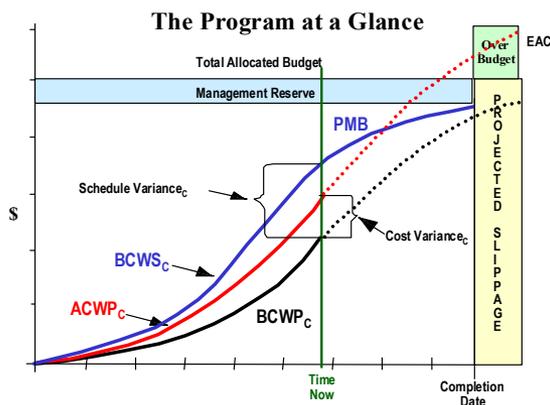




# 2003

## Business Manager's Conference

### Earned Value Management “Fundamentals”



**Bob Carlson, PMP**

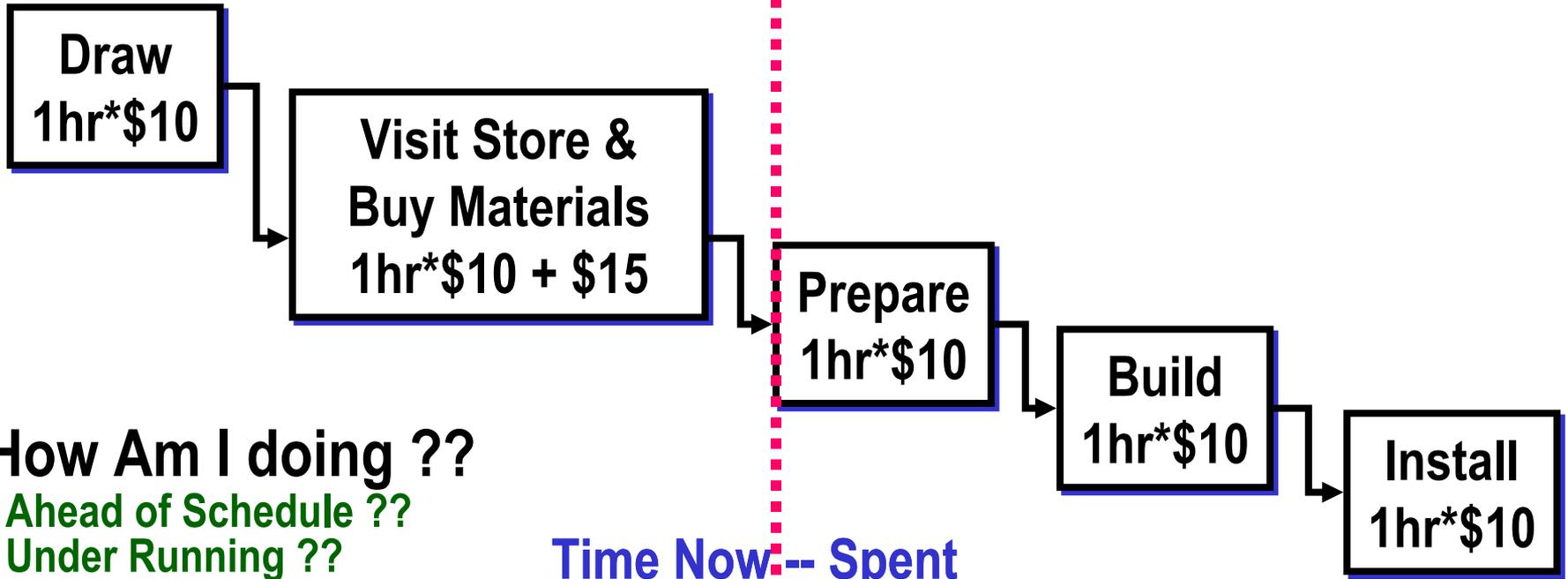
Building 204 // Room 210

703.805.4601 DSN 655

Bob.Carlson@dau.mil



# Build A Birdhouse



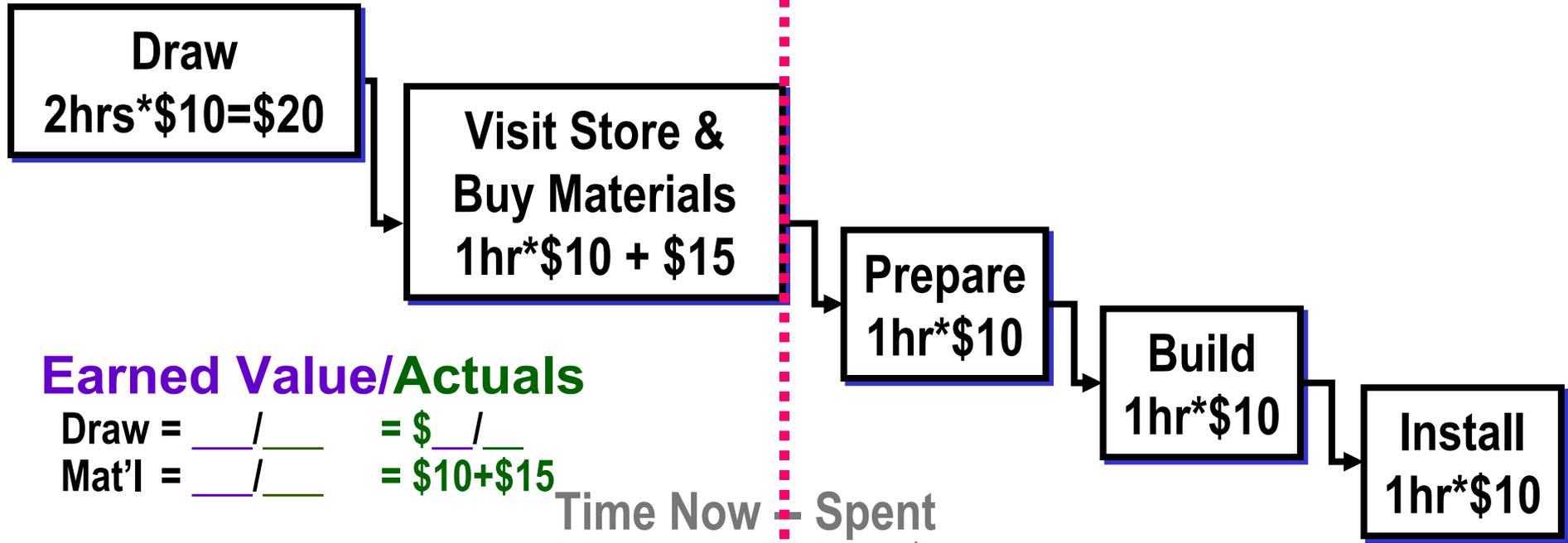
How Am I doing ??  
 Ahead of Schedule ??  
 Under Running ??

Time Now	--	Spent
Labor		= \$ <u>30</u>
Materials		= \$ <u>15</u>
Total		= \$ <u>45</u>

Labor = 5 hours @ \$10/hr	= \$ <u>50</u>
Materials	= \$ <u>15</u>
	\$ <u>65</u>



# Build A Birdhouse



## Earned Value/Actuals

Draw =      /      = \$      /       
 Mat'l =      /      = \$ 10 + \$15

## Now What ??

Over Run =       
 Schedule =     

Time Now	Spent
Labor	= \$ <u>30</u>
Materials	= \$ <u>15</u>
Total	= \$ <u>45</u>

Labor = 5 hours @ \$10/hr	= \$ <u>50</u>
Materials	= \$ <u>15</u>
	\$ <u>65</u>



# Software Development

**Design**  
1hr = \$10

**Code**  
3hrs\*\$10 + \$15

**ORD** = Manage 5 priorities simultaneously  
Currently = Manage 4 priorities

In 6 months = New Processor Speed  $\leq 5 = P^3!$

**GAIN & Risk**

Plan = BCWS

Labor = \$20  
Materials = \$15  
Total = \$35

Actuals = ACWP

Labor = \$40  
Materials = \$15  
Total = \$55

Earned Value = BCWP (0/100)

Labor = \$10  
Materials = \$15  
Total = \$25

**Integrate**  
1hr\*\$10

**Test**  
1hr\*\$10

**Install**  
1hr\*\$10

**Now What ??**

Over Running = \$20+  
Schedule = +2hrs+

**EAC**

Labor = 5 + 2hrs = \$70  
Materials = \$15  
\$85+

Today

Ahead ??



