

Towards a Complete Earned Value Analysis

Presented by

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Fundamental Rule of Production

The determining factors of a productive process are:

- Its efficiency
- Its level of activity

Efficiency and Activity

Efficiency

(Output against Input)

- Litters per machine hour
- Tonnes per truck cycle
- Cubic meters per work hour
- Progress against Effort
- Meters per stroke (stroke length)

Activity

(Level of intensity of effort)

- Machine hours per unit time
- Truck Cycles per day
- Work hours per day (attendance)
- Effort per day
- Strokes per second (arm pulls & 2)

Example 1 – Generator Assembly Line



- This generator machine might have a high rate of unit per working hour. (High working efficiency)
- However, what if it breaks down frequently (has a low activity level)?

This would offset overall performance (schedule) measures

Example 2



- This man can lay 4 square meters of concrete per hour.
- He works an average of 6 hours per day



- This man can lay 3 square meters of concrete per hour.
- He works an average of 8 hours per day

Example 3 – Sydney Olympics 2000



Michael Klim

X meters per free-style stroke

Y strokes per second

Pieter van den Hoogenband

$2 * X$ meters per free-style stroke

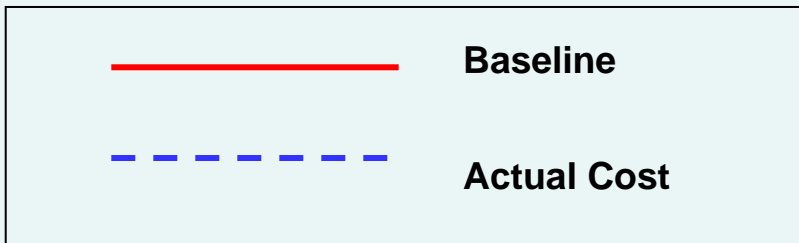
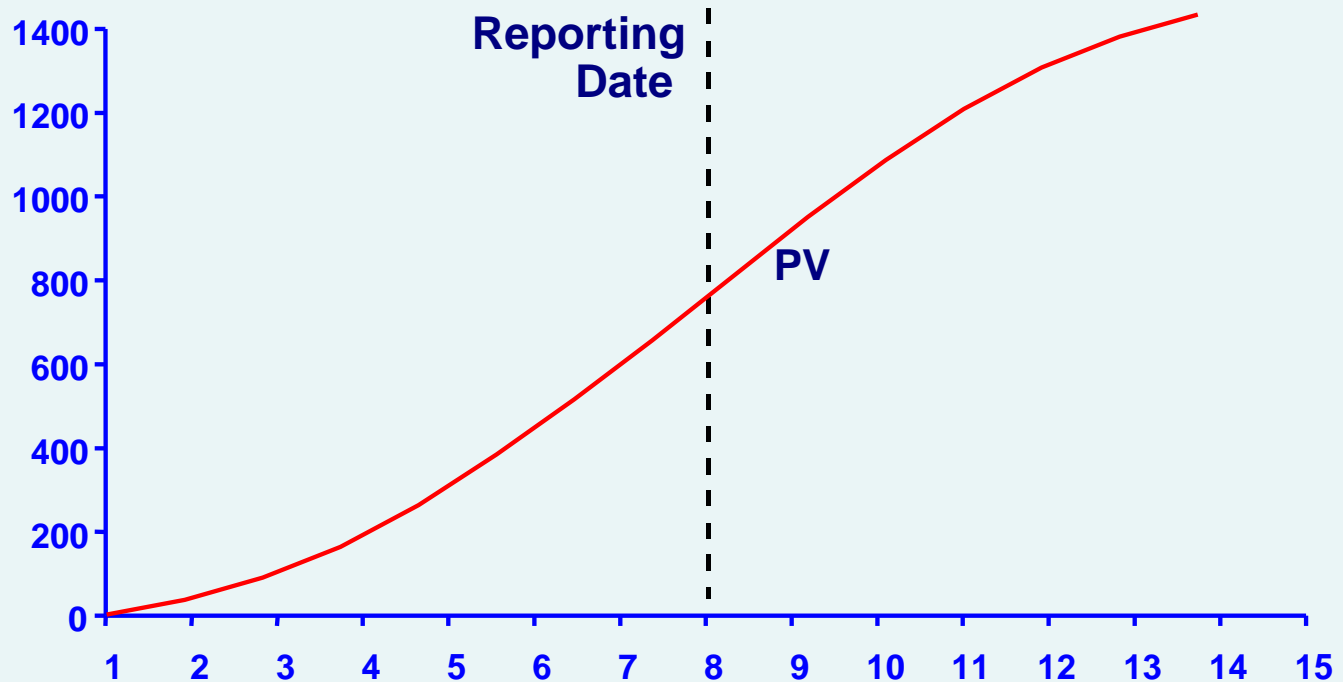
$Y/2$ strokes per second

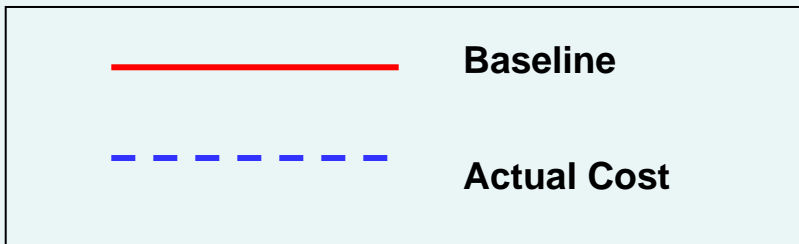
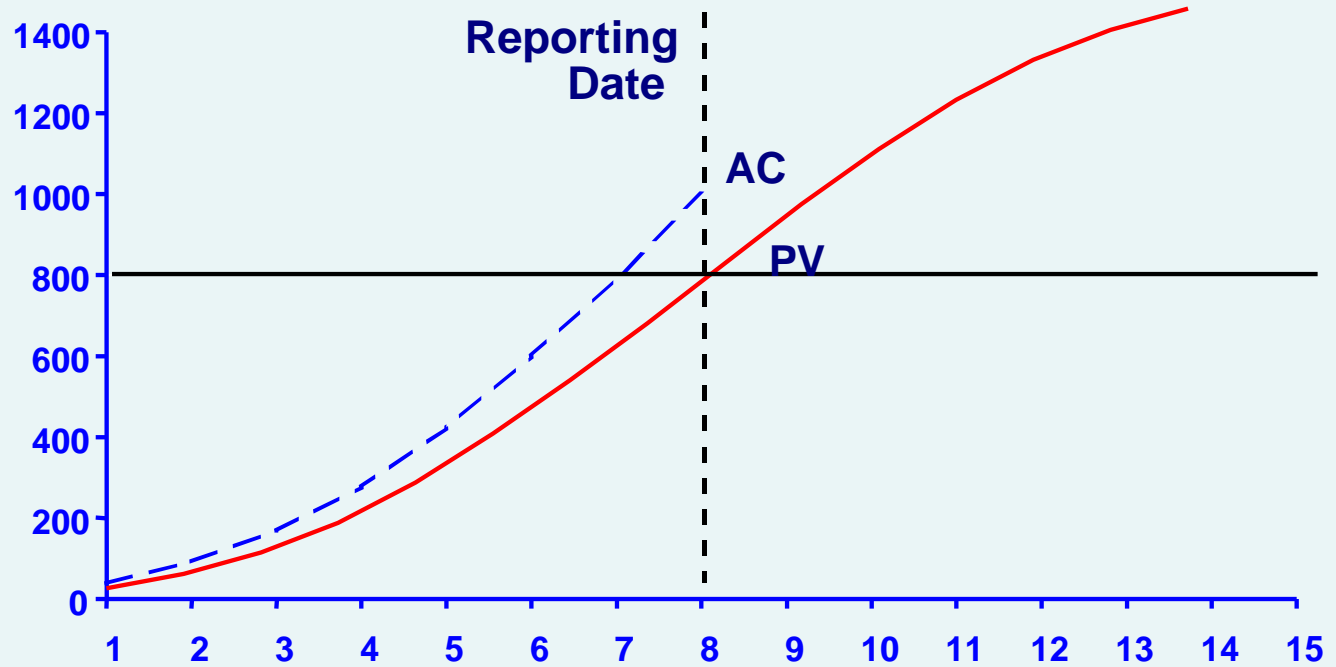
Extension of Fundamental Rule of Production

