complete the project** | EAC –AC |
| **Variance At Completion (VAC) When complete, the project will have cost x dollars more or less than originally budgeted** | BAC –EAC |

# Classical Earned Value



| PV = BCWS | EV= BCWP<br>ACWP | AC = |
|---|---|---|
| Earned Value Terminology & Definition | | Formula |
| Planned Value (PV) What we had planned on spending according to the schedule | | PV = BCWS |
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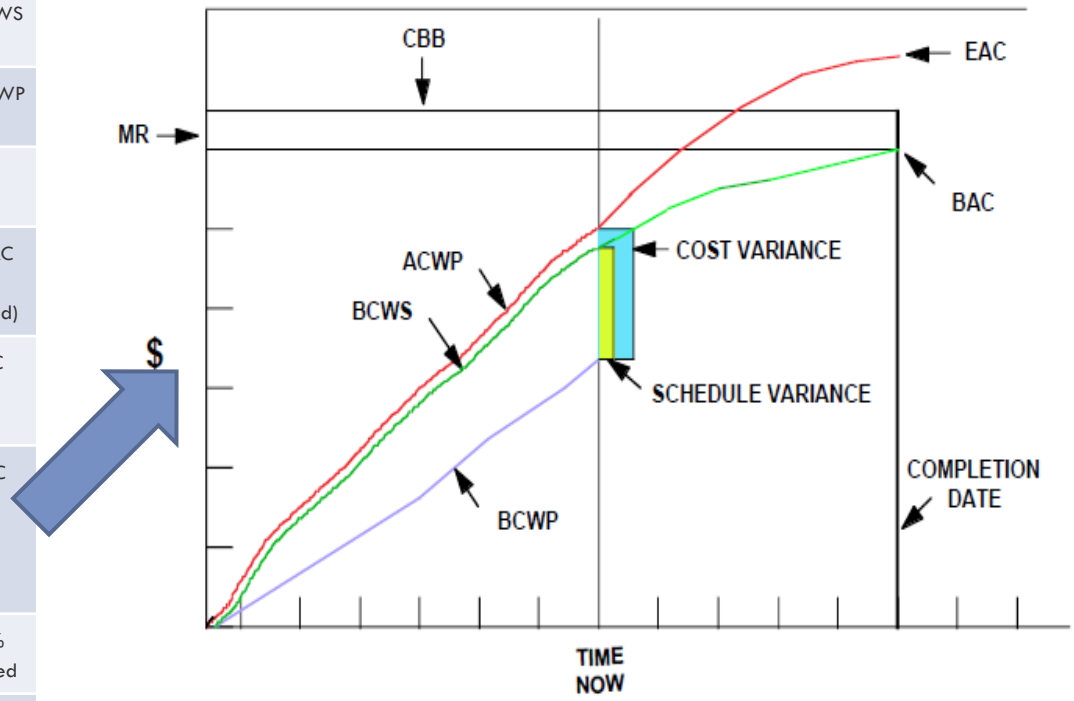



Earned Value Management (EVM) concepts adapted from (Program Executive Office Air and Missile Defense, 1996)

# Classical Earned Value



Value = $$$ or Estimated Effort for a deliverable

Earned Value = Deliverable completed x Estimated Effort at reporting time

**What if Estimates are incorrect?**

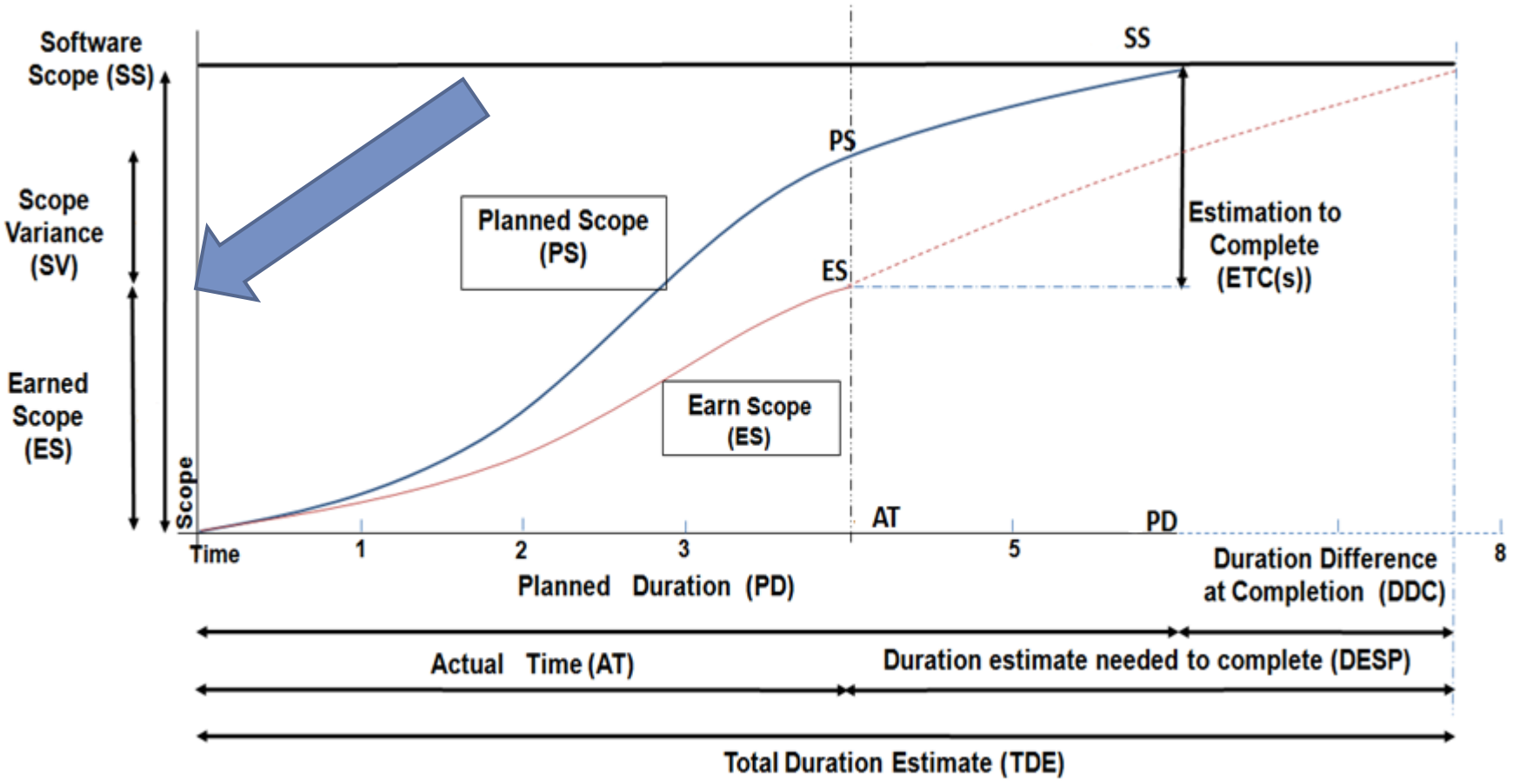
**imprecise monitoring & less control!**