# EARNED VALUE CONCEPT

**A Management Technique**

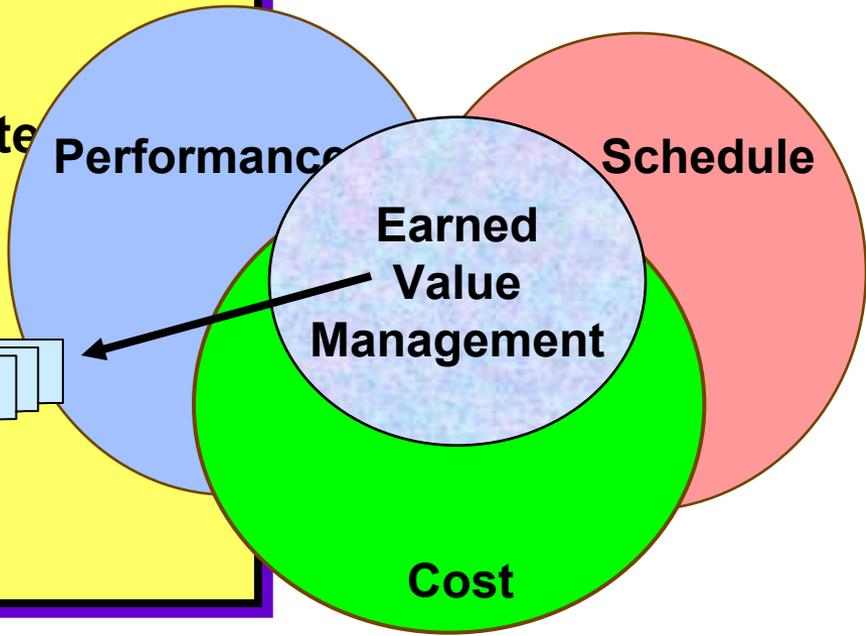
Emphasizes Disciplined Integration of Technical Performance to Associated **Co\$t** & Schedule

‘Objectively’ Measures Work Progress  
States ‘Value of Work’ Complete

Provides ‘Objective’ Cost & Schedule Metrics

Enables Trend Analysis & **CAIV** Trades

Industry Standard **ANSI/EIA-748-1998**

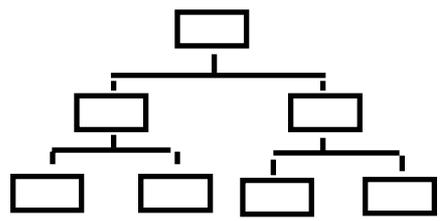


**DoD & Industry Embrace EARNED VALUE as a Risk Management tool**



# Integrated Program Management System

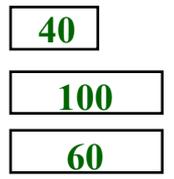
## Scope



MNS / ORD / **APB** / PMD  
ID 'Contract' Req's  
Extend '**Measurable**' WBS  
**Products** to control  
account [Mil Hdbk 881]  
'planning & work packages'

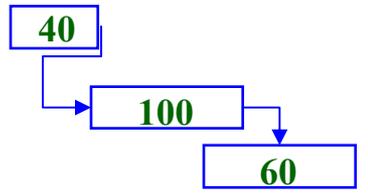


## Allocate Budgets

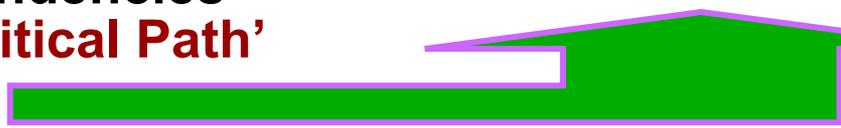
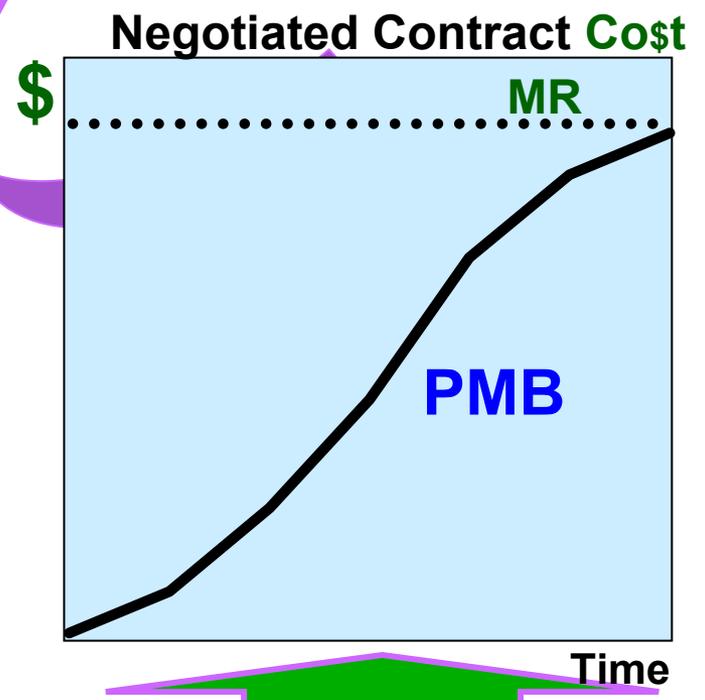


Budget Tasks  
Apply 'Appropriate' EV  
Technique  
Calculate BCWS<sub>Cumulative</sub>

## Schedule Work



Schedule tasks  
Sequence  
Interdependencies  
Float / '**Critical Path**'

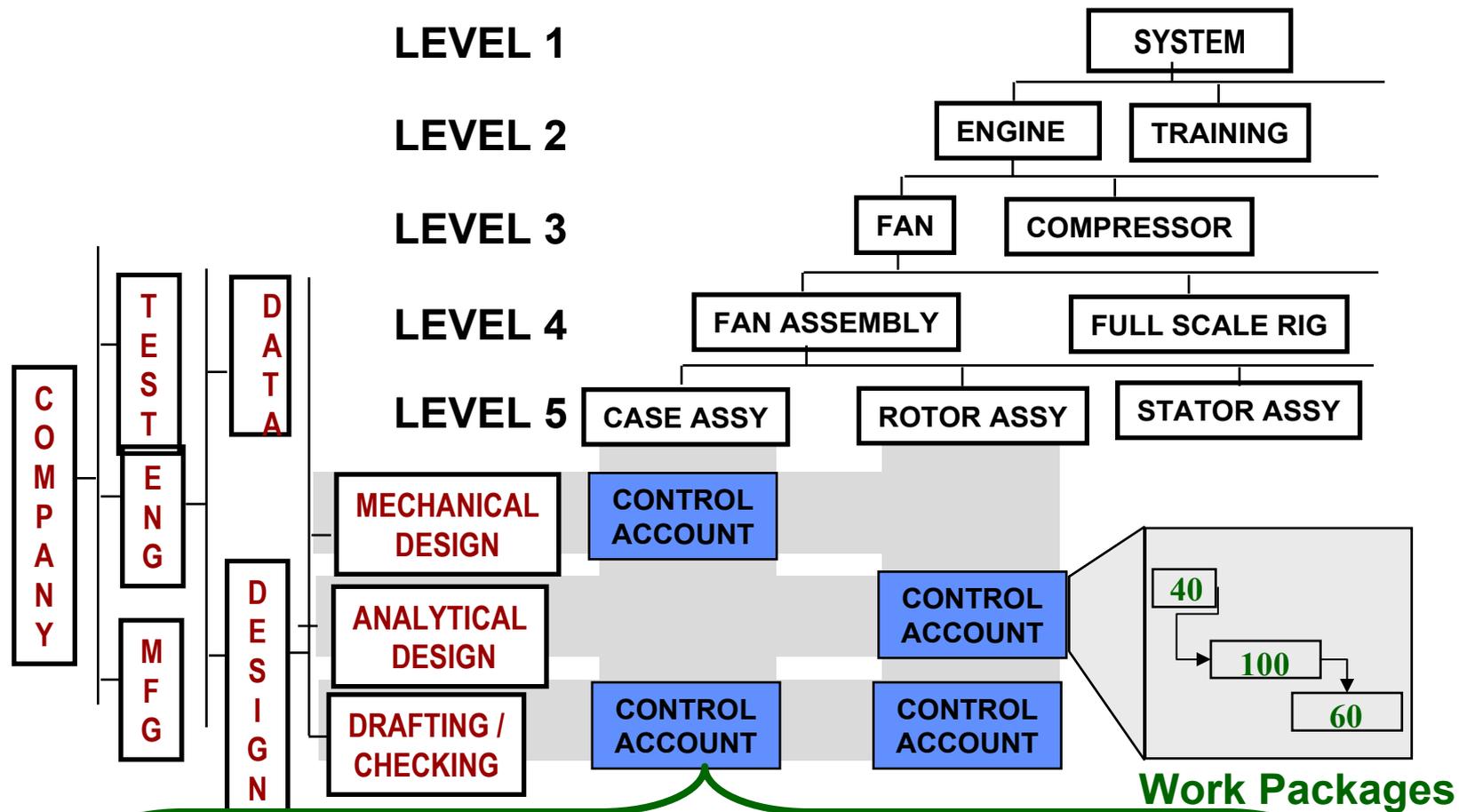




# Control Account

## A Key Management Control Point

### WORK BREAKDOWN STRUCTURE



**BCWS** established  
**BCWP** determined  
**ACWP** collected

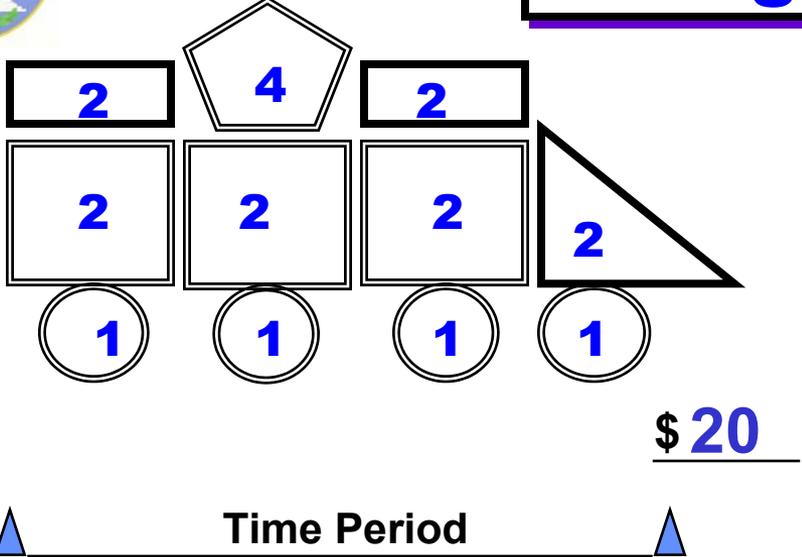
**Variations** assessed  
**Estimates** revised  
**Work Around Plans** devised