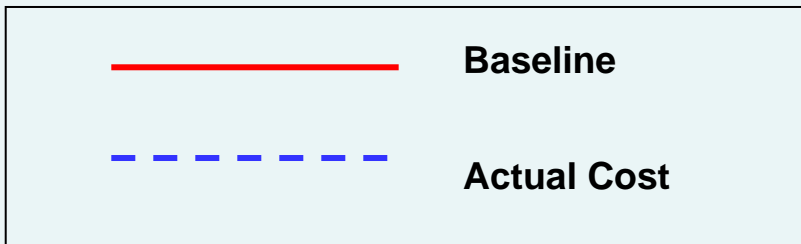
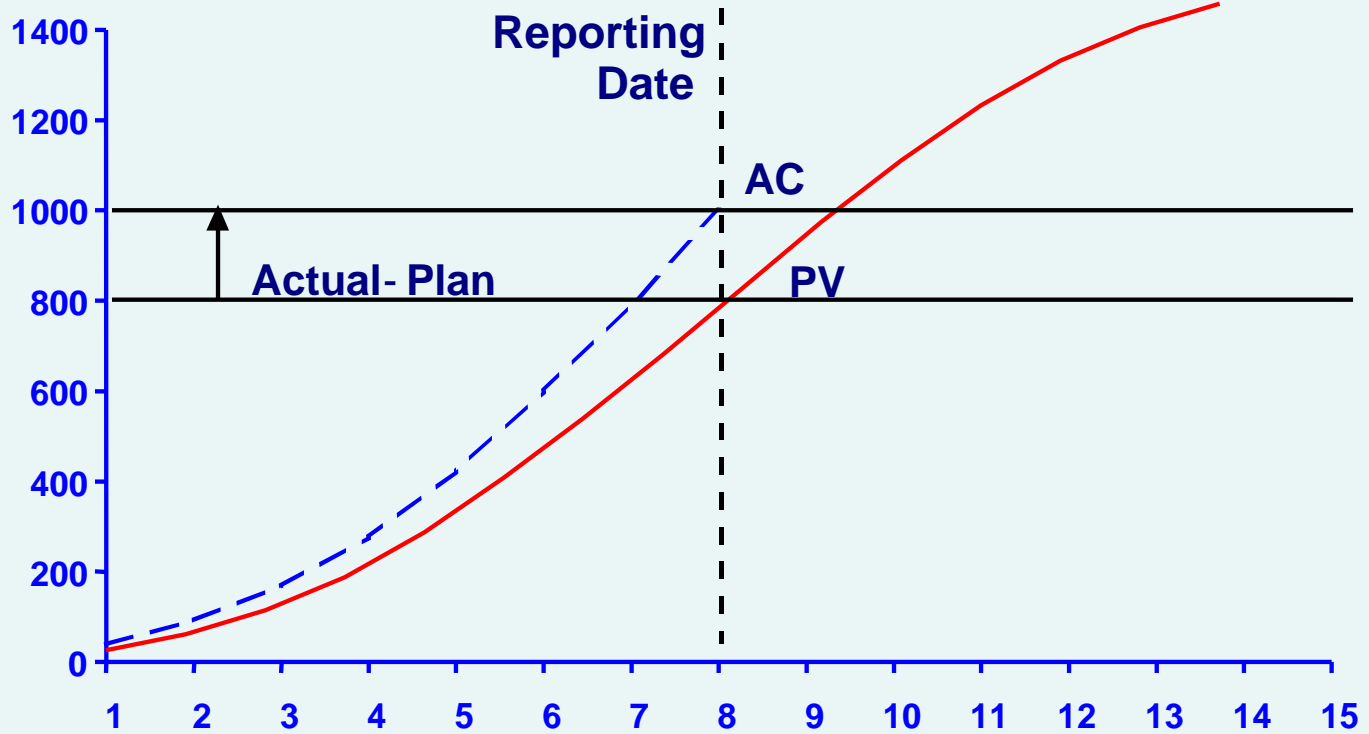
The determining factors of a productive schedule are:

- Its efficiency
- Its level of activity after start
- Punctuality of start

Planned Value at each point of time is the value (cost) of the work planned to be completed at that point.

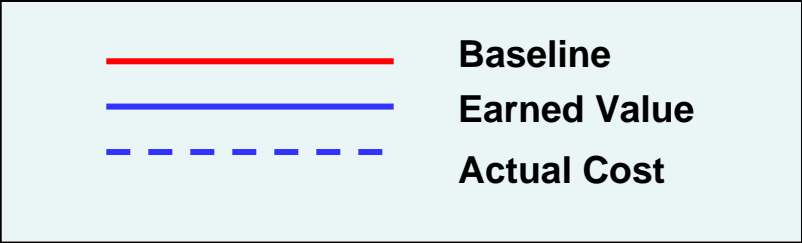
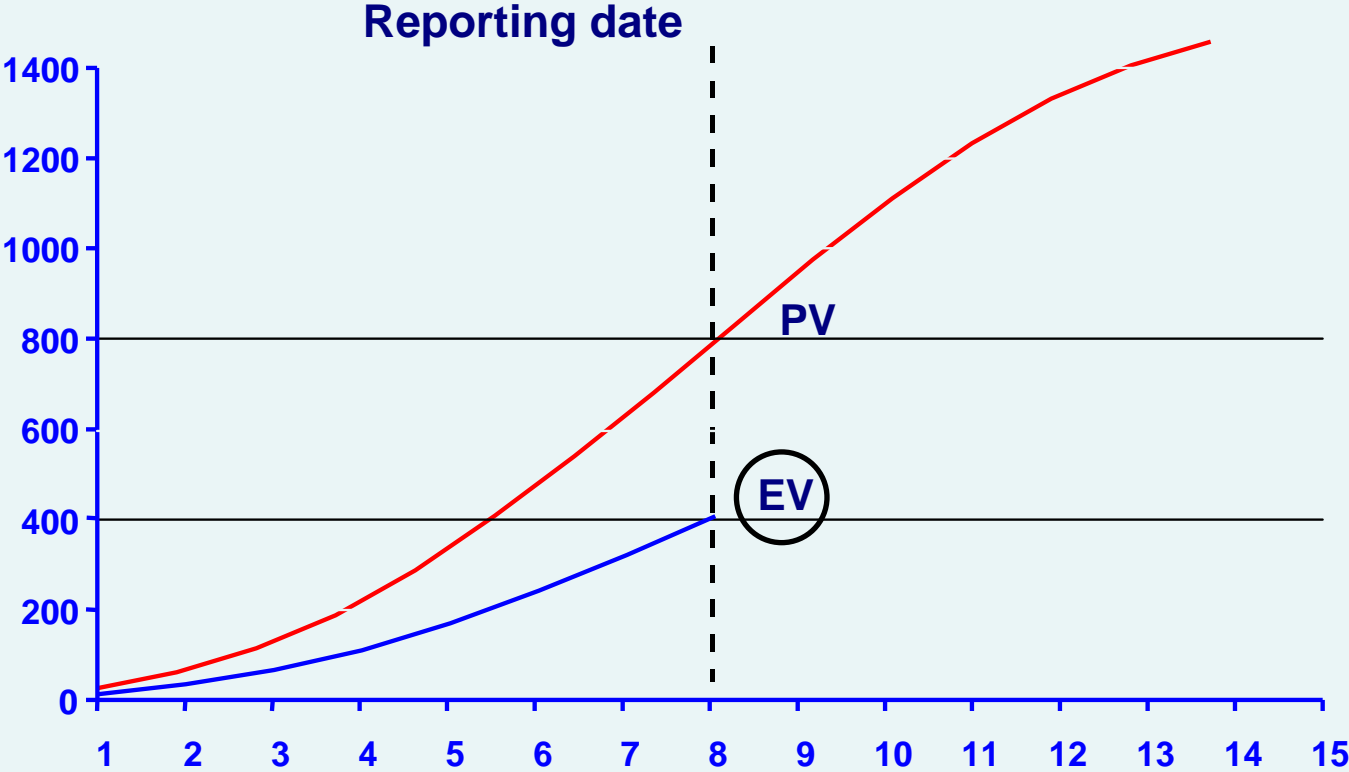






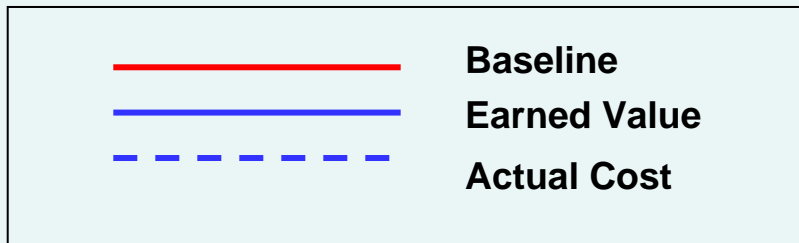
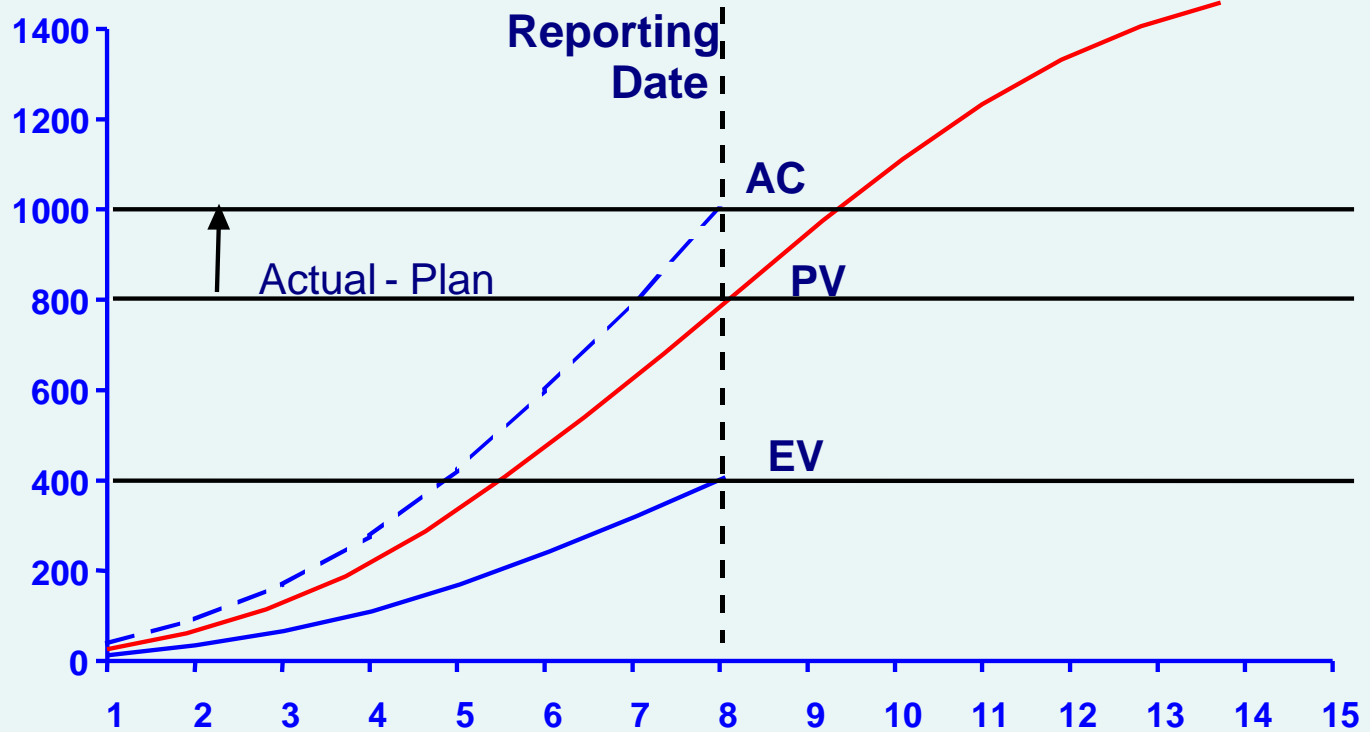
Introducing Earned Value