**Solution: monitor directly the scope of the deliverable completed**

**- in COSMIC Function Points**

**(without the estimate bias!)**

# Earned Scope Management Concept (ESM)

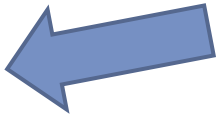


| ESM Element | Earned Scope Management | Formula |
|---|---|---|
| Input Data | Planned Duration (PD)<br>Planned Project Duration. | If the ESM is used in conjunction to ES this value is gathered from ES |
| | Actual Time (AT)<br>Period number at which the scope performance is calculated | |
| | Software Scope (SS)<br>The scope of a software application in terms of Functional Size units (FSU) | |
| | Planned Scope (PS)<br>What had been planned to be done according to the schedule | |
| | Earned Scope (ES)<br>Scope earned at the period. | If the %C is an input data then:<br>ES = SS (% completed) |
| | % completed (%C) | If the ES is an input data then:<br>%C = ES/SS |
| | Software Project Human Resources (SPHR)<br>The whole human resources used in the period reviewed according to the planned scope for the software activities (requirements, design, construction, test). | |

| ESM Element | Earned Scope Management |
|---|---|
| Scope Status | Scope Variance (SV(s))<br>Positive is over scope, Negative is under scope |
| | Scope Performance Index (SPI(s))<br>The project is progressing at x% of the planned scope: <1 is behind scope, > 1 is ahead of scope. |
| | Productivity by Resource (PR)<br>The average productivity by person involved in the software development. |
| | |
| | Average Productivity by Human Resource(PROAVG)<br>The average productivity in the periods reviewed |
| | Productivity Variation (PV)<br>Positive: ahead of productivity required,<br>Negative: behind productivity required. |
| | Estimation to Complete (ETC(s))<br>Scope estimation to Complete the Project |

| ESM Element | Earned Scope Management |
|---|---|
| Scope Prediction | Total Duration Estimate (TDE)<br>The Duration Estimation needed to complete the project with the same PR for the next periods. |
| | Duration estimate needed to complete the Project with the same productivity. (DESP) |
| | Duration Difference at Completion (DDC)<br>The difference between the planned duration and the total duration estimated in the evaluated period. |
| | Productivity required by resources defined to complete the scope as was planned (PRTC). |
| | Resources Variation to Complete the Planned Scope by period (RVTC).<br>Indicates the difference of human resources needed to complete the scope planned in the period evaluated. |
| | Human Resources Needed to Complete the project (RNTC)<br>Resources estimated by next periods to complete the scope as was planned. |

# Agenda

- Planning & Monitoring in SWEBOK
- Earned Value-Scope Management
- **Example** 
- Lifecycle & Extensibility to early phases

# Example



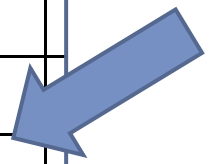
- Project functional size = 254 CFP
- Planned duration = 10.5 months
- Resources available = 11 people
- Expected avg productivity = 2.2 CFP per person per month

# Example



**Raw status data for the first 3 periods**

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| Planned Duration (PD) | 10.5 | | | [months] |
| Actual Time (AT) | 1 | | | [Period] |
| Software Scope (SS) | 254 | | | [CFP] |
| Planned Scope (PS) | 24 | | | [CFP] |
| Earned Scope (ES) | 20 | | | [CFP] |
| Software Project Human Resources (SPHR) | 11 | | | [Persons] |
| % completed of scope | 8 | | | [%] |



# Example

**"Scope Progress Status" with ESM**

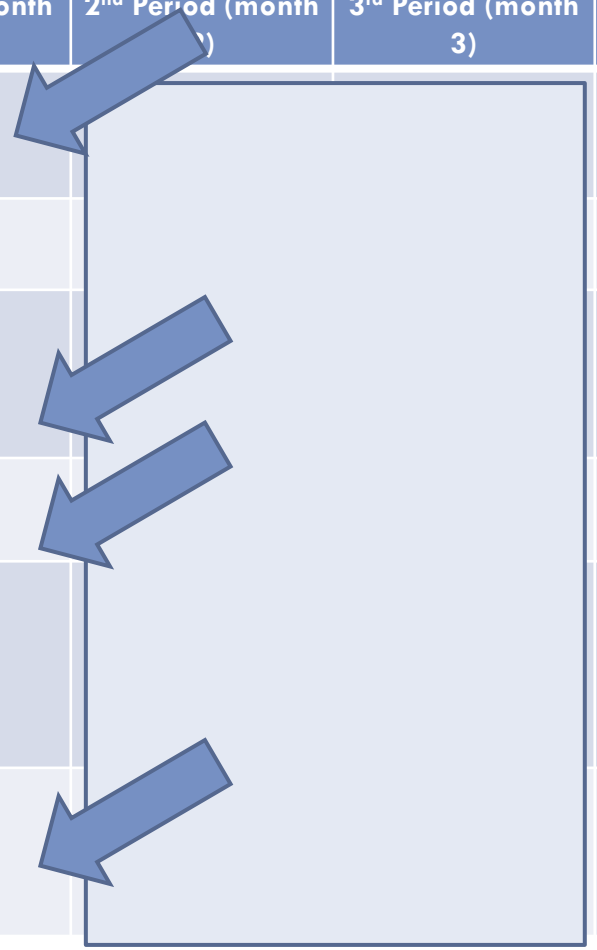
Expected productivity:
254CFP /
(11persons & 10.5 months)
= 2.2 CFP-person-month

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| 1) Scope Variance (SV(s)) Positive is over scope, Negative is under scope | -4 | | | [CFP] |
| 2) Scope Performance Index (SPI) The project is progressing at x% of the planned scope: <1 is behind scope, > 1 is ahead of scope. | 83% | | | [%] |
| 3) Productivity by Resource (PR) The average productivity by person involved in the software development. | 1.82 | | | [CFP/ Person] |
| 5) Average Productivity by Human Resource (PROAVG) The average productivity in the periods reviewed | 1.82 | | | [CFP/ Person] |
| 6) Productivity Variation (PV) Positive ahead of productivity required, Negative is behind productivity required. | -0.36 | | | [CFP/ Person] |
| 7) Estimation to Complete (ETC(s)) Scope estimation to complete the project | 234 | | | [CFP] |

# ESM Prediction



| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| 1) Total Duration Estimate (TDE) The total Duration Estimation needed to complete the project with the same PR for the next periods. | 12.70 | | | [months] |
| 2) Duration estimate needed to complete the project with the same productivity. (DESP) | 11.70 | | | [months] |
| 3) Duration Difference at Completion (DDC) The difference between planned duration and total duration estimated in the evaluated period. | -2.20 | | | [months] |
| 4) Productivity required by resources planned to complete the scope as planned (PRTC). | 2.24 | | | [CFP/ Person] |
| 5) Resource Variation to complete Planned Scope by period (RVTC) Indicates the difference in the number of human resources needed to complete the scope planned in the period evaluated. | 2.20 | | | [Person] |
| 6) Human Resources Needed to Complete the project (RNTC) Resources estimated for next periods to complete the scope as planned. | 13.20 | | | [Person] |