# THE PLAN

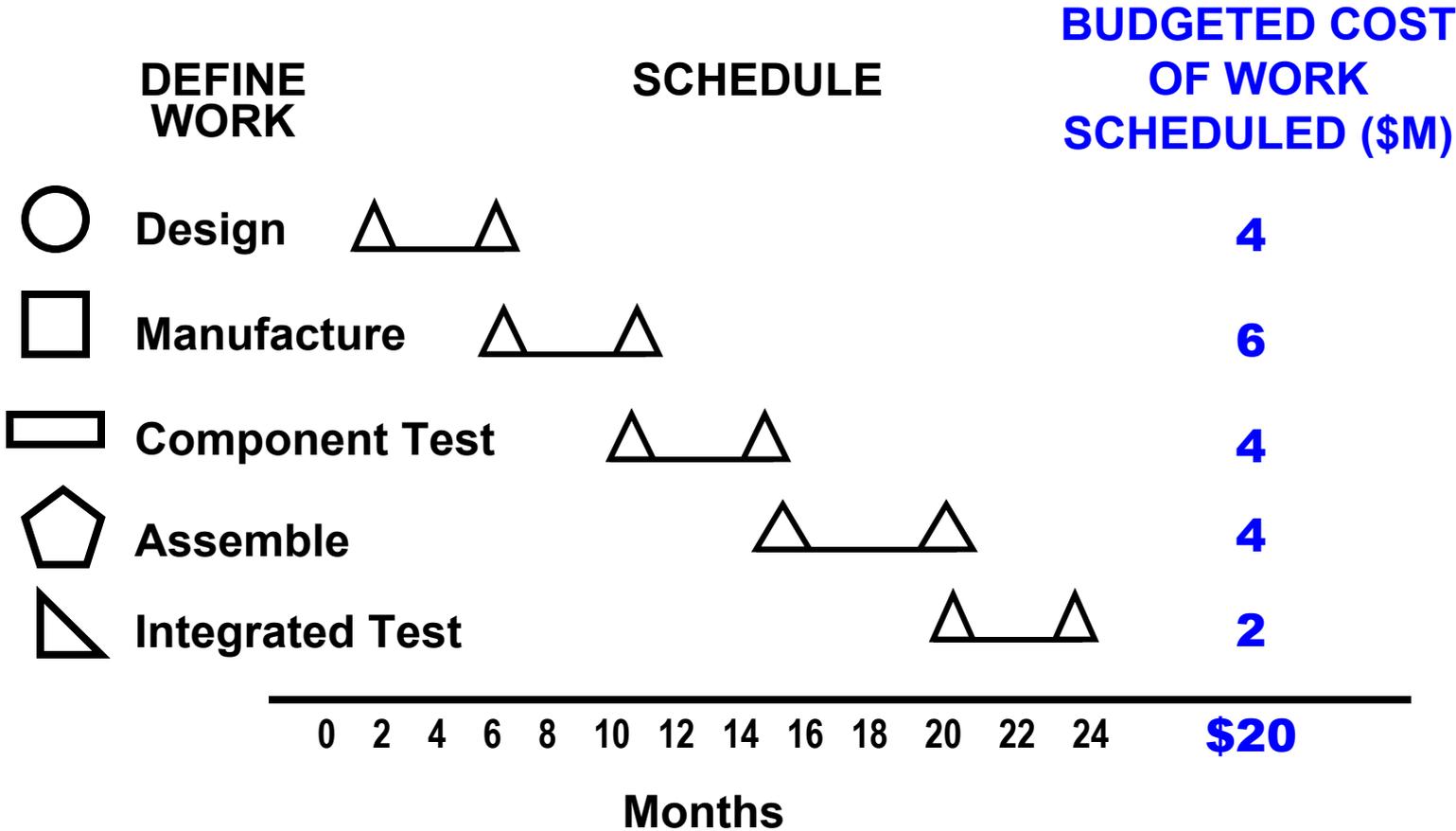
# Budget Plan

W  
o  
r  
k  
s  
c  
o  
p  
e





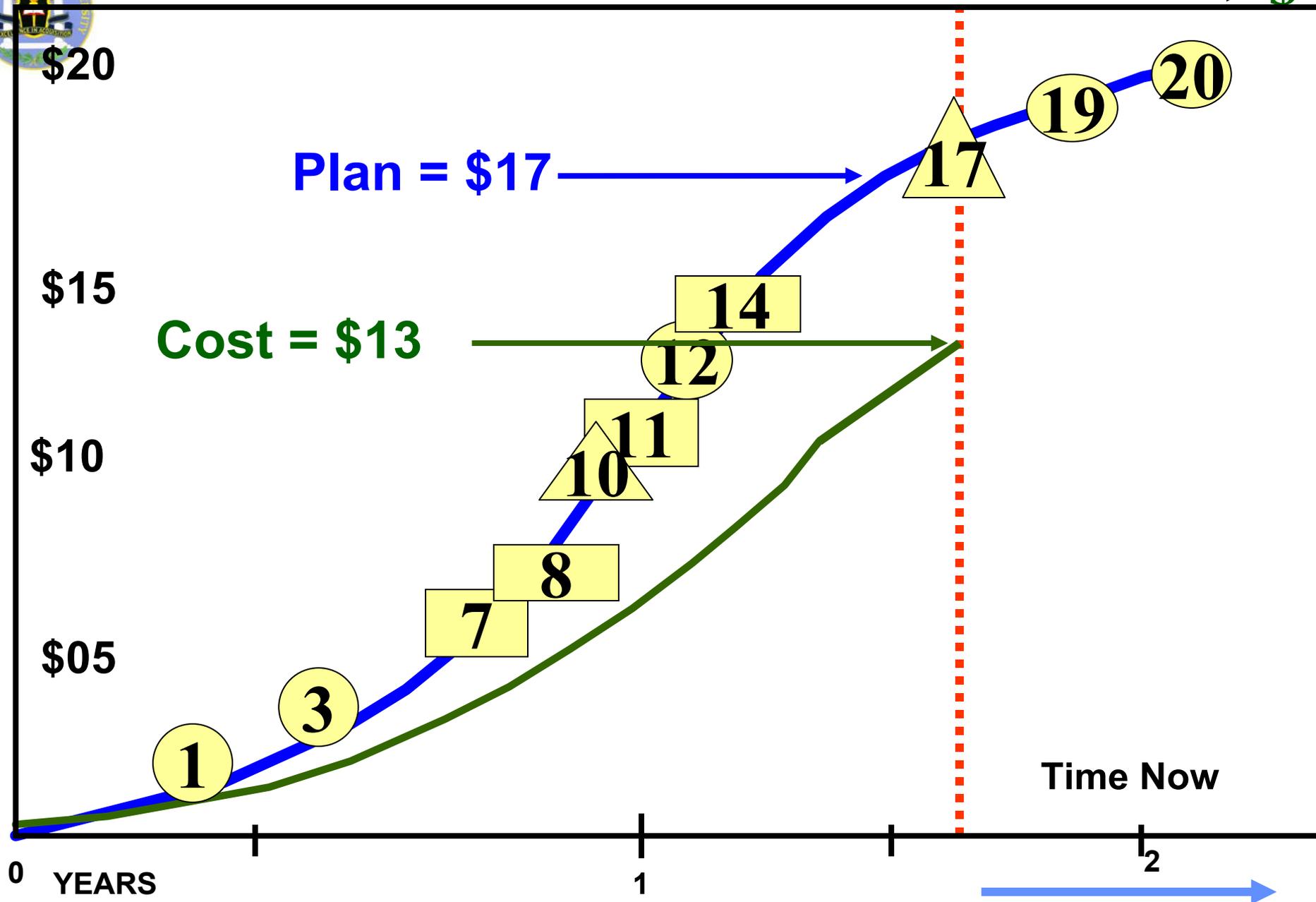
# The Program Plan





# PLANNED WORK & INCURRED COSTS

Estimated Cost  $\$$



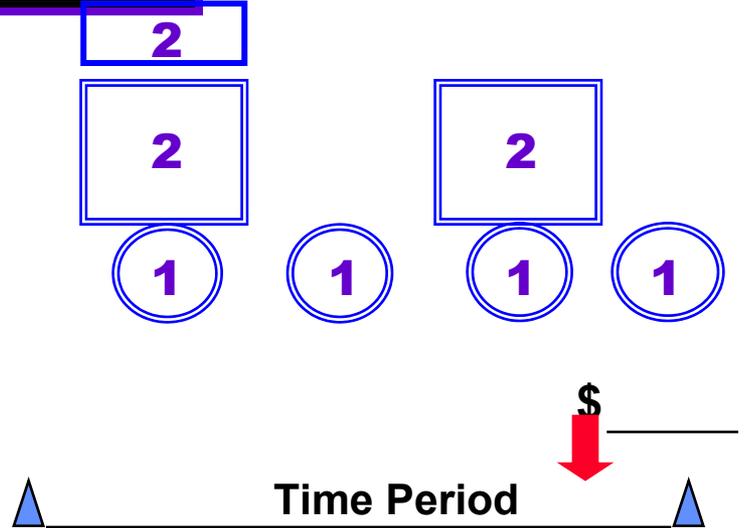
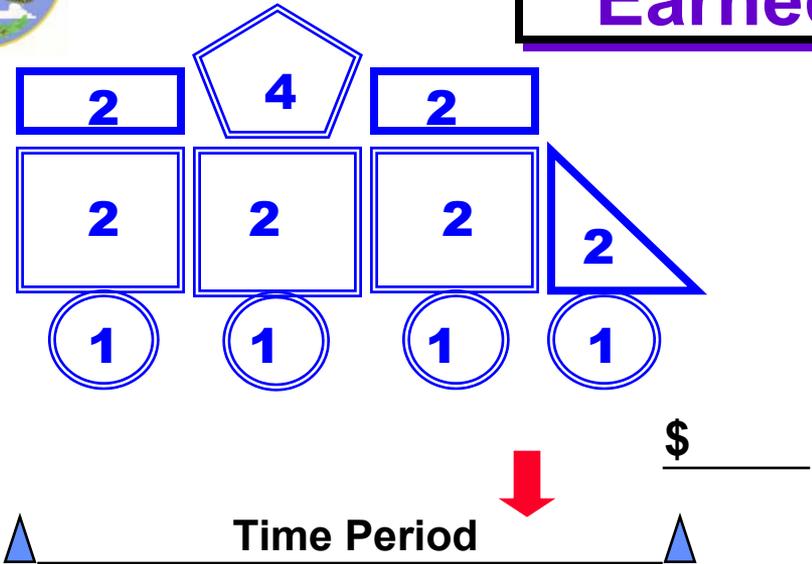