Planned Value at each point of time is the value (cost) of the work planned to be completed at that point.

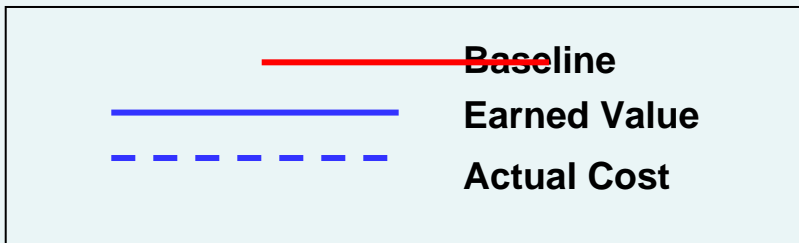
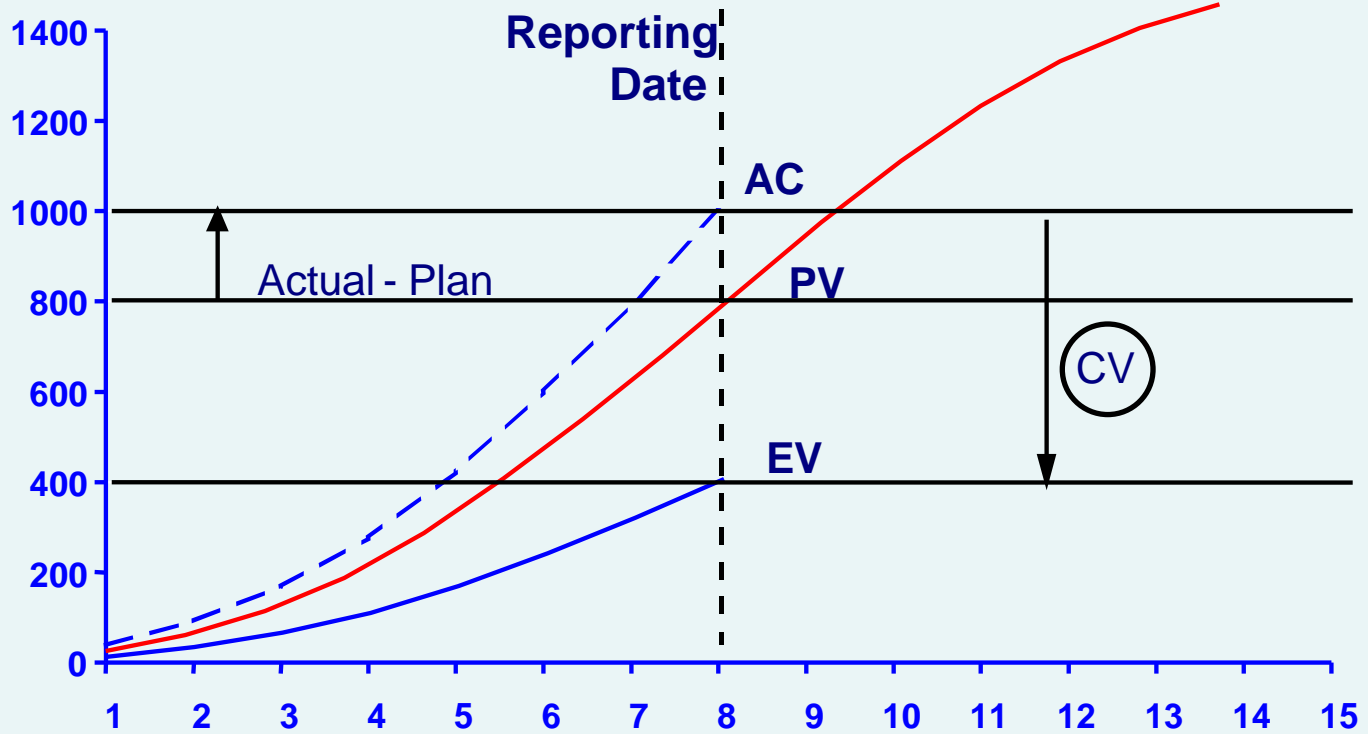


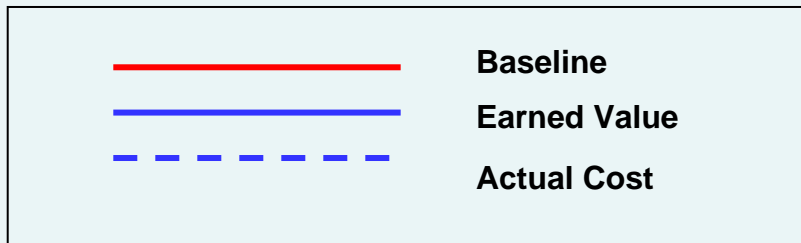
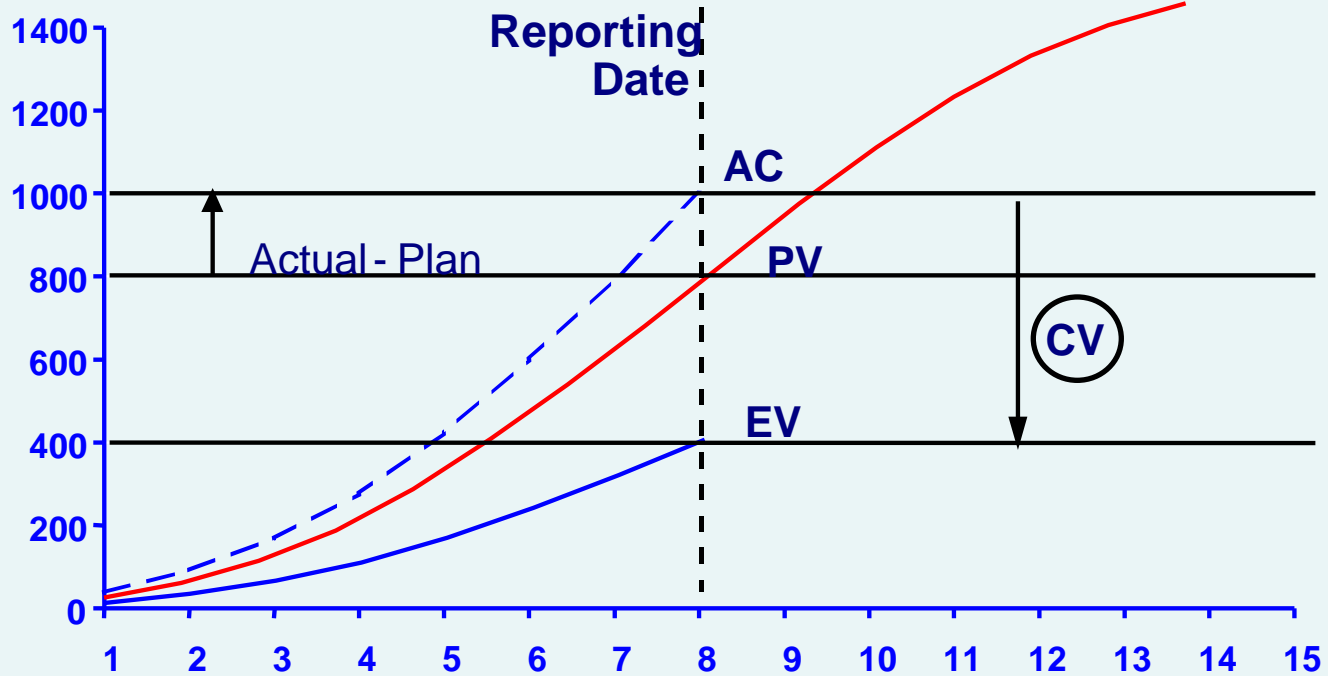
Earned Value at each point of time is the value (cost) of the work that has been completed at that point.

Planned Value at each point of time is the value (cost) of the work planned to be completed at that point.