# Example



**Raw status data for the first 3 periods**

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| Planned Duration (PD) | 10.5 | 10.5 | | [months] |
| Actual Time (AT) | 1 | 2 | | [Period] |
| Software Scope (SS) | 254 | 254 | | [CFP] |
| Planned Scope (PS) | 24 | 48 | | [CFP] |
| Earned Scope (ES) | 20 | 40 | | [CFP] |
| Software Project Human Resources (SPHR) | 11 | 11 | | [Persons] |
| % completed of scope | 8 | 16 | | [%] |

# Example



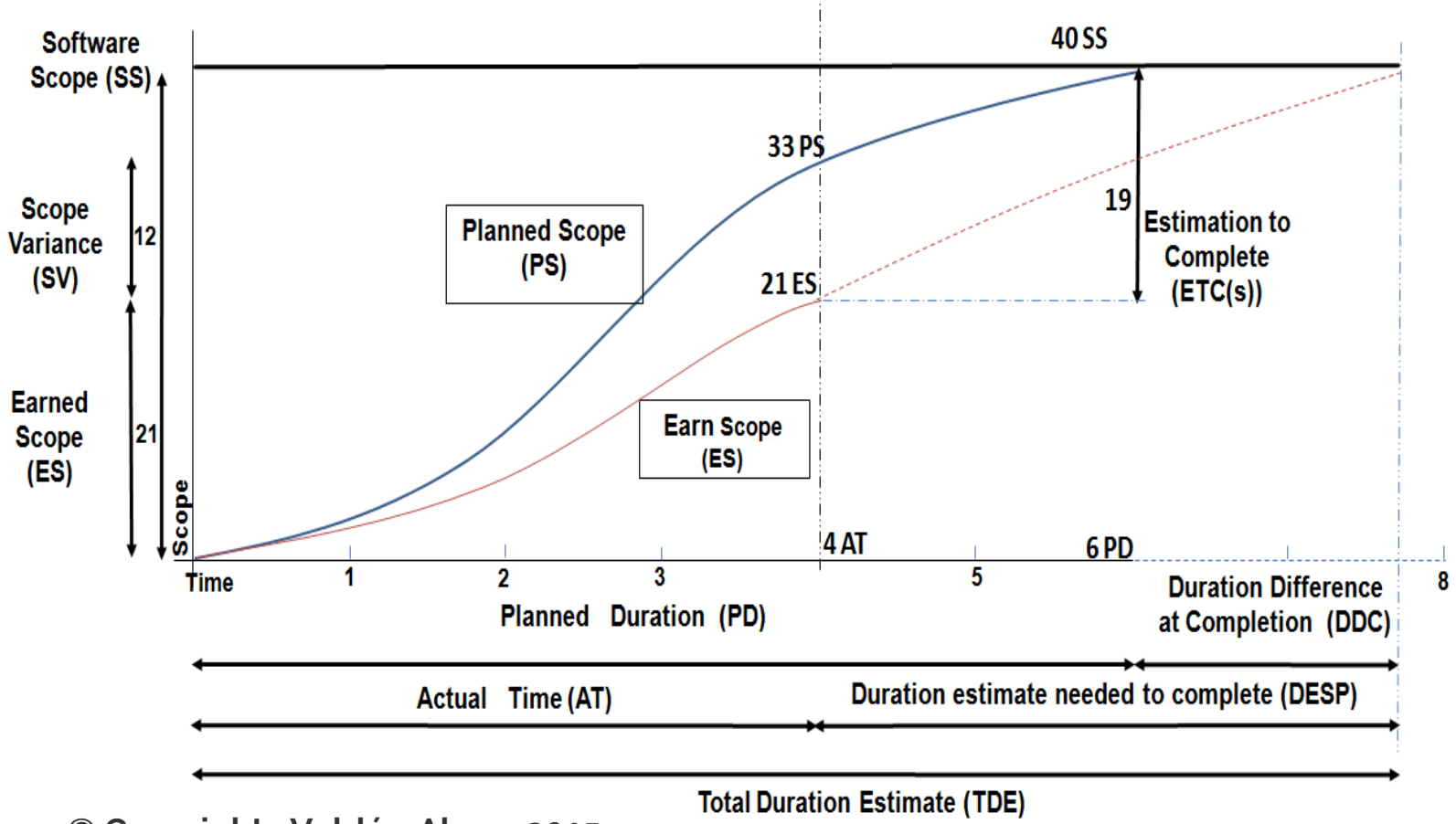
**“Scope Progress Status” with ESM**

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Peri (m | Unit |
|---|---|---|---|---|
| 1) Scope Variance (SV(s)) Positive is over scope, Negative is under scope | -4 | -8 | | [CFP] |
| 2) Scope Performance Index (SPI) The project is progressing at x% of the planned scope: <1 is behind scope, > 1 is ahead of scope. | 83% | 83% | | [%] |
| 3) Productivity by Resource (PR) The average productivity by person involved in the software development. | 1.82 | 1.82 | | [CFP/ Person] |
| 5) Average Productivity by Human Resource (PROAVG) The average productivity in the periods reviewed | 1.82 | 1.82 | | [CFP/ Person] |
| 6) Productivity Variation (PV) Positive ahead of productivity required, Negative is behind productivity required. | -0.36 | -0.36 | | [CFP/ Person] |
| 7) Estimation to Complete (ETC(s)) Scope estimation to complete the project | 234 | 214 | | [CFP] |

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| 1) **Total Duration Estimate (TDE)** The total Duration Estimation needed to complete the project with the same PR for the next periods. | 12.70 | 12.70 | | [months] |
| 2) **Duration estimate needed to complete the project with the same productivity. (DESP)** | 11.70 | 10.70 | | [months] |
| 3) **Duration Difference at Completion (DDC)** The difference between planned duration and total duration estimated in the evaluated period. | -2.20 | -2.20 | | [months] |
| 4) **Productivity required by resources planned to complete the scope as planned (PRTC).** | 2.24 | 2.29 | | [CFP/ Person] |
| 5) **Resource Variation to complete Planned Scope by period (RVTC)** Indicates the difference in the number of human resources needed to complete the scope planned in the period evaluated. | 2.20 | 4.40 | | [Person] |
| 6) **Human Resources Needed to Complete the project (RNTC)** Resources estimated for next periods to complete the scope as planned. | 13.20 | 15.40 | | [Person] |

# Earned Scope Management Concepts





# Example



**Raw status data for the first 3 periods**

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| Planned Duration (PD) | 10.5 | 10.5 | 10.5 | [months] |
| Actual Time (AT) | 1 | 2 | 3 | [Period] |
| Software Scope (SS) | 254 | 254 | 254 | [CFP] |
| Planned Scope (PS) | 24 | 48 | 86 | [CFP] |
| Earned Scope (ES) | 20 | 40 | 87 | [CFP] |
| Software Project Human Resources (SPHR) | 11 | 11 | 11 | [Persons] |
| % completed of scope | 8 | 16 | 34 | [%] |