**PLAN**

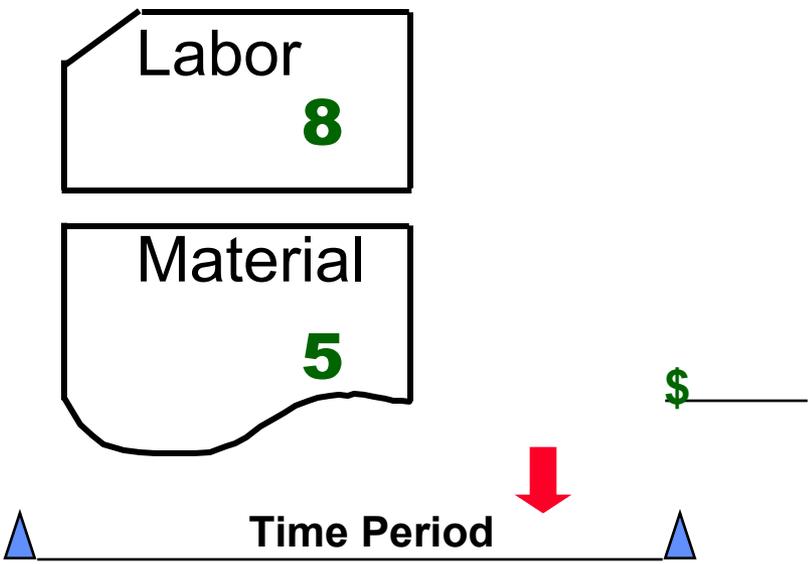
**Plan, Actuals & Earned Value**

**WORK PERFORMED**

W  
o  
r  
k  
  
s  
c  
o  
p  
e



**ACTUAL COSTS**



**VARIANCES**

Schedule Variance = Performed - Plan

$$SV = \frac{\$}{\text{ }} - \frac{\$}{\text{ }}$$

$$SV = - \$$$

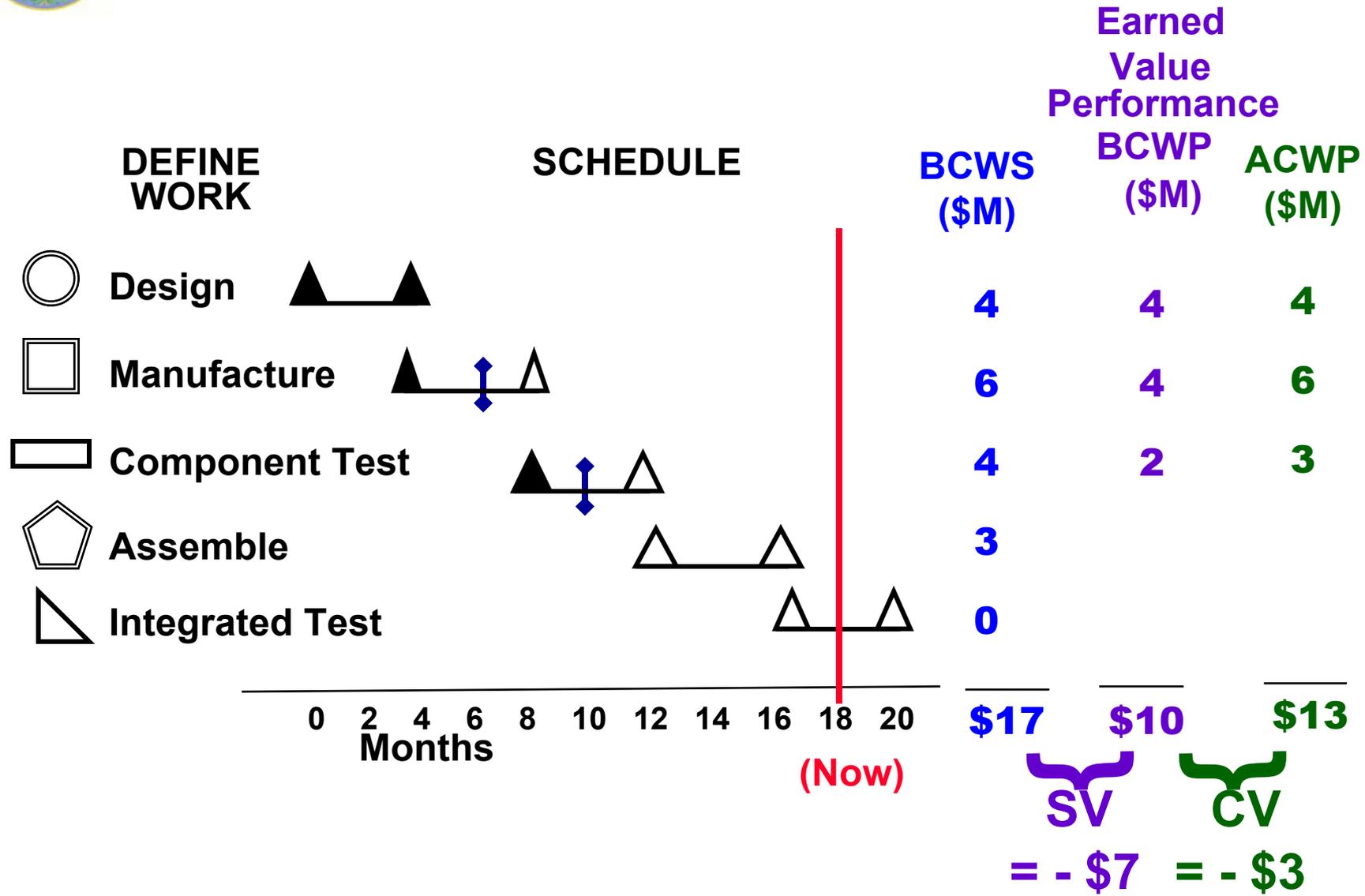
Cost Variance = Performed - Actuals

$$CV = \frac{\$}{\text{ }} - \frac{\$}{\text{ }}$$

$$CV = - \$$$



# Earned Value Current Status

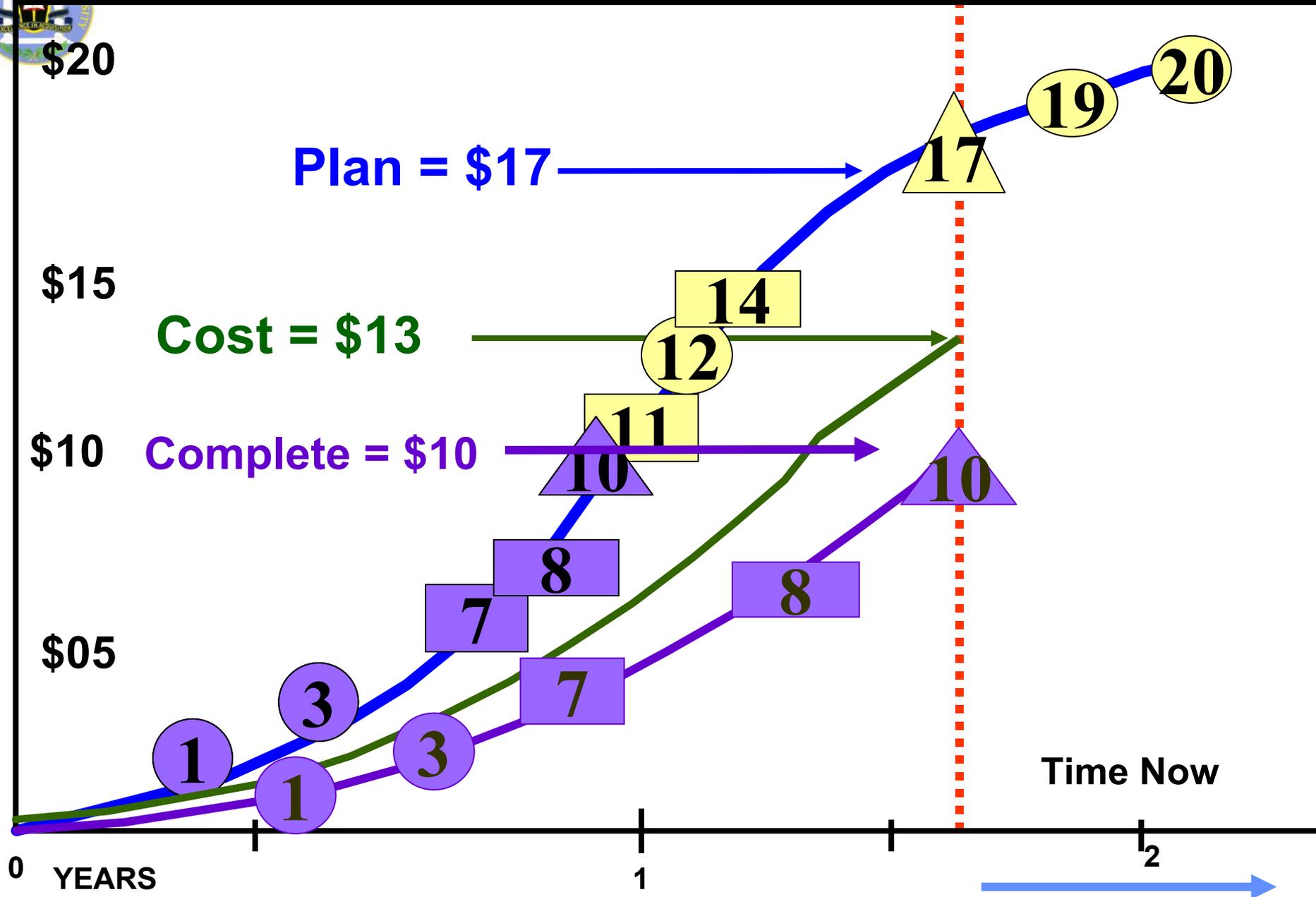




# PROJECT PLAN, COSTS & WORK DONE

# & WORK DONE

Estimated Cost  $\$$



Completion Date  $\rightarrow$



# The 'Control' Account

A key management control point:  
**lowest level of management  
accountability** for 'integrated'  
performance measurement

**BCWS - established**

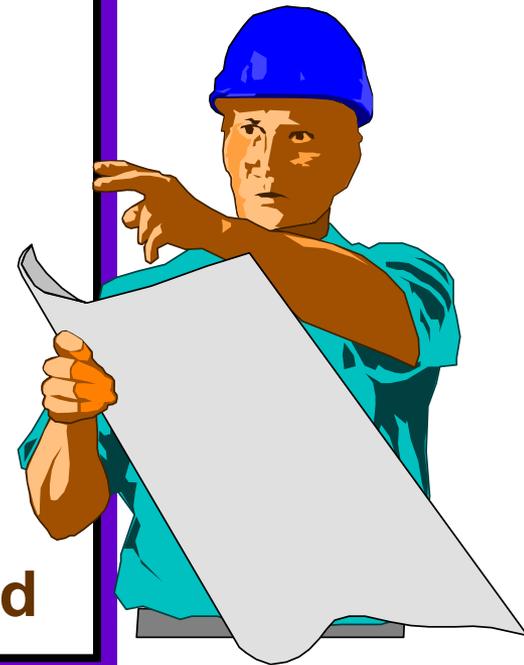
**BCWP - determined**

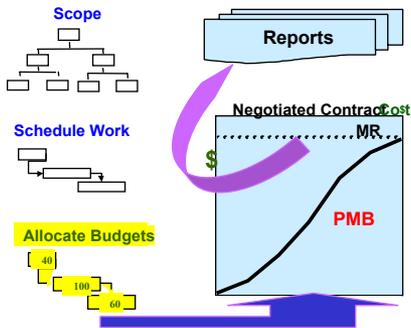
**ACWP - collected**

**Variances - assessed**

**Estimates - revised**

**Work Around Plans devised**





# WORK CATEGORIES

## Discrete Effort

Specific End Product or Result