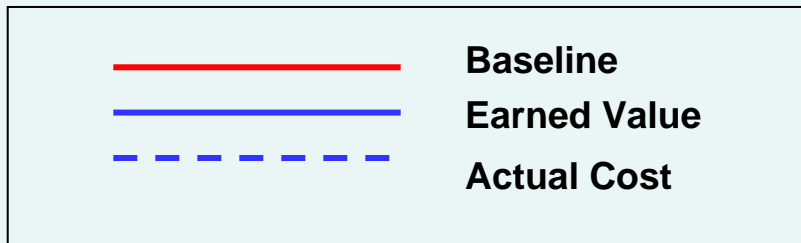
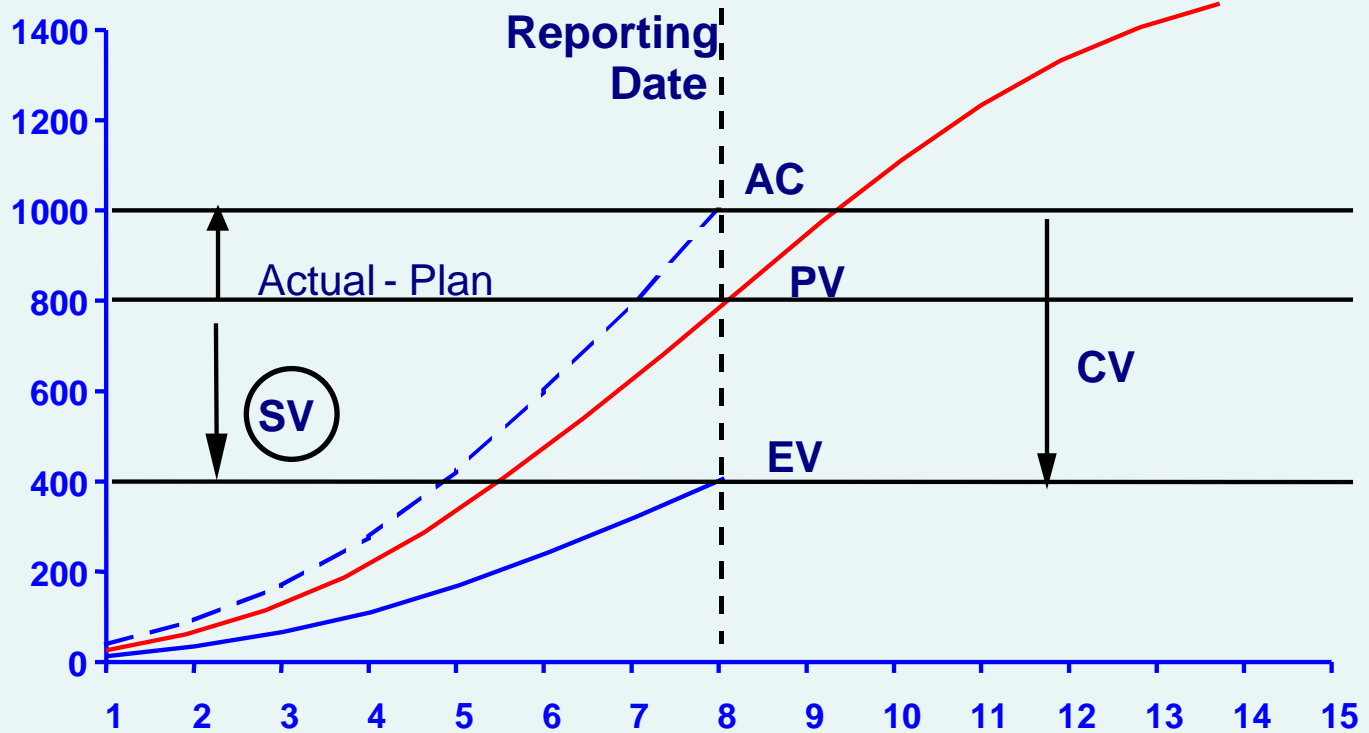


Earned Value at each point of time is the value (cost) of the work that has been completed at that point.

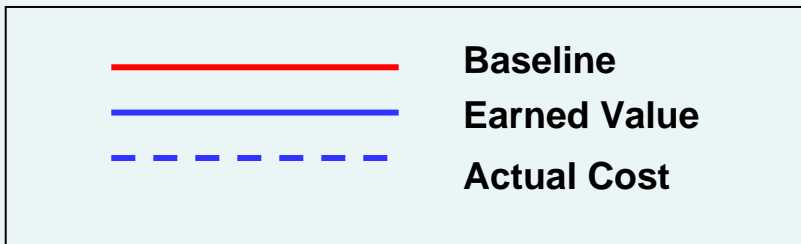
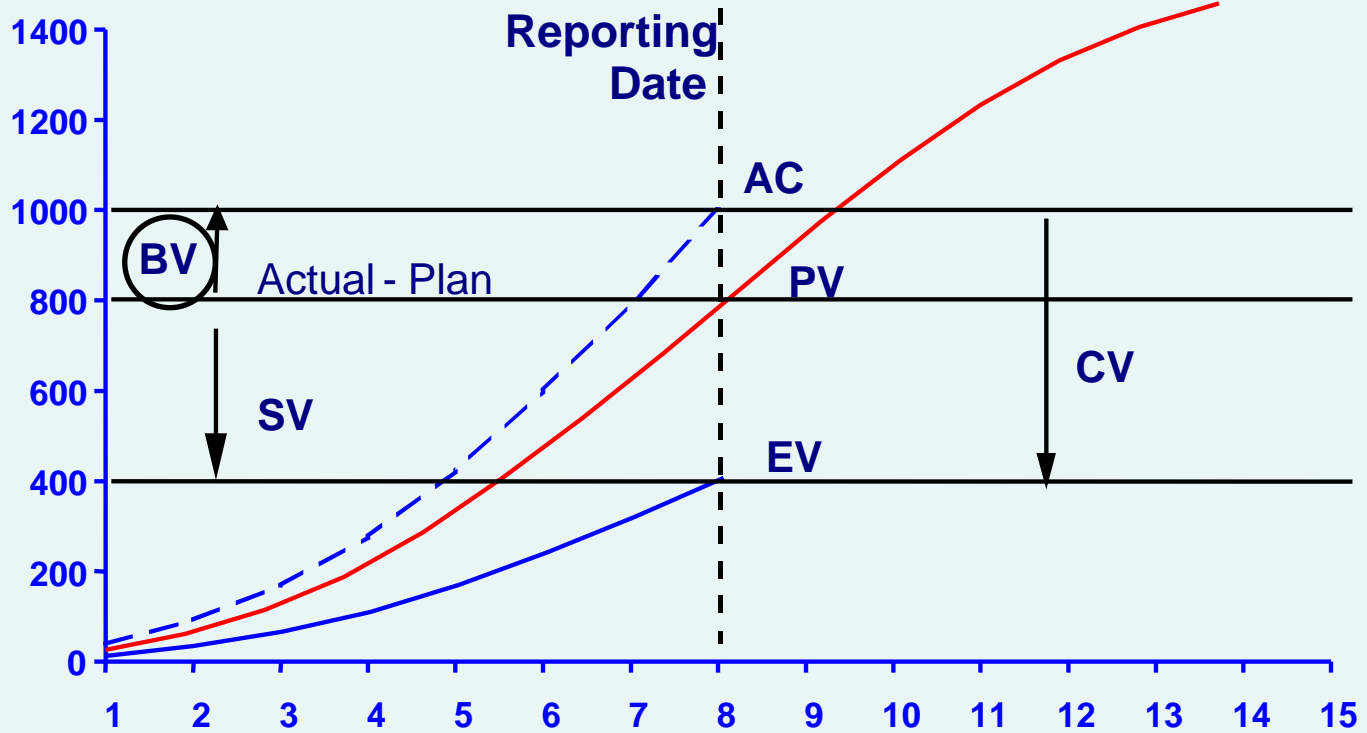




Cost Variance is the difference between Earned Value and Actual Cost. It is a measure of efficiency of work completed.



Schedule Variance is the difference between Earned Value and Planned Value. It is a measure of the degree to which baseline schedule is met.



Variations

- Cost Variance

$$CV = EV - AC$$

- Schedule Variance

$$SV = EV - PV$$

Indexes

- Cost Performance Index

$$\text{CPI} = \text{EV} / \text{AC}$$

- Schedule Performance Index

$$\text{SPI} = \text{EV} / \text{PV}$$

Plan vs Actual

A New Interpretation

'Budget Variance'

$$\text{Let } BV = AC - PV$$

'Budget Performance Index'

$$\text{Let } BPI = AC / PV$$

These are measures of Activity (Attendance)