# Example



**"Scope Progress Status" with ESM**

| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| 1) Scope Variance (SV(s)) Positive is over scope, Negative is under scope | -4 | -8 | 1 | [CFP] |
| 2) Scope Performance Index (SPI) The project is progressing at x% of the planned scope: <1 is behind scope, > 1 is ahead of scope. | 83% | 83% | 101% | [ |
| 3) Productivity by Resource (PR) The average productivity by person involved in the software development. | 1.82 | 1.82 | 4.27 | [CFP/ Person] |
| | | | | |
| 5) Average Productivity by Human Resource (PROAVG) The average productivity in the periods reviewed | 1.82 | 1.82 | 2.64 | P/ erson] |
| 6) Productivity Variation (PV) Positive ahead of productivity required, Negative is behind productivity required. | -0.36 | -0.36 | 0.82 | P/ erson] |
| 7) Estimation to Complete (ETC(s)) Scope estimation to complete the project | 234 | 214 | 167 | [CFP] |

# ESM Prediction



| ESM Element | 1st Period (month 1) | 2nd Period (month 2) | 3rd Period (month 3) | Unit |
|---|---|---|---|---|
| 1) Total Duration Estimate (TDE) The total Duration Estimation needed to complete the project with the same PR for the next periods. | 12.70 | 12.70 | 6.55 | [month |
| 2) Duration estimate needed to complete the project with the same productivity. (DESP) | 11.70 | 10.70 | 3.55 | [months] |
| 3) Duration Difference at Completion (DDC) The difference between planned duration and total duration estimated in the evaluated period. | -2.20 | -2.20 | 3.95 | [months] |
| 4) Productivity required by resources planned to complete the scope as planned (PRTC). | 2.24 | 2.29 | 2.02 | [CFP/ Person] |
| 5) Resource Variation to complete Planned Scope by period (RVTC) Indicates the difference in the number of human resources needed to complete the scope planned in the period evaluated. | 2.20 | 4.40 | -0.23 | [Person] |
| 6) Human Resources Needed to Complete the project (RNTC) Resources estimated for next periods to complete the scope as planned. | 13.20 | 15.40 | 10.77 | [Person] |

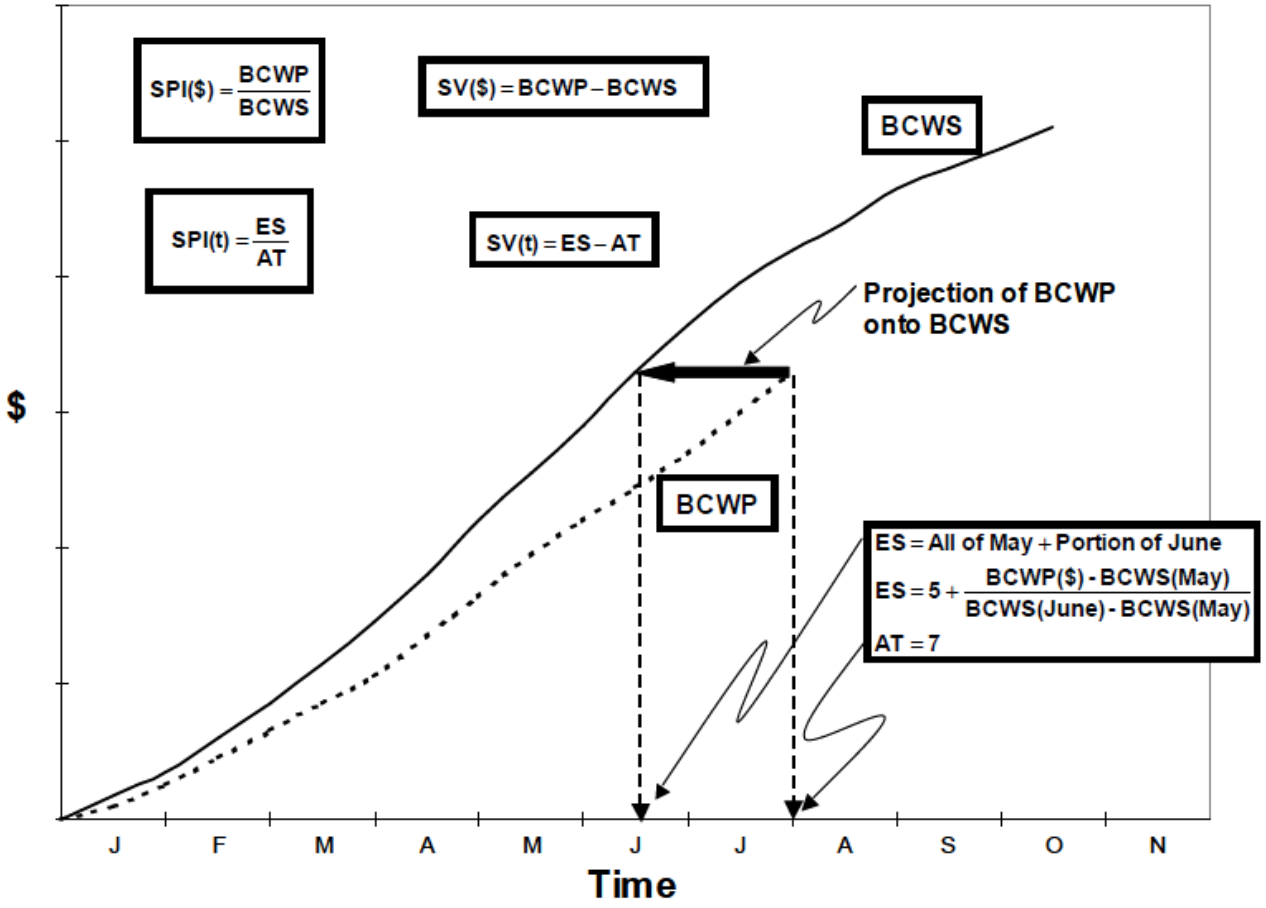
# Earned Schedule: Definitions



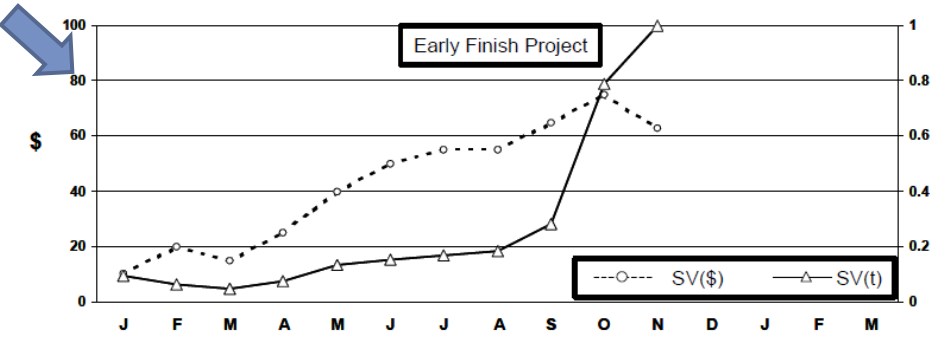
| | | |
|---|---|---|
| Metrics | Earned Schedule | ES cum |
| | Actual time | AT cum |
| Indicators | Schedule Variance | SV (t) |
| | Schedule Performance Index | SPI (t) |
| | To Complete Schedule Performance Index | TSPI (t) |
| Predictors | Independent Estimate at Completion (time) | IEAC (t) |