## Apportioned Effort

Effort Directly Related to Discrete Tasks, w/  
a Historical Dependent Relationship

## Level of Effort

No Final Product; Continuing Support (T&M)



# EARNED VALUE TECHNIQUES

<u>METHOD</u>	<u>LENGTH</u>	<u>BCWP CALCULATION</u>
0 / 100 %	1 Mth	
50 / 50 %	2-3 Mths	
% Complete	Varies	
Variant Milestone	3 or More Mths	
Level of Effort	Varies	
AppORTIONED Effort	Varies	

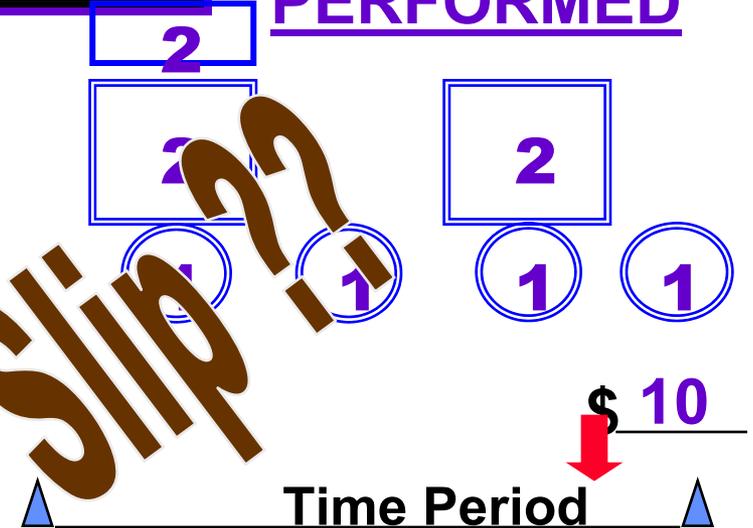
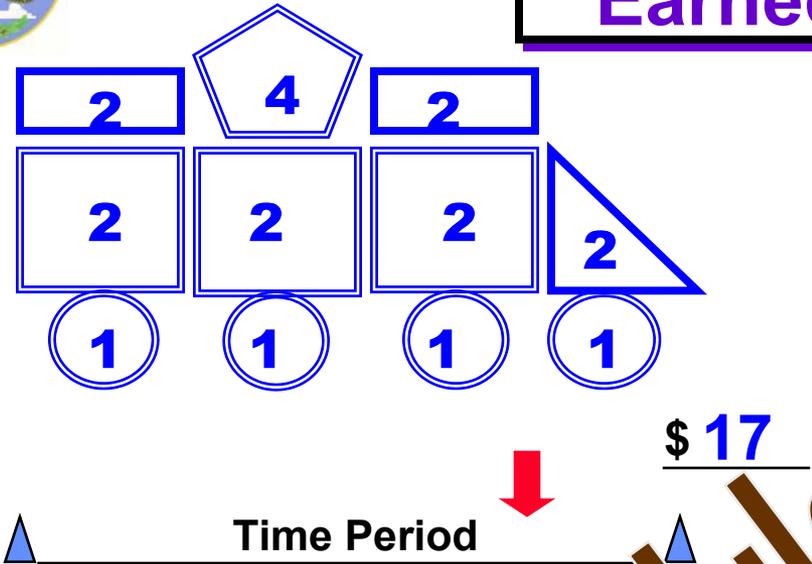


**PLAN**

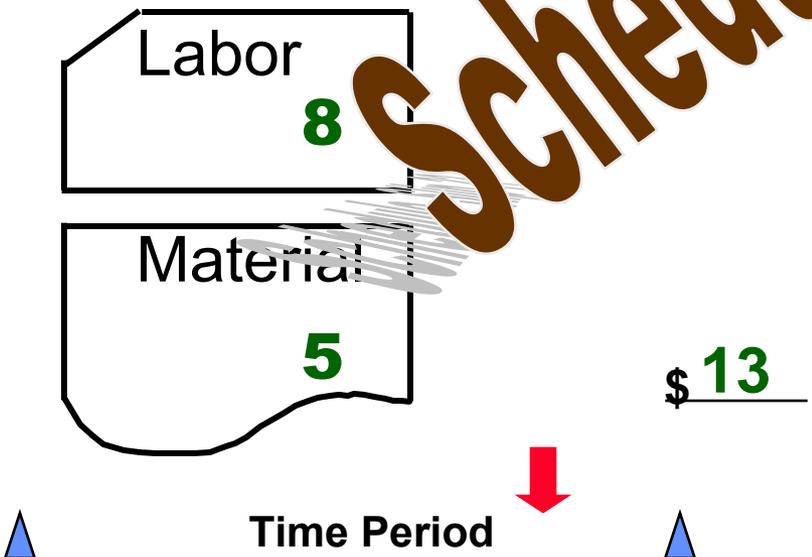
**Plan, Actuals & Earned Value**

**WORK PERFORMED**

W  
o  
r  
k  
  
s  
c  
o  
p  
e



**ACTUAL COSTS**



**VARIANCES**

Schedule Variance = Performed - Plan

$$SV = \frac{\$10}{-} - \frac{\$17}{-}$$

$$SV = -\$7$$

Cost Variance = Performed - Actuals

$$CV = \frac{\$10}{-} - \frac{\$13}{-}$$

$$CV = -\$3$$

Schedule Slip??



# Basic Performance Data Analysis

## Determine Current Status

Where Are We Today?

## Identify Trends

Where Are We Headed?

Any **Cost**, **Schedule** Surprises ?

## Forecast the Future

What Is the **Estimated Cost at Completion**?

