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# Basics of Earned Value Management

## Part 2

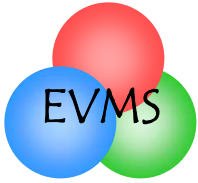
Eleanor Haupt

Earned Value Associates LLC

ehaupt@earnedvalue.biz

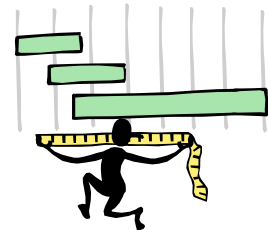
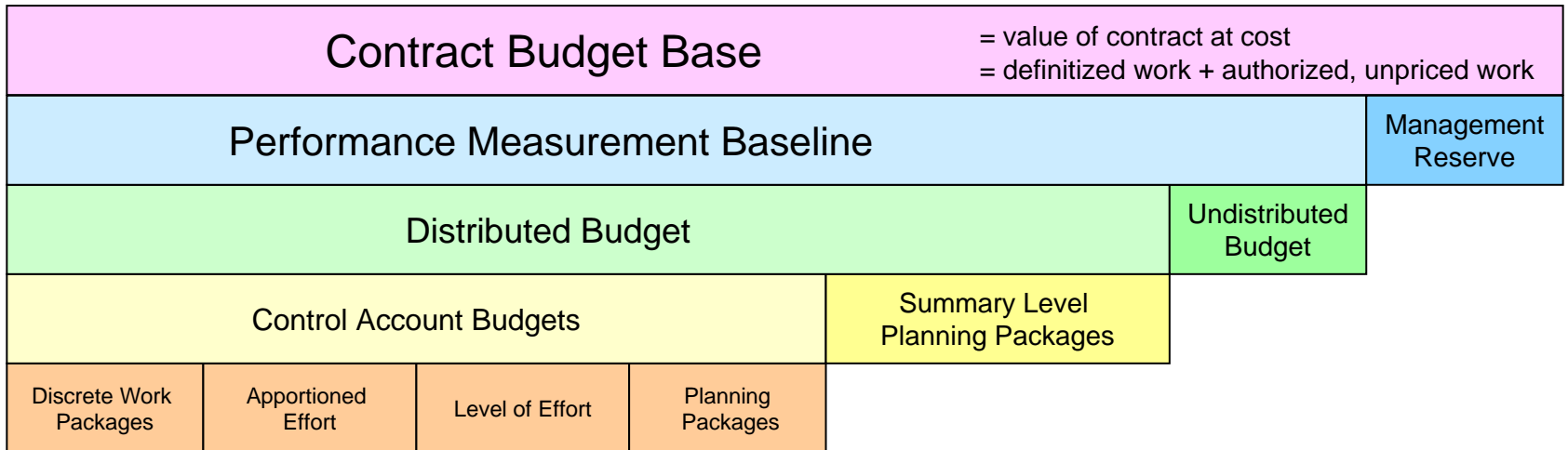
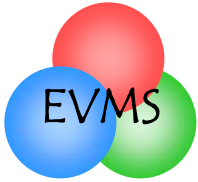
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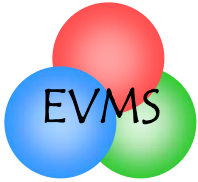




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# Total Baseline

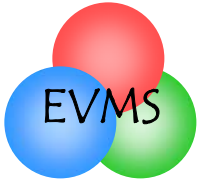




# Performance Management Baseline

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- **Performance Management Baseline (PMB)**
  - Sum of:
    - All detailed control accounts and/or work packages
    - Summary level planning packages (future, not planned in detail)
    - Undistributed budget

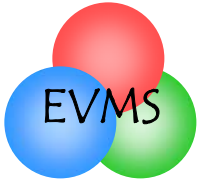


# Undistributed Budget

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## **UB** Undistributed Budget

- = authorized work held at top level until it can be planned in detail  
(will eventually have performance measurement)
- = temporary holding account for new changes
- = budget should only stay here for < 60 days



# Management Reserve

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## MR Management Reserve

= amount withheld at top level for control purposes

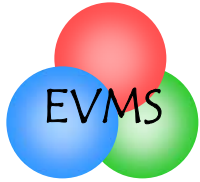
(no performance measurement)

= used for unforeseen changes that are within scope of the contract

## CBB Contract Budget Base

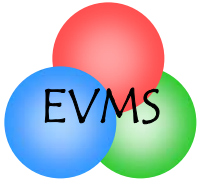
= PMB + MR

= contract at cost



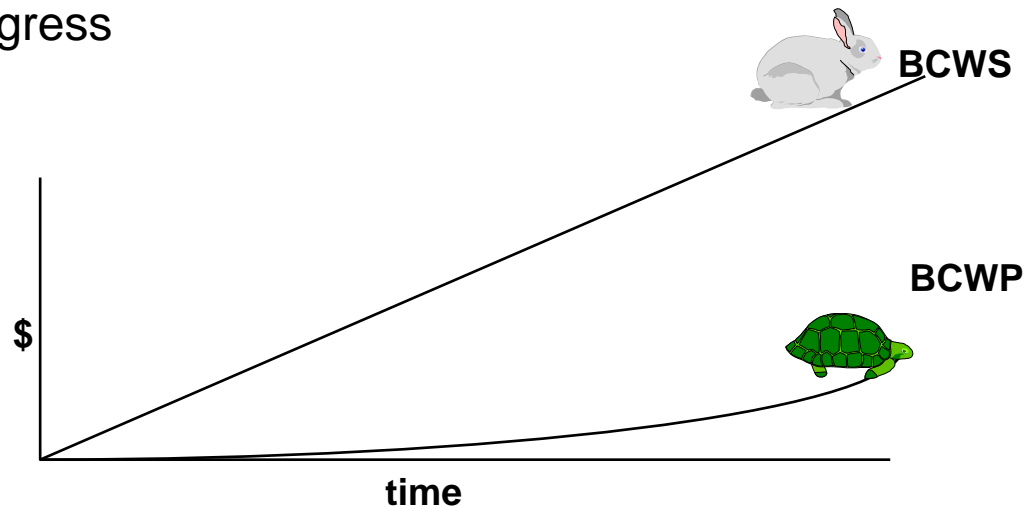
# Should MR be Used?

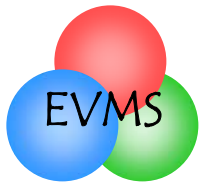
<b>Need to repeat some tests due to test failure (software problem)</b>	<b>YES</b>
<b>Requirement for additional software code was identified during testing</b>	<b>YES</b>
<b>Overran labor for test set-up</b>	<b>NO – cost overrun</b>
<b>Used more material during testing</b>	<b>NO – cost overrun</b>
<b>Government demanded new tests (expansion of test envelope)</b>	<b>NO – should be contract change</b>
<b>Tests took longer than planned and added an additional month of labor charges</b>	<b>NO – schedule and cost overrun</b>



# Project Control

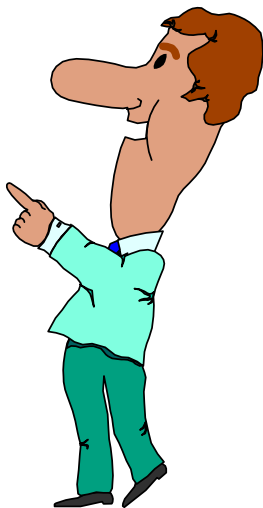
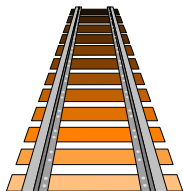
- So, your project has been baselined and work has started
- Is everything going according to plan?
- Next steps
  - Measure work progress
  - Maintain the baseline
  - Report progress
  - Analyze





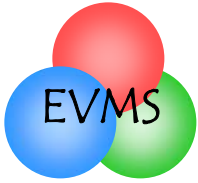
# Budgeted Cost for Work Performed (BCWP)

the **EARNED VALUE** concept



We're at the end of the second month, but only 1 section of track is complete.  
Earned value of work completed = \$1,000

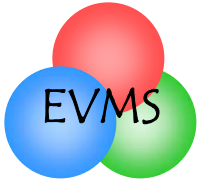
- Assess progress on recurring basis
- There are different methods of earning value
- You earn value the same way as it was budgeted in baseline



# General Principles of Measuring Performance (BCWP)

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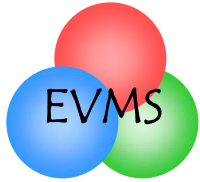
- **Establish valid metrics as you establish the time phased baseline**
  - Relate true work status
  - Objective and quantifiable
- **Should be a quantitative and discrete way to measure the work**
- **May tie in with success criteria or technical measure**
  - Example: successful completion of a specific test
- **Must be consistent in following established metric as work progresses**
- **BCWP value drives both cost and schedule variances**
  - If overstated or understated, it will distort variances
  - Can impact estimate at complete calculations



# Three Basic Methods of Earning Value

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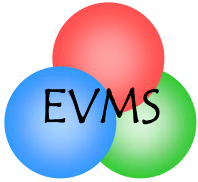
- **Discrete**
  - Physical, tangible end product
  - Common techniques: interim milestone, % complete, 0/100, 50/50, units complete
- **Apportioned**
  - Discrete, but dependent on another discrete work package
    - Example: quality assurance (depends on assembly labor)
  - Planned as historical estimating factor (e.g., 7%)
- **Level of Effort**
  - No tangible end product
  - Basis of measurement: time
  - When clock starts ticking, you automatically accumulate earned value
  - Results in no schedule variance (BCWP will always equal BCWS)
  - Example: management personnel



# Typical Discrete Techniques

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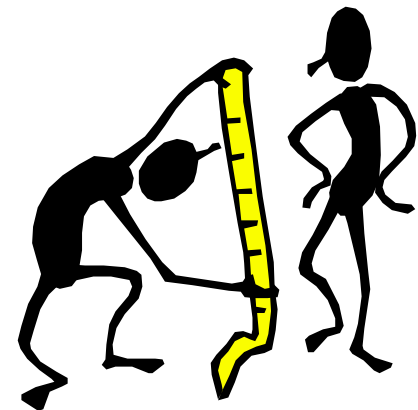
<u>Method</u>	<u>How Value is Earned</u>
Weighted Milestone	requires 2 milestones: start and stop 50%/50%, 0/100%, or other weighting
Interim Milestone	milestones assigned a resource value or % ideal to have a milestone each month
Units Completed	same budget value for identical units
Equivalent Units	planned unit standards, allows partial credit
Percent Complete	subjective (least desirable)