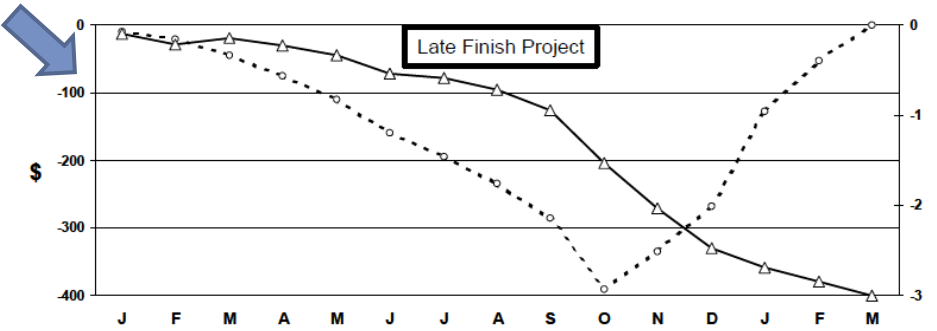
# Earned Schedule Mgnt





# Earned Schedule Variance



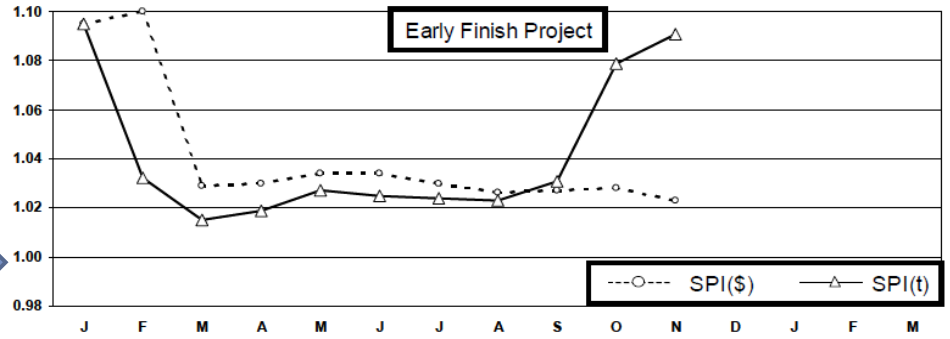



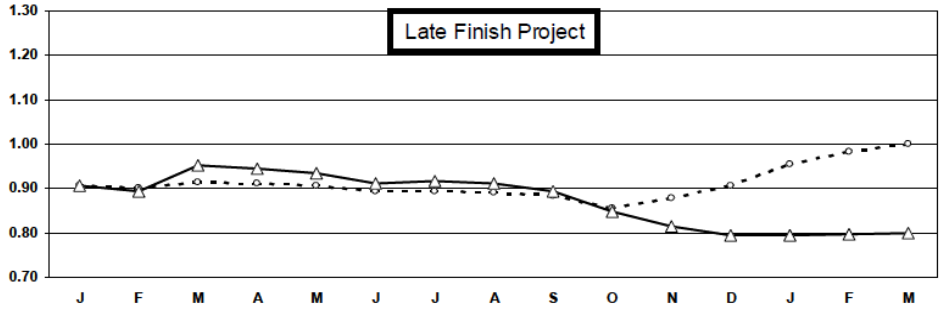

- Schedule Variance (SV) Comparison. [12]

**SV = EV – PV**

**SPI = EV / PV**

•Schedule Performance Index (SPI) Comparison. [12]



# Agenda



- Planning & Monitoring in SWEBOK
- Earned Value-Scope Management
- Example
- **Life cycly & Extensibility to:**
  - **Early project phases**