Is It Achievable = **TCPI**

## Indicate Areas for Management Action

What Should We Do Now?



# Simple Quantitative Metrics

## DAU's EV Gold Card

**Performance Indices**

(Unfavorable < 1.0)

Cost (efficiency)  $CPI = \frac{BCWP}{ACWP}$

Schedule (efficiency)  $SPI = \frac{BCWP}{BCWS}$

---

**To Complete Performance Index**

$TCP\ EAC = \frac{WORK\ REMAINING}{COST\ REMAINING} = \frac{BAC - BCWP (CUM)}{EAC - ACWP (CUM)}$

---

**Overall Status**

% COMPLETE =  $\frac{BCWP (CUM)}{BAC}$

% SPENT =  $\frac{ACWP (CUM)}{EAC\ or\ BAC}$

---

**Estimate At Completion (EAC)**

$EAC_1 = \frac{BAC}{CPI (CUM)}$

(Floor, assumes past performance continues)

$EAC_2 = ACWP (CUM) + \frac{BAC - BCWP (CUM)}{(CPI (CUM)) \cdot (SPI (CUM))}$

(Alternate, factors in schedule)

**Defense Systems Management College  
EV Gold Card  
Contract Performance Measurement Data**

**Cost Variance**

$CV = BCWP - ACWP$

**Schedule Variance**

$SV = BCWP - BCWS$

**Variance At Completion**

$VAC = BAC - EAC$

**Cost Variance %**

$CV\% = \frac{CV}{BCWP}$

**Schedule Variance %**

$SV\% = \frac{SV}{BCWS}$

**Note: Negative is Unfavorable**

```

    graph TD
      NCC --> CBB
      AUW[Authorized Unpriced Work] --> CBB
      CBB --> TAB
      OTB[OTB] --> TAB
      TAB --> PMB
      TAB --> MR[Management Reserve]
      PMB --> DBA[Distributed Budget]
      PMB --> UBA[Undistributed Budget]
  
```

**Terminology**

- NCC – Negotiated Contract Cost
- AUW – Authorized Unpriced Work (Authorized But Not Negotiated)
- CBB – Contract Budget Base (CTC + AUW)
- OTB – Over Target Baseline (Authorized Plan > contract value)
- TAB – Total Allocated Budget (CBB or OTB)
- BAC – Budget At Completion
- MR – Management Reserve
- PMB – Performance Measurement Baseline
- BCWS – Budgeted Cost for Work Scheduled (Planned Value)
- BCWP – Budgeted Cost for Work Performed (Earned Value)
- ACWP – Actual Cost of Work Performed (Actual Value)
- EAC – Estimate At Completion (Government or Contractor)

**Thresholds (DODI 5000.2)**

**EVMS required: (FY 96 Base Year \$)**

- Significant Contracts and Subcontracts (except FFP) that exceed \$70M RDT&E or \$300M in production (CY 96\$)
- Requires obtaining Cost Performance Report (CPR)
- Consider seeking below threshold use or waiver when appropriate (examine benefits, risk and criticality)

**Other (Non-FFP) Contracts (below threshold):**

- C/SSR (Cost/Schedule Status Report)
- Reasonably objective earned value methods are adequate

**Sample Causes of Performance Variance**

**Favorable Variances**

- Technical breakthrough
- Cost of labor or material lower than planned
- Front-end loading

**Unfavorable Variances**

- Poor initial planning or estimating
- Unexpected technical problems or complexity
- Cost of labor or material higher than planned
- Inflation
- New labor contracts
- Increase in overhead rates

**Performance Reporting:**

CPR – Cost Performance Report  
 C/SSR – Cost/Schedule Status Report  
 Purpose – Obtain meaningful contract cost and schedule status information.



# Cost Performance Index (CPI)

Cost Performance Index Is a Measure of Contractor cost efficiency, i.e., Indicates the Value of the Work Performed for Each Dollar Actually Spent

$$\text{CPI} = \frac{\text{Value of the Work Performed}}{\text{Actual Cost of the Work Performed}} = \frac{\text{BCWP}}{\text{ACWP}}$$

**A Number < 1.0 Indicates an Overrun.**



# Schedule Performance Index (SPI)

Schedule Performance Index Is a Measure of Ktr's **schedule efficiency**, i.e., Indicates the **Value of the Work Performed** for Each Dollars Worth of **Work Scheduled**

$$\text{SPI} = \frac{\text{Value of the Work Performed}}{\text{Value of the Work Scheduled}} = \frac{\text{BCWP}}{\text{BCWS}}$$

**A Number < 1.0 “Indicates” an Slip.**



# EAC Methods

## METHOD

## FORMULA \*

**CPI<sub>Cum</sub>**

$$\frac{BAC}{CPI_C}$$

**Composite**

$$ACWP_C + \frac{BAC - BCWP_C}{CPI_C \times SPI_C \text{ or } 6, \text{ Cur}}$$

**3 MO AVG**

$$ACWP_C + \frac{BAC - BCWP_C}{CPI_3 \text{ or } 6, \text{ Cur}}$$

**COST & SCH**

$$ACWP_C + \frac{BAC - BCWP_C}{(.4 \cdot CPI_{\text{factory}}) + (.4 \cdot CPI_{\text{test}}) + (.2 \cdot CPI_{\text{quality}})}$$

\* Sub CBB for BAC = Assumes Ktr Uses ALL MR  
Reminder: wlnsight Uses CBB to Determine EAC



# To Complete Performance Index (EAC, LRE, or BAC)

$$\text{TCPI}_{\text{EAC (LRE/BAC)}} = \frac{\text{Work Remaining}}{\text{Budget Required to Achieve EAC}}$$
$$= \frac{\text{BAC} - \text{BCWP}_{\text{Cumulative}}}{\text{EAC (or LRE / BAC)} - \text{ACWP}_{\text{Cumulative}}}$$

Efficiency Required to Achieve the **EAC / LRE / BAC**.  
**An Achievability Index !!!**



**TCPI Example:  $CPI_{24\text{ mns}} = 0.69$**   
**Which TCPI is more realistic?**

$$TCPI_{BAC} = \frac{BAC - BCWP}{BAC - ACWP} = \frac{\$2,400 - \$1,100}{\$2,400 - \$1,600} = \frac{\$1,300}{\$800} = 1.63$$

$$TCPI_{EAC} = \frac{BAC - BCWP}{EAC - ACWP} = \frac{\$2,400 - \$1,100}{\$3,200 - \$1,600} = \frac{\$1,300}{\$1,600} = 0.81$$

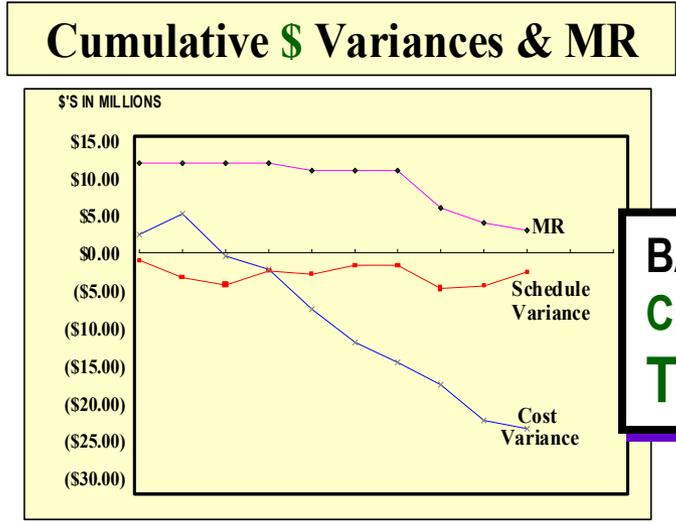
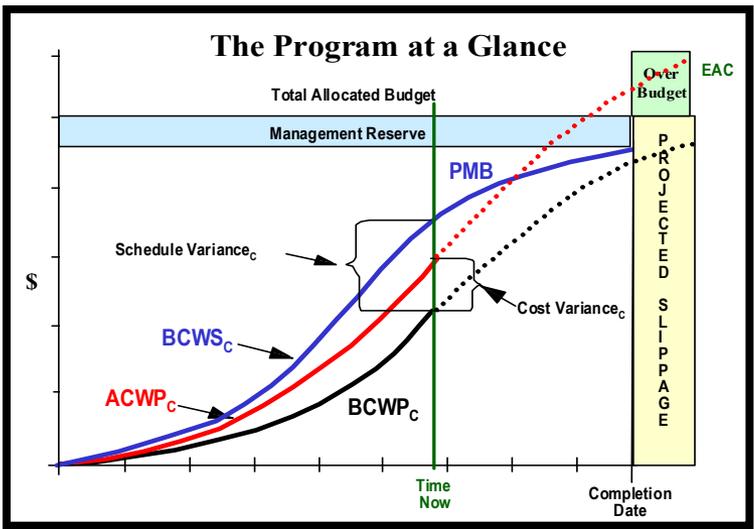
**Ktr Must Complete All Remaining Work @ a Performance Efficiency of :**  
**1.63 to Deliver @ the BAC,**  
**or**  
**0.81 to Deliver @ the EAC.**

**The 1.63 Is Improbable, 0.81 is Possible ??**  
**Based Upon the CPI of 0.69.**  
**What is a better EAC ??**



# EVM = Program / Engineering Management

## A Picture Is Worth....



**BAC / LRE / EAC**  
**CPI / SPI**  
**TCPI<sub>LRE / EAC / BAC</sub>**



So What ?!!  
 What do WE do ?