Decomposition Formulae

$$\text{SPI} = \text{EV} / \text{PV}$$

$$\text{CPI} = \text{EV} / \text{AC}$$

$$\text{BPI} = \text{AC} / \text{PV}$$

Therefore:

$$\text{SPI} = \text{CPI} * \text{BPI}$$

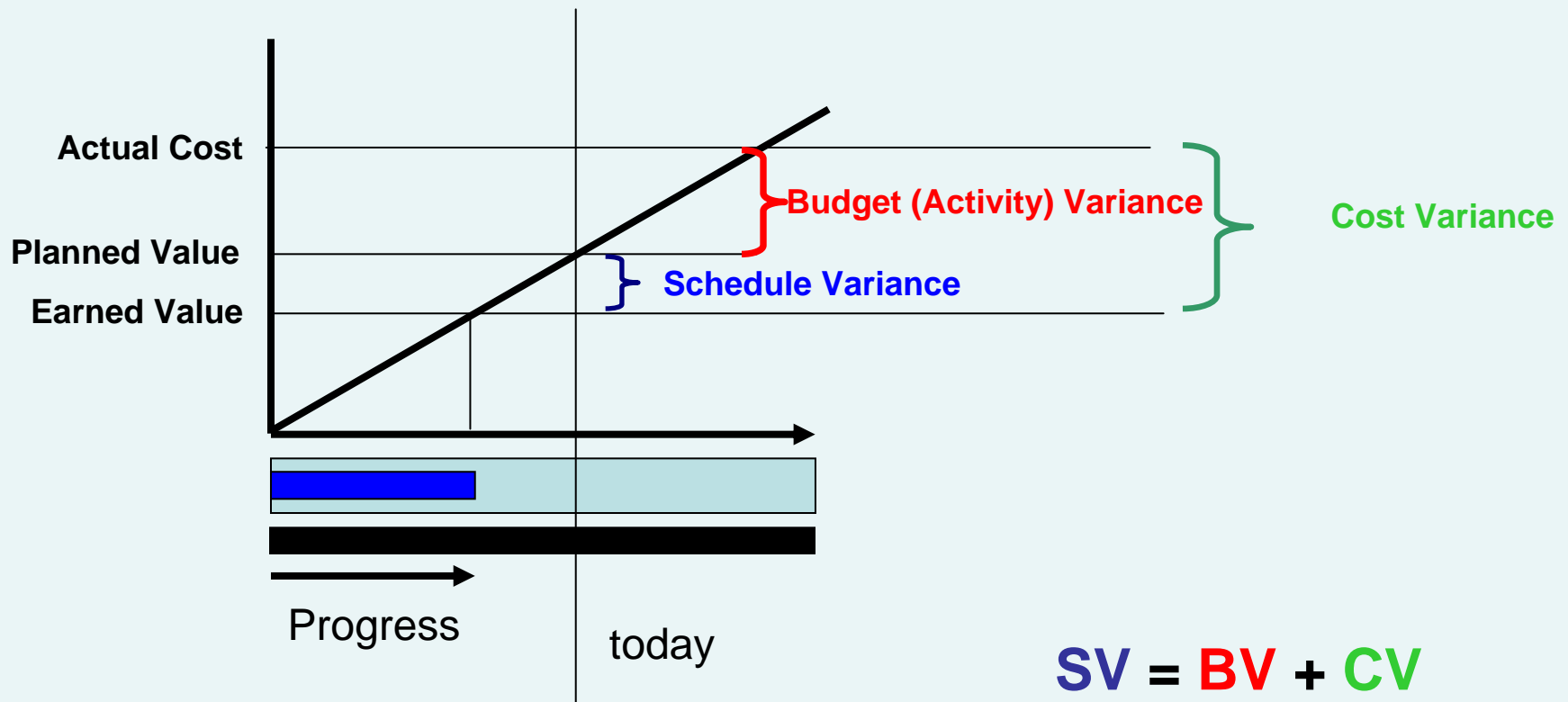
Or

$$\text{Schedule Performance} = \text{Efficiency} * \text{Attendance}$$

(i.e. delays are caused by a combination of inefficiency and lack of attendance – as in the swimming example)

The determining factors of a productive process are:

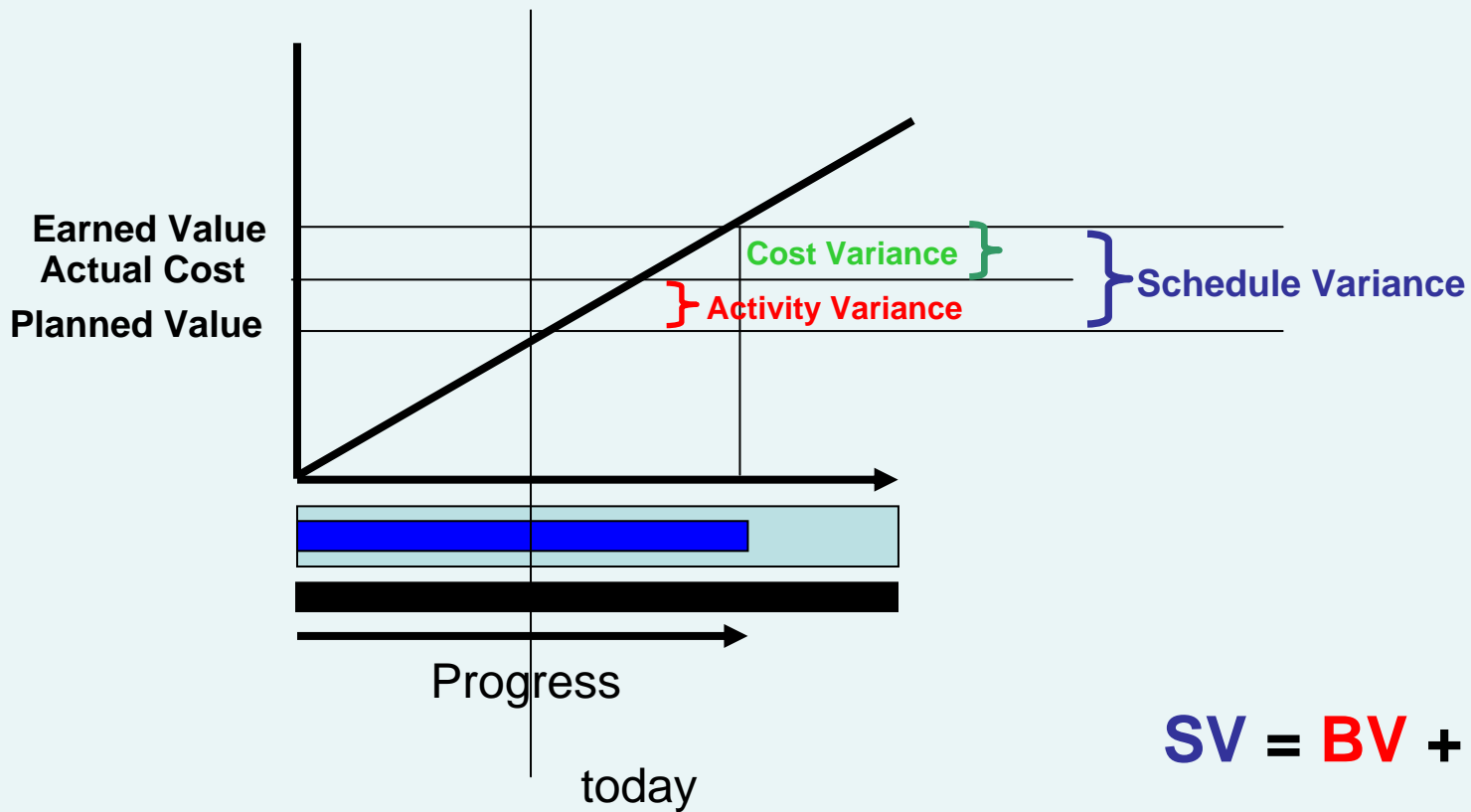
- Its efficiency
- Its level of activity



What has led to a negative schedule variance?

Inefficient but highly active which almost compensates

Case Study 1

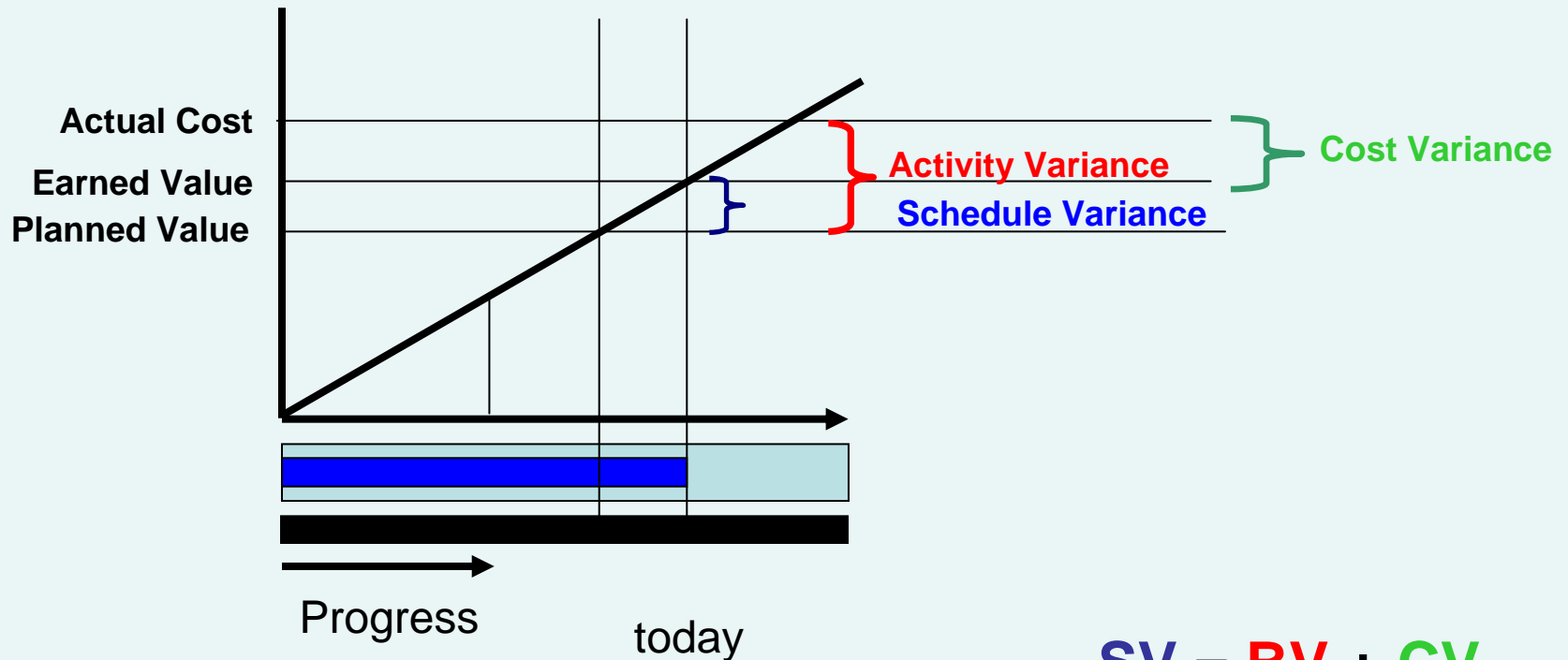


$$SV = BV + CV$$

What has led to a positive schedule variance

Efficient and active which re-enforce

Case Study 2



$$SV = BV + CV$$

What has led to a positive schedule variance?