# Earned Scope through Phases



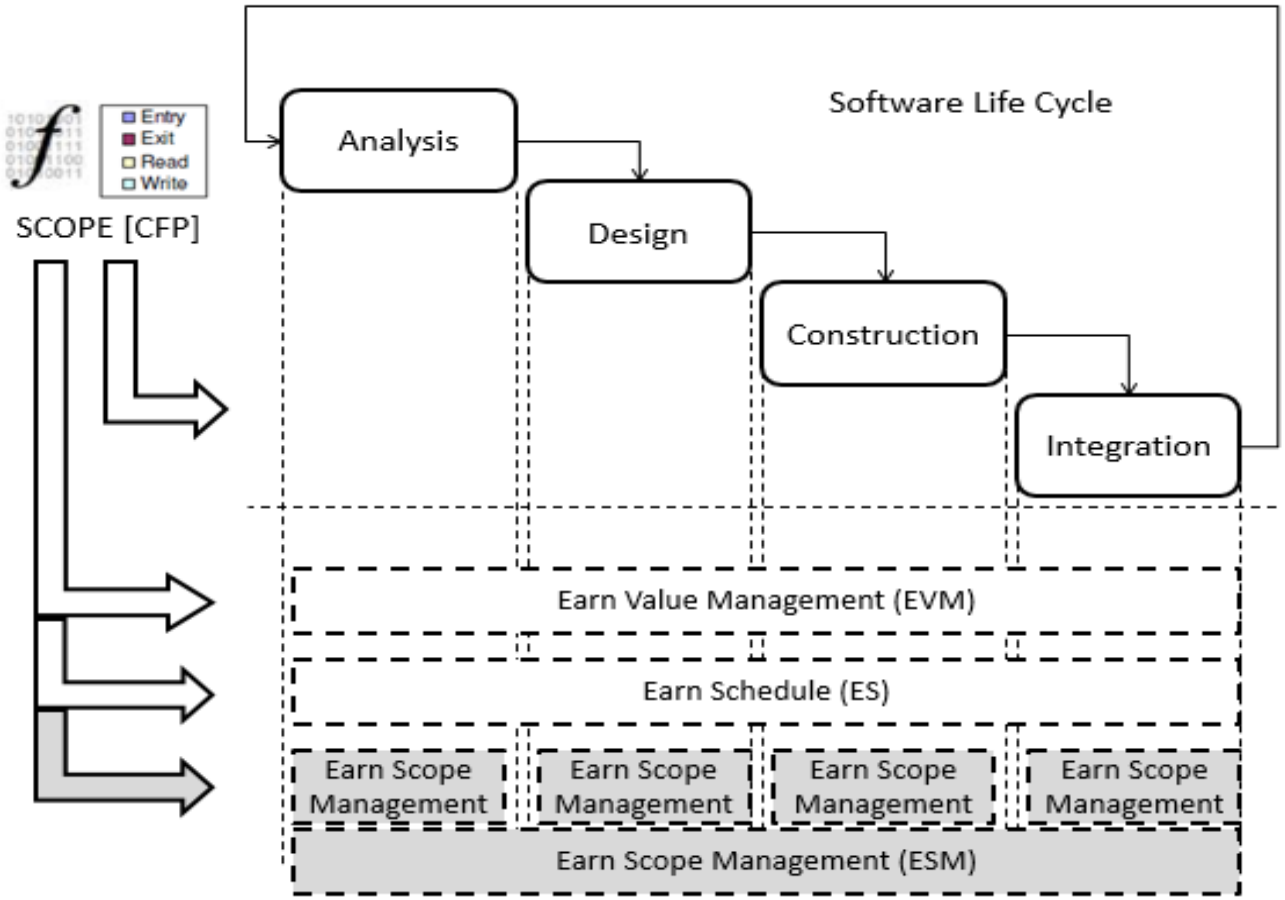



 **Figure 8. Application of the ESM during the project life cycle.