**REQUIREMENTS MNS / ORD / **APB** / Contract**  
**“RISK MANAGEMENT”** Customer / PO / Ktr  
**ACQ STRATEGY w/ PPB\$ (POM / BES / PB)**  
**OBL & EXP**  
**EXIT CRITERIA**  
**ISSUES & RECOMMENDATIONS**  
**IMPLEMENTATION [Plan] ??**



# CONSIDER

<b>DCMA</b>	<b>= Assistance = Past Performance / Sub-Ktrs</b>
<b>Insight</b>	<b>= Trends / Problem(s) / Cause(s) / Fixes</b>
<b>Reporting</b>	<b>= CARS / DAES / SAR / UCR</b>
<b>Risks</b>	<b>= Customer / User / Ktr's</b>
<b>Affordability</b>	<b>= CAIV = Trades -- Perf / Sch / Cost</b>
<b>PPBS</b>	<b>= Obl &amp; Exp / PPB\$ = POM &amp; BES</b>
<b>Congress</b>	<b>= Reelection / Jobs / DoD / TOA / FMS</b>
<b>OMB</b>	<b>= No Supplementals</b>



# YOUR Program @ a Glance

Price  
-  
Profit

$$= \text{Contract Budget Base / TAB / NCC}$$

EAC

Over Budget

Management Reserve

PMB

Schedule Variance<sub>C</sub>

Cost Variance<sub>C</sub>

BCWS<sub>C</sub>

BCWP<sub>C</sub>

ACWP<sub>C</sub>

Schedule Slip?

PRODUCTION SLIP

Time Now

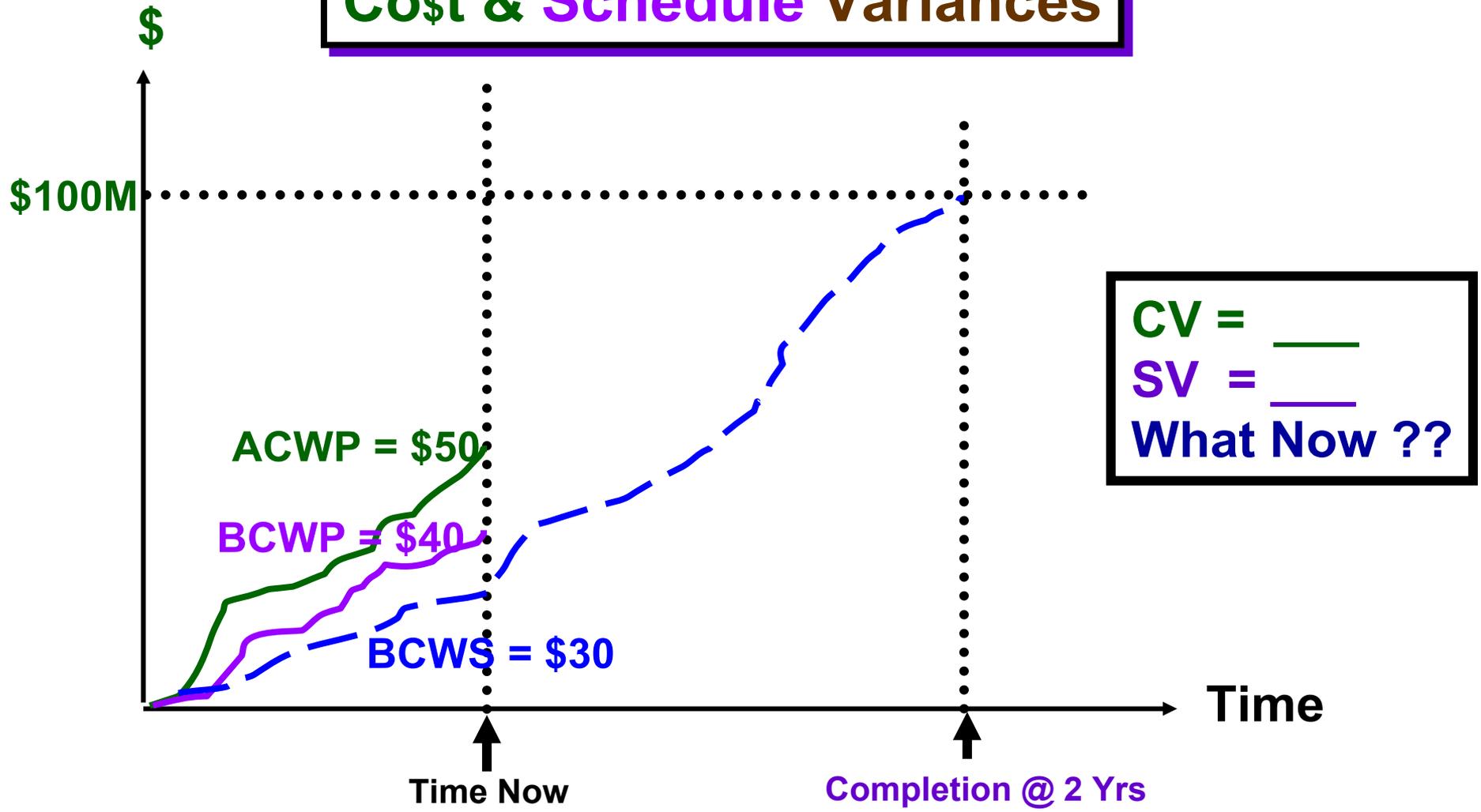
Completion Date





# Project X

## Cost & Schedule Variances



CV = \_\_\_\_\_  
SV = \_\_\_\_\_  
What Now ??



# Cost Variance

$$CV = \text{Earned Value} - \text{Actuals}$$

$$CV = BCWP - ACWP$$

- ▲ **Cost Variance Compares Value of Work Completed to Cost to Complete That Work.**
- ▲ **Example: Project X Is Budgeted to Cost \$100M. The Task Is 40% Complete, Cumulative Charges = \$50.**

\$40	Earned Value (BCWP)	
- \$50	Actual Costs (ACWP)	
<u>        </u>		
- \$10	Cost Variance (CV)	(unfavorable)

**THIS TASK IS OVERRUNNING**



# Schedule Variance

$SV = \text{Earned Value} - \text{Spend Plan}$   
 $SV = \text{BCWP} - \text{BCWS}$

- ▲ Schedule Variance {**NOT SLIP !!**} Compares the Spend Plan to the Value of Work Completed.
- ▲ Example: Project X Is Budgeted to **Cost \$100M**. The Task Is **40% Complete**. The **Spend Plan Shows \$30** of Work Was **Planned** to Be Complete by This Date.

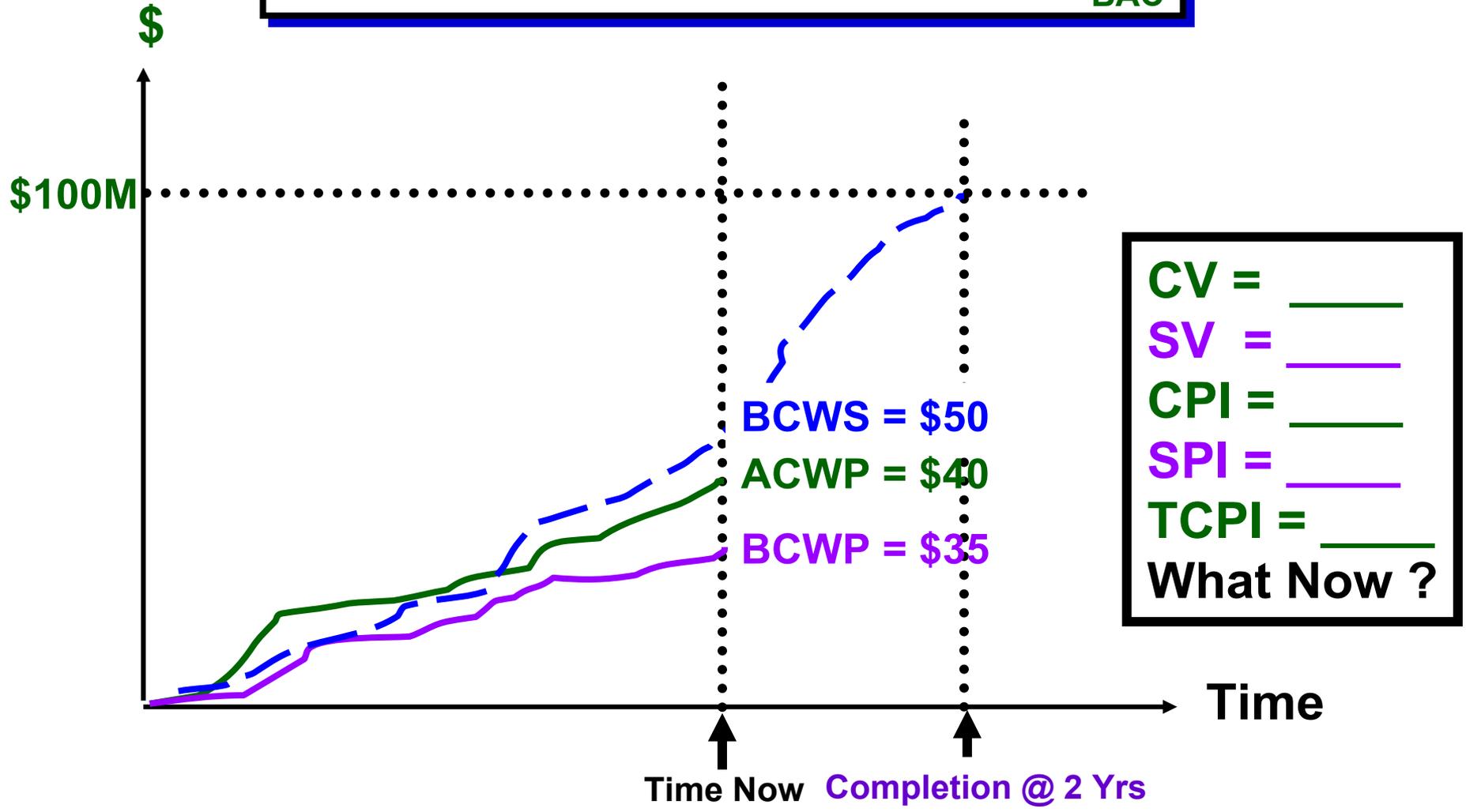
\$40	Earned Value (BCWP)
<u>- \$30</u>	Spend Plan (BCWS)
+\$10	Schedule Variance