Very active but dragged back by inefficiency

Case Study 3

| Variable | Value | Description | Formula |
|---------------------------------|--------------|--------------------------------------|----------------|
| Current Date | Day 7 | 7 days elapsed since BS start | |
| Baseline Duration | 10 d | Original baseline duration | |
| BAC | 10000 | Budget at Completion | |
| Percent Complete | 50% | Progress to date | |
| EV | 5000 | Earned Value | |
| PV | 7000 | Planned Value | |
| AC | 4500 | Actual Cost | |
| CV | 500 | Cost Variance | EV-AC |
| SV | -2000 | Schedule Variance | EV-PV |
| CPI | 1.11 | Cost Performance Index | EV/AC |
| SPI | 0.714 | Schedule Performance Index | EV/PV |
| | | | |
| Non-Standard Refinements | | | |
| BV | -2500 | | AC-PV |
| BPI | 0.643 | | AC/PV |
| | | | |

$$\mathbf{SPI = CPI * BPI}$$

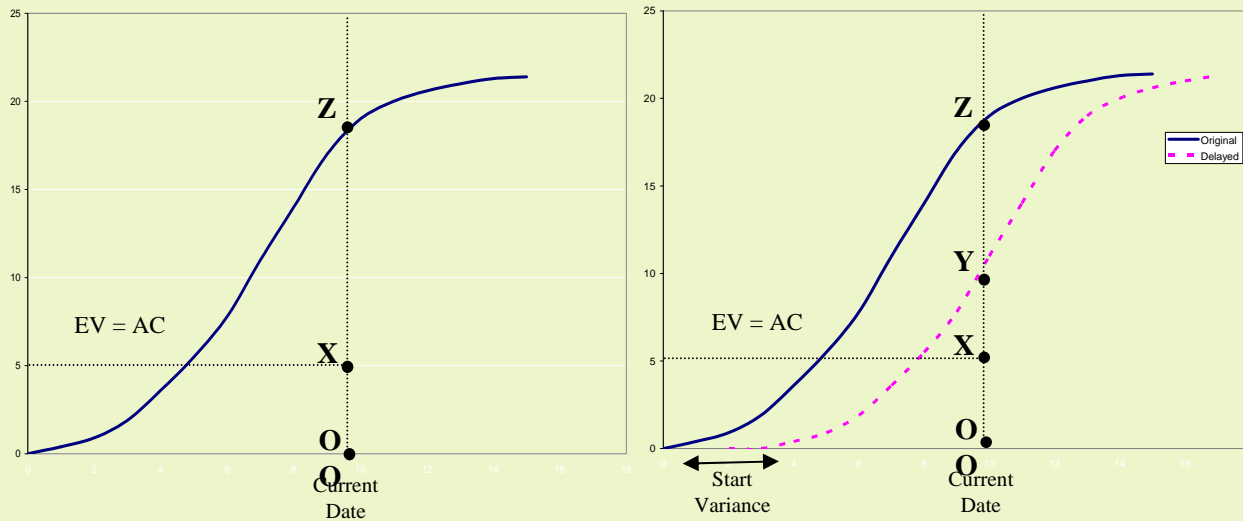
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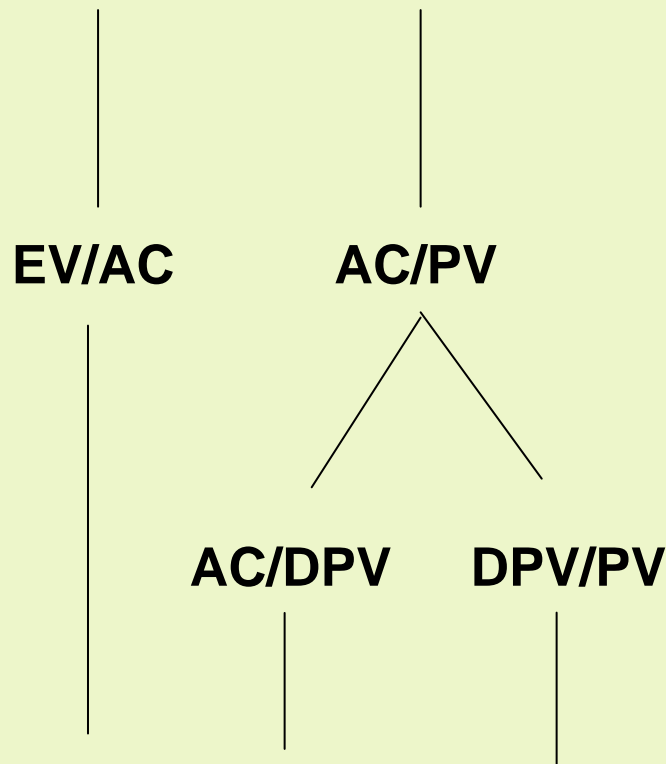
Refinement 2 – Start Variance