**

# Planned Process: An organized set of activities



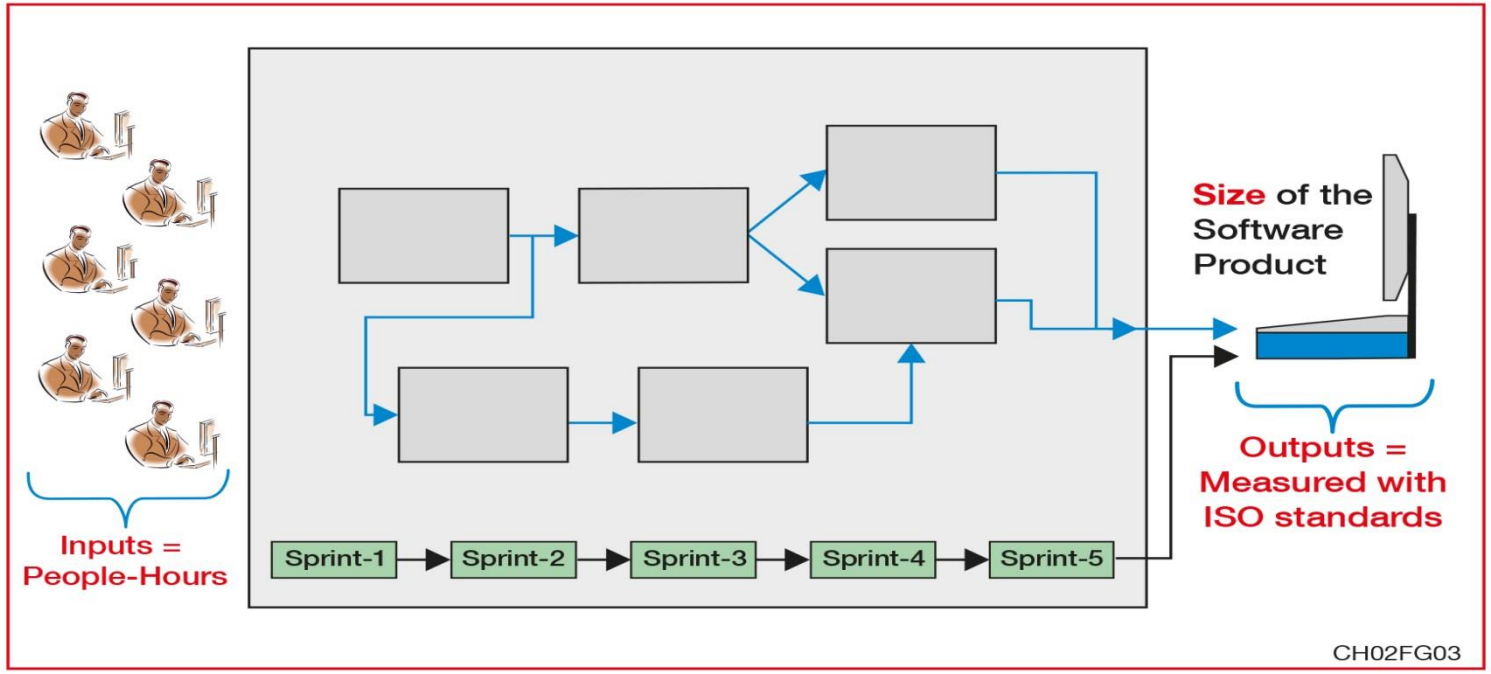
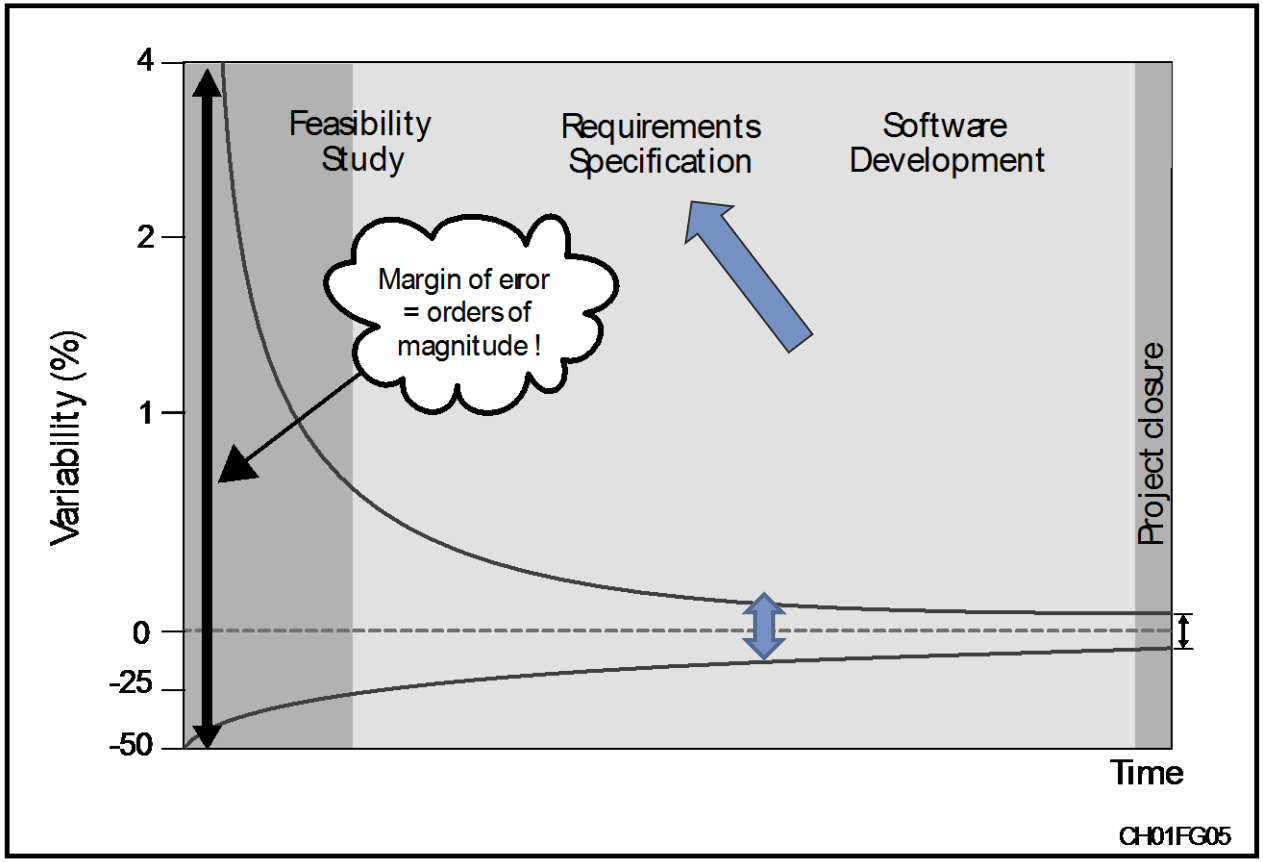
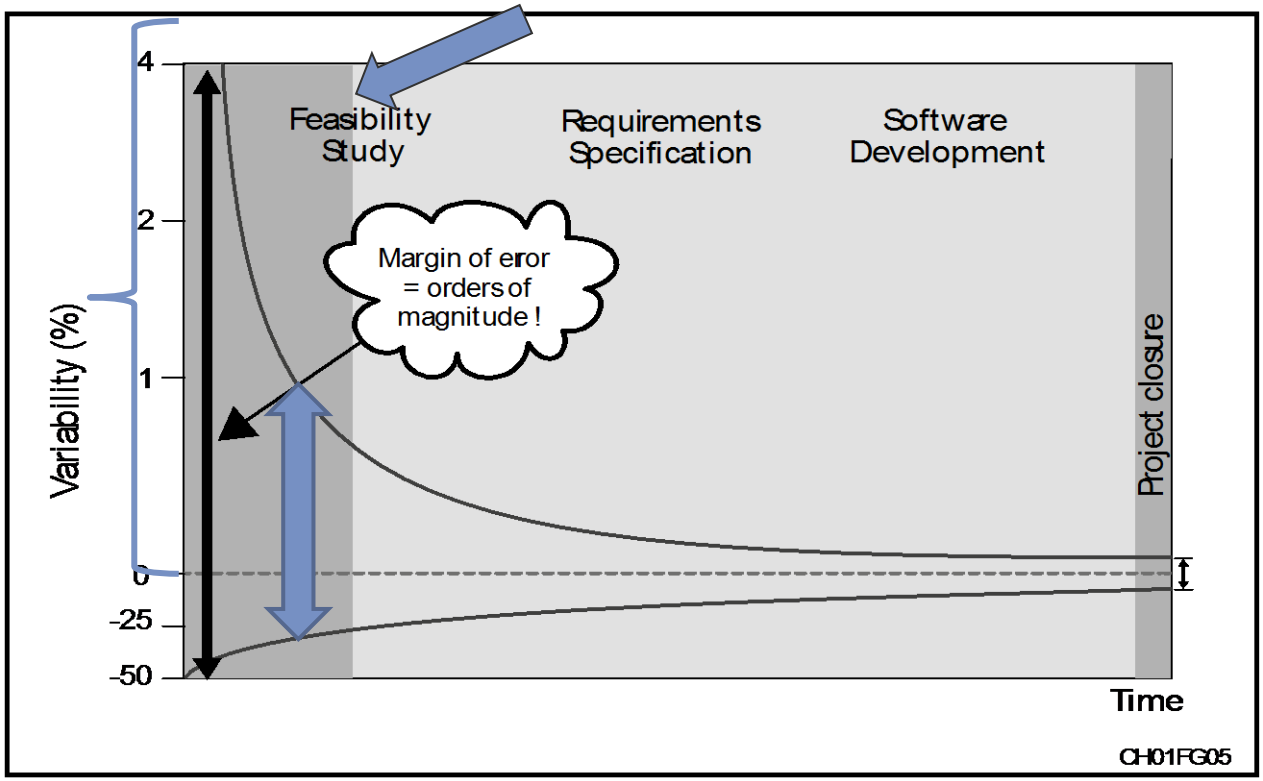