**IS THIS TASK AHEAD OF SCHEDULE ??**  
**Check Critical Path !!**



# Project "U"

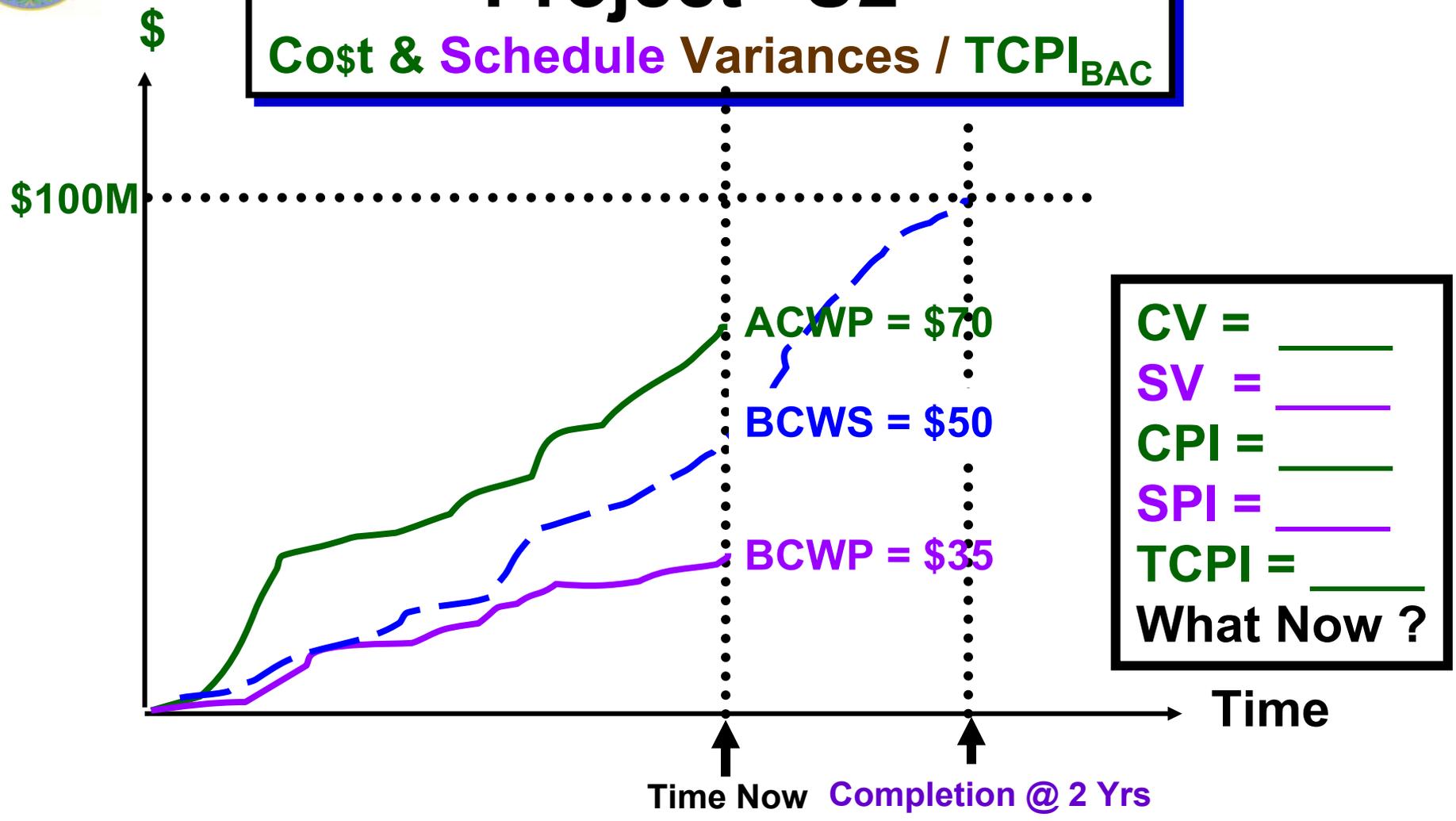
## Cost & Schedule Variances / $TCPI_{BAC}$





# Project "U2"

## Cost & Schedule Variances / $TCPI_{BAC}$

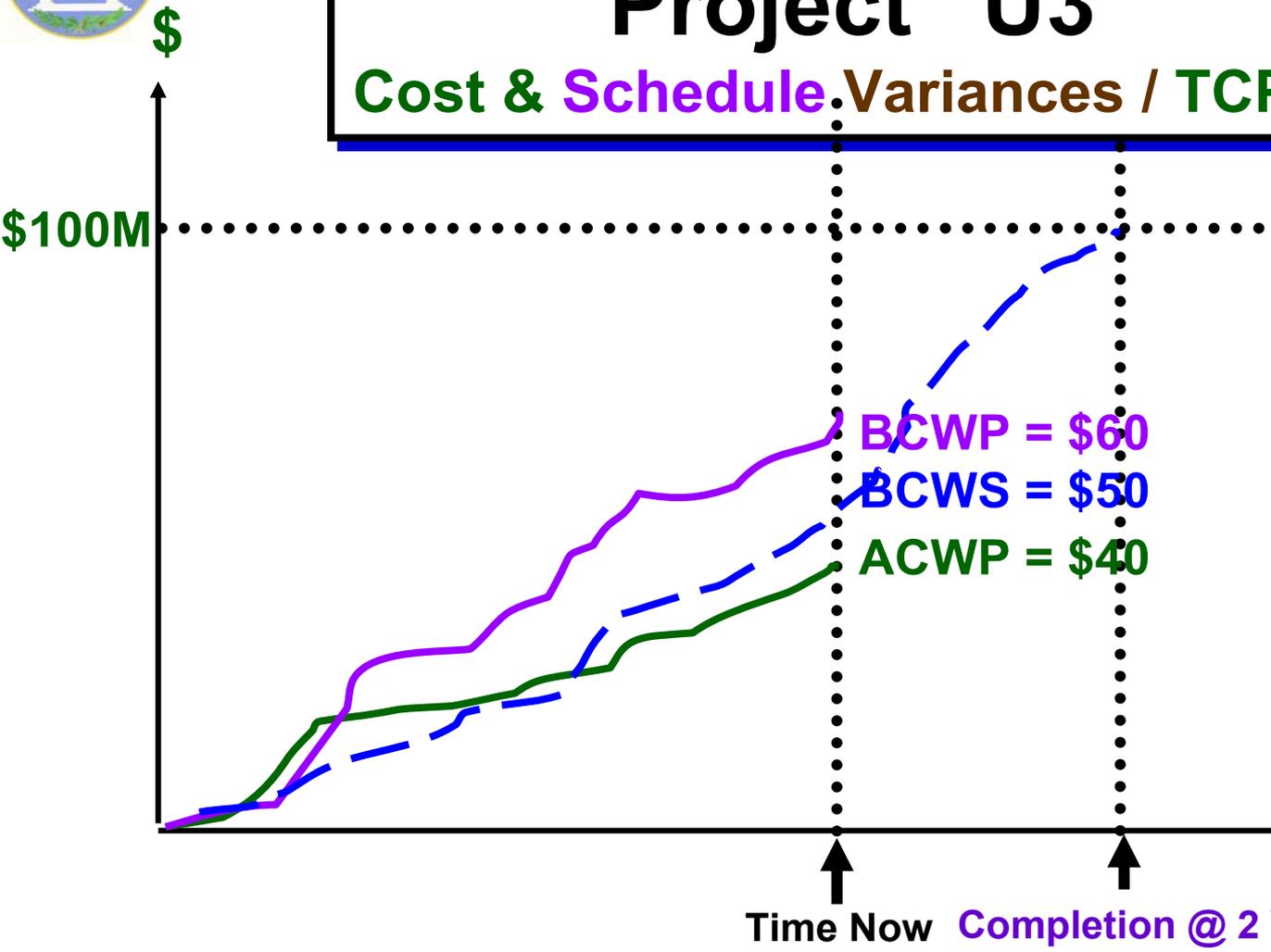


CV = \_\_\_\_\_  
SV = \_\_\_\_\_  
CPI = \_\_\_\_\_  
SPI = \_\_\_\_\_  
TCPI = \_\_\_\_\_  
What Now ?



# Project "U3"

## Cost & Schedule Variances / TCPI<sub>BAC</sub>



CV = \_\_\_\_\_

SV = \_\_\_\_\_

CPI = \_\_\_\_\_

SPI = \_\_\_\_\_

TCPI = \_\_\_\_\_

What Now ?



# QUESTIONS ??