Define Delayed Planned Value (DPV) to be PV offset by start variance



Incorporating Start Delays

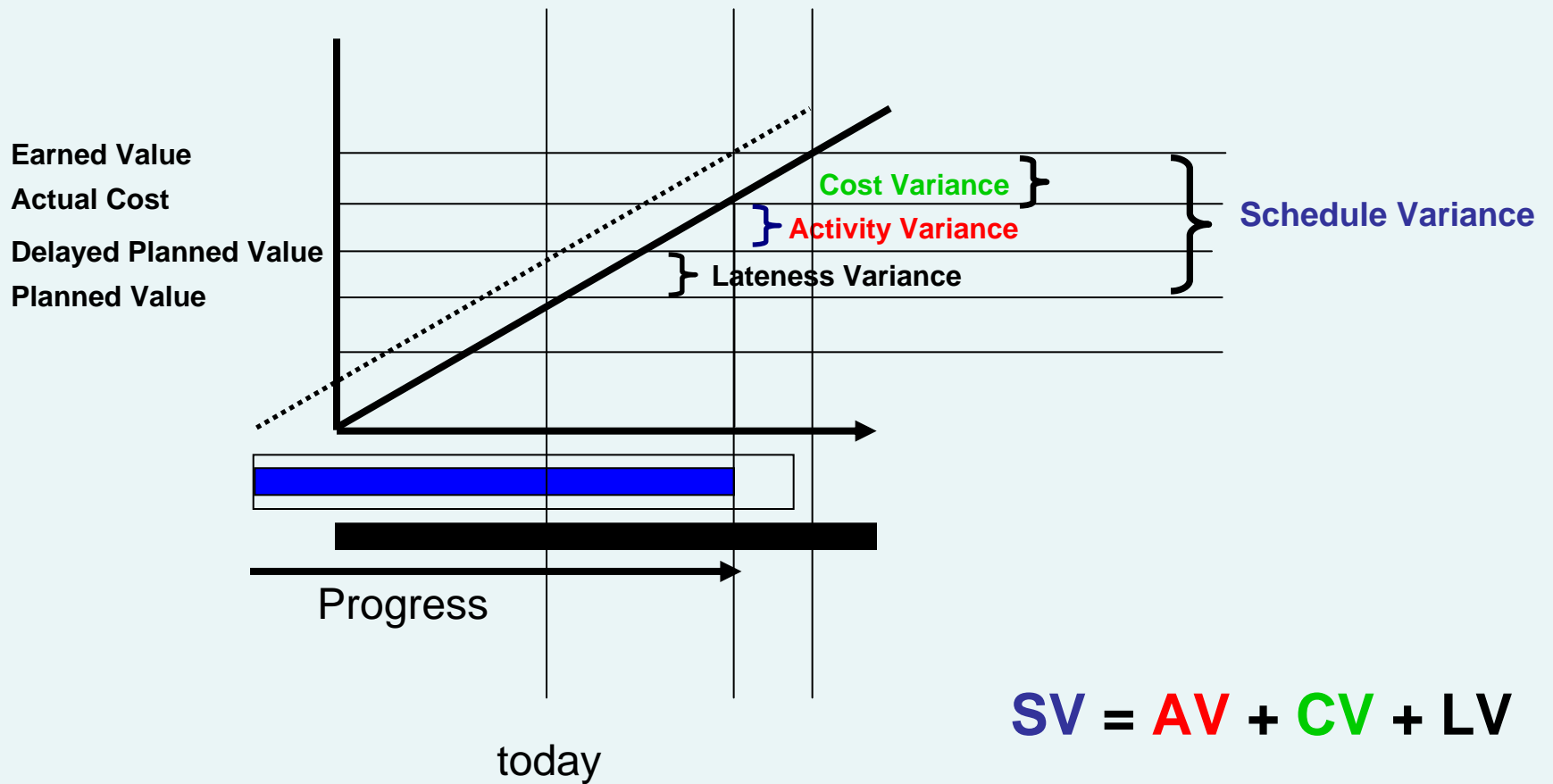
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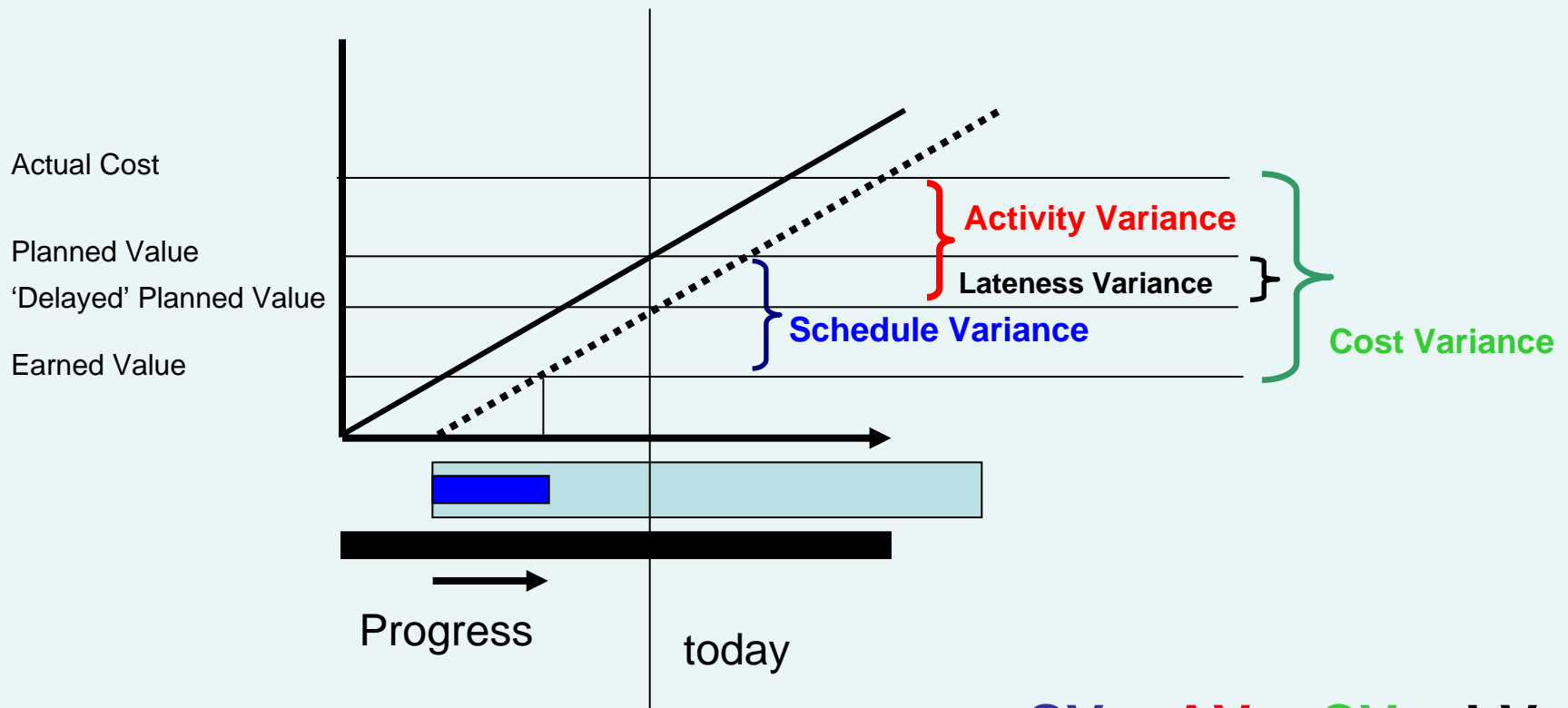
$$\text{SPI} = \text{CPI} * \text{API} * \text{PPI}$$



Why are we so far ahead of schedule (big positive SV?)

All measures are good and contribute to an early finish

Case Study 4



$$SV = AV + CV + LV$$

Why are we so far behind schedule (big negative SV?)

Late and inefficient but helped by high post-start activity

Case Study 5

Non-Standard Refinements

| Variable | Value | Description | Formula |
|------------|-----------------|--------------------------------------|------------------------|
| DPV | 5000 | Delayed Planned Value (2 day delay) | |
| PPI | 0.714 | Punctuality Performance Index | DPV/PV |
| SPI | 0.714285 | 01.11 * 0.643 | CPI * BPI |
| API | 0.9 | Activity Performance Index | AC/DPV |
| SPI | 0.714285 | 1.11 * 0.9 * 0.714 | CPI * API * PPI |
| CPI | 1.11 | Cost Performance Index | EV/AC |
| AV | -500 | Activity Variance | AC-DPV |
| DRV | 0 | Duration Variance | CV + AV |
| DPI | 1 | Duration Performance Index | CPI * API |

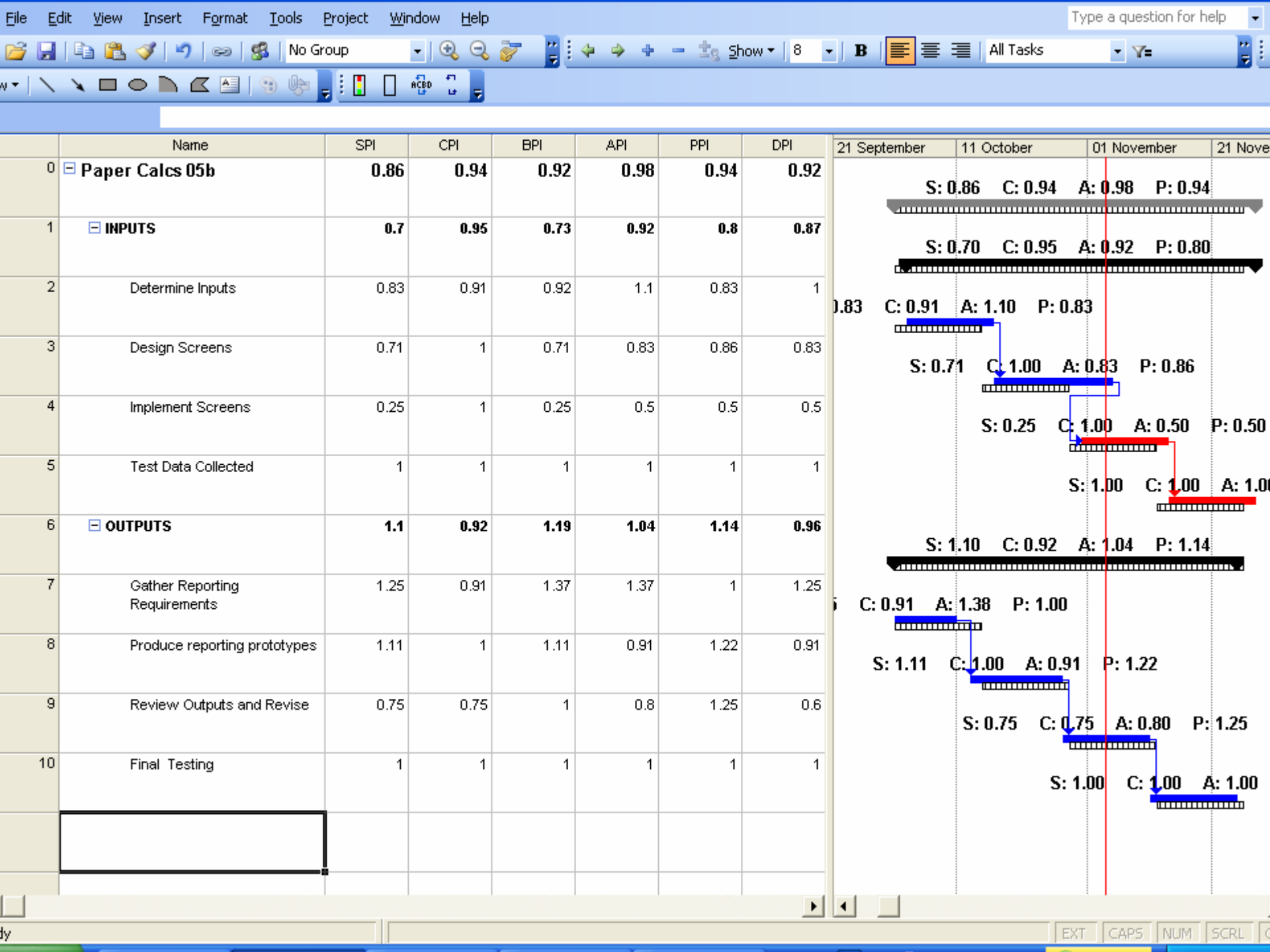
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| DRV | 0 | Duration Variance | CV + AV |
| DPI | 1 | Duration Performance Index | CPI * API |

$$SPI = \underbrace{CPI * API}_{DPI} * PPI$$

$$SPI = DPI * PPI$$



| | EV | AC | PV | DPV | CV | SV | CPI | SPI | BPI | API | DPI | PPI |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-----|-----|-----|-----|-----|-----|
| 0 | \$44,000.00 | \$47,000.00 | \$51,000.00 | \$48,000.00 | -\$3,000.00 | -\$7,000.00 | ● | ● | ● | ● | ● | ● |
| 1 | \$21,000.00 | \$22,000.00 | \$30,000.00 | \$24,000.00 | -\$1,000.00 | -\$9,000.00 | ● | ● | ● | ● | ● | ● |
| 2 | \$10,000.00 | \$11,000.00 | \$12,000.00 | \$10,000.00 | -\$1,000.00 | -\$2,000.00 | ● | ● | ● | ● | ● | ● |
| 3 | \$10,000.00 | \$10,000.00 | \$14,000.00 | \$12,000.00 | \$0.00 | -\$4,000.00 | ● | ● | ● | ● | ● | ● |
| 4 | \$1,000.00 | \$1,000.00 | \$4,000.00 | \$2,000.00 | \$0.00 | -\$3,000.00 | ● | ● | ● | ● | ● | ● |
| 5 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | ● | ● | ● | ● | ● | ● |
| 6 | \$23,000.00 | \$25,000.00 | \$21,000.00 | \$24,000.00 | -\$2,000.00 | \$2,000.00 | ● | ● | ● | ● | ● | ● |
| 7 | \$10,000.00 | \$11,000.00 | \$8,000.00 | \$8,000.00 | -\$1,000.00 | \$2,000.00 | ● | ● | ● | ● | ● | ● |
| 8 | \$10,000.00 | \$10,000.00 | \$9,000.00 | \$11,000.00 | \$0.00 | \$1,000.00 | ● | ● | ● | ● | ● | ● |
| 9 | \$3,000.00 | \$4,000.00 | \$4,000.00 | \$5,000.00 | -\$1,000.00 | -\$1,000.00 | ● | ● | ● | ● | ● | ● |
| 10 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$0.00 | ● | ● | ● | ● | ● | ● |

Incorporating Scope Change

$$\text{SPI} = \text{CPI} * \text{BPI}$$

EV/AC

AC/PV

AC/DPV

DPV/PV

$$\text{SPI} = \text{CPI} * \text{API} * \text{PPI}$$

Incorporating Scope Change

$$\text{SPI} = \text{CPI} * \text{API} * \text{PPI}$$

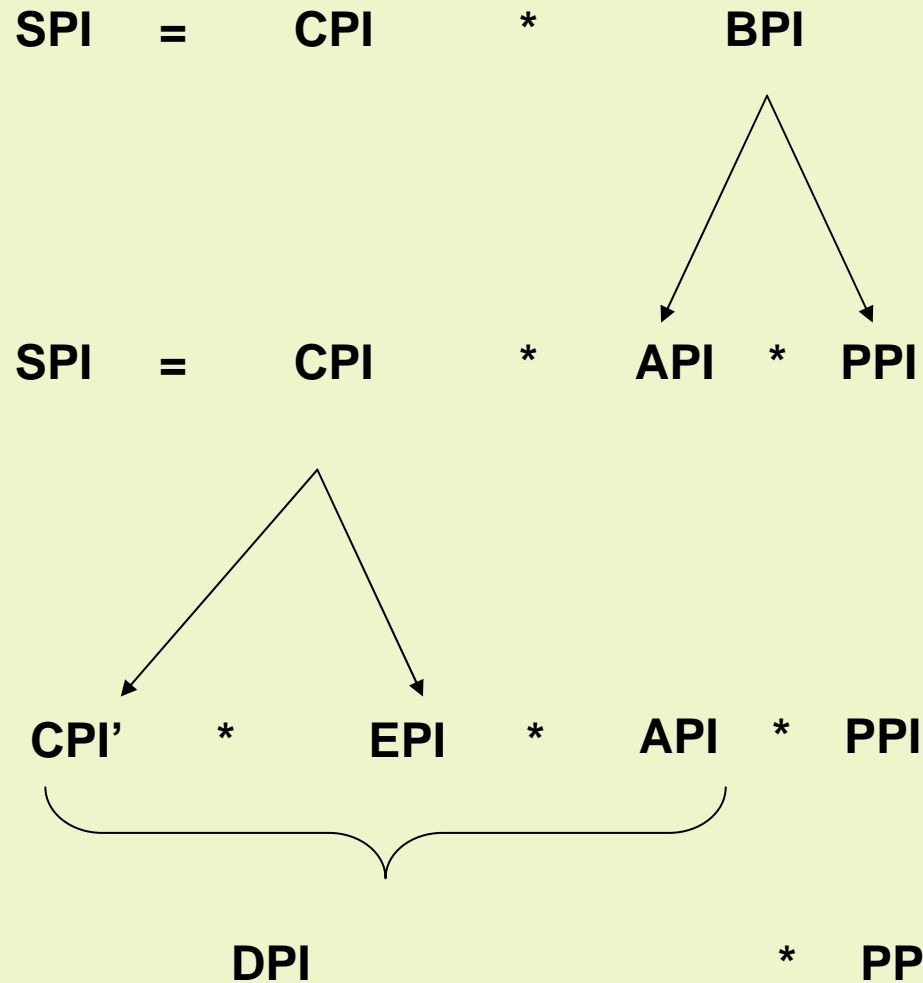
$$\text{EV} / \text{AC}$$

$$\text{EV}' * \text{EPI} / \text{AC}$$

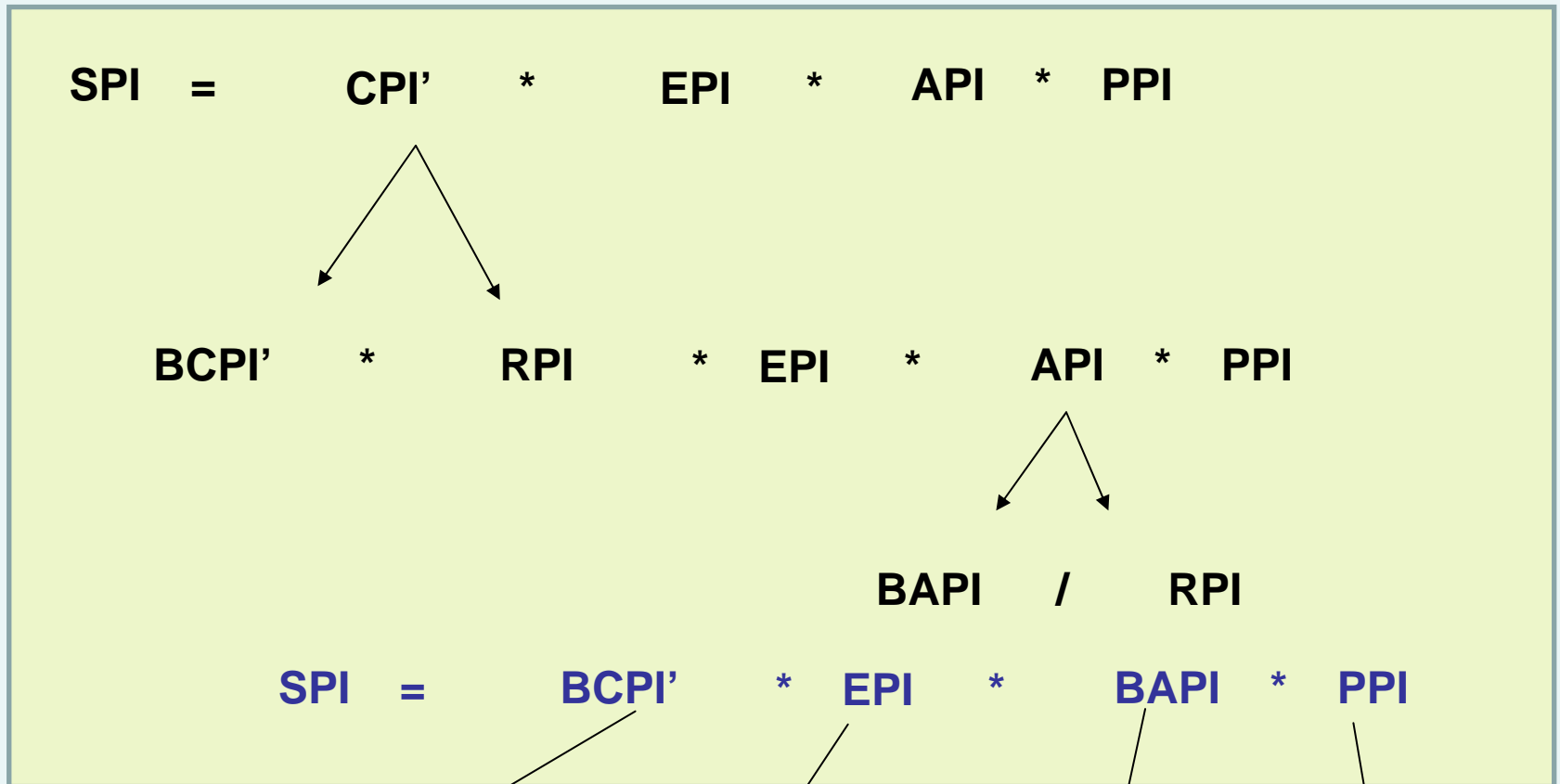
$$\text{EV}' / \text{AC} * \text{EPI}$$

$$\text{SPI} = \text{CPI}' * \text{EPI} * \text{API} * \text{PPI}$$

SPI - Further Decompositions



Incorporating Rate Changes



Cost efficiency Stripped of rate and estimate changes

Scope or Estimate Change

Attendance stripped of rate and start delays

Delay

Thank You!