Figure 2.3 The Productivity Ratio.

# Earned Value & Scope Management
# Strong Measurement Accuracy



# Imprecise Inputs at Feasibility Analysis – EVM & ESM Challenging



# Scaling – high-level



# Scaling – details



# Scaling – Level of Granularity



| Level of granularity of the Actual Requirements | Measurement method | Measurement standard |
|---|---|---|
| Actual requirements at a high level of granularity derived from e.g.:<br>• high-level statement of actual requirements for the software<br>• architecture artifacts<br>• high-level view of existing software<br>expressed in locally-defined (countable) units e.g. Use Cases, or in CFP | An 'Approximate approach' to the COSMIC measurement method.<br>Calibrated locally | The size of the locally defined unit, expressed in local units or in CFP<br>↕ scaling factor |
| The functional process level of granularity | COSMIC measurement method | The CFP |

# Available Scope Approximation Techniques



COSMIC Guideline for Early-Rapid Sizing

- Average functional process
- Equal size bands
- Early & Quick
- EPCU
- Etc.

# Early & Quick Approximation



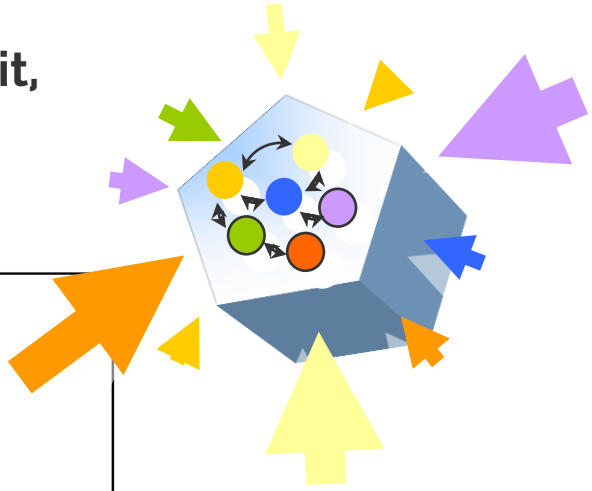
## Two levels of classification

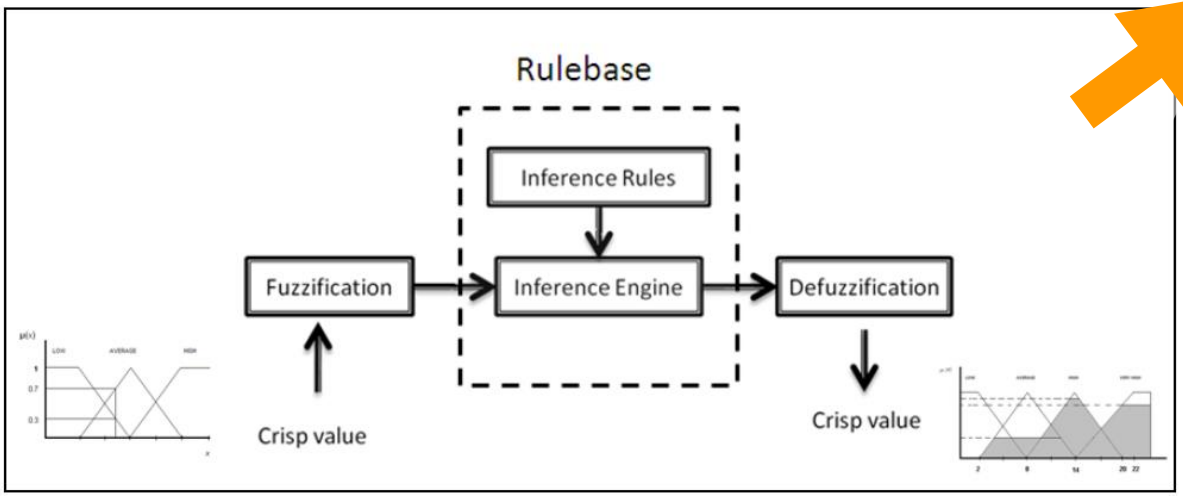
| Type | Level | Ranges / COSMIC Equivalent | min CFP | most likely | max CFP |
|---|---|---|---|---|---|
| Functional Process | Small | 1 - 5 Data movements | 2.0 | 3.9 | 5.0 |
| | Medium | 5 - 8 Data movements | 5.0 | 6.9 | 8.0 |
| | Large | 8 - 14 Data movements | 8.0 | 10.5 | 14.0 |
| | Very large | 14+ Data movements | 14.0 | 23.7 | 30.0 |
| Typical process | Small | CRUD (Small/Medium processes)<br>CRUD + List (Small processes) | 15.6 | 20.4 | 27.6 |
| | Medium | CRUD (Medium/Large processes)<br>CRUD + List (Medium processes)<br>CRUD + List + Report (Small processes) | 27.6 | 32.3 | 42.0 |
| | Large | CRUD (Large processes)<br>CRUD + List (Medium/Large processes)<br>CRUD + List + Report (Medium processes) | 42.0 | 48.5 | 63.0 |
| General process | Small | 6 -10 Generic FP's | 20.0 | 60.0 | 110.0 |
| | Medium | 10 - 15 Generic FP's | 40.0 | 95.0 | 160.0 |
| | Large | 15 - 20 Generic FP's | 60.0 | 130.0 | 220.0 |
| Macro process | Small | 2 - 4 Generic GP's | 120.0 | 285.0 | 520.0 |
| | Medium | 4 - 6 Generic GP's | 240.0 | 475.0 | 780.0 |
| | Large | 6 - 10 Generic GP's | 360.0 | 760.0 | 1,300 |

# EPCU Approximation



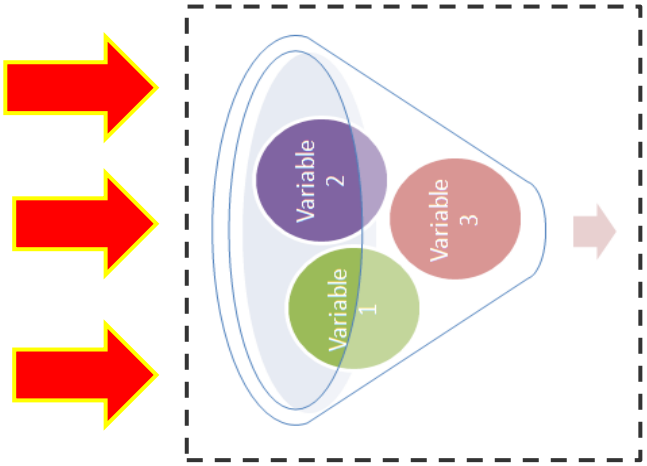
"The Uncertainty: it is not possible to measure it, however it is possible to contextualize it"



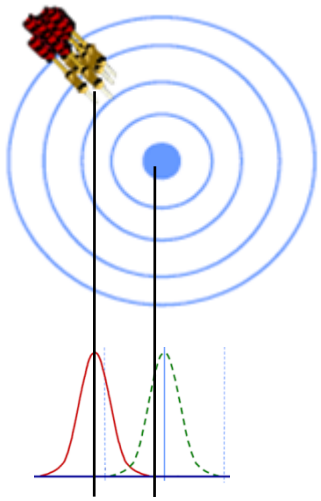



EPCU: Estimation of Projects in a Context of Uncertainty

# EPCU Approximation

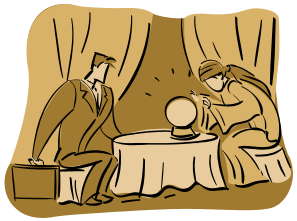



Generador de Estimados



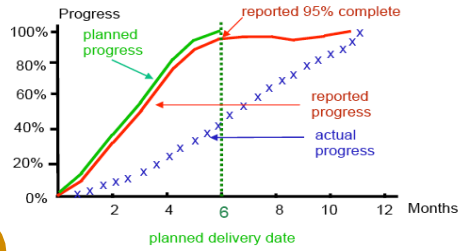
More details in the 15.30 workshop by

# Earned Scope Management

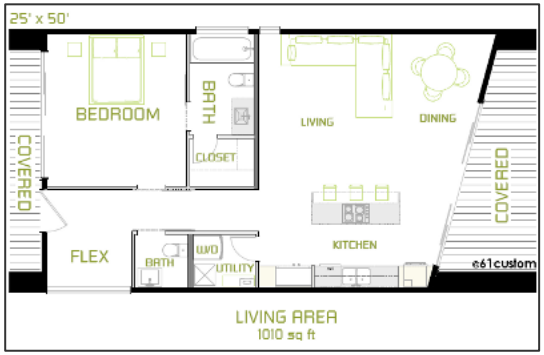


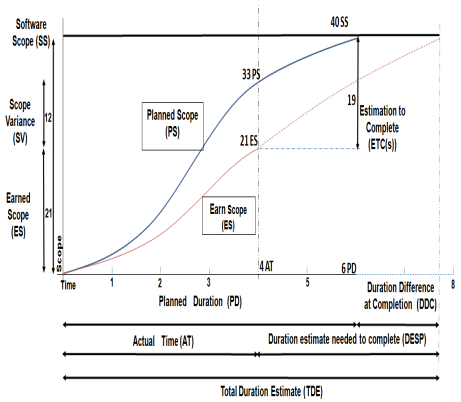
## Craft

## or




## Engineering



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http://www.syerasite.com/how-to-choose-home-design-house-plans/3d-home-plans-1-2/

COSMIC



# QUESTIONS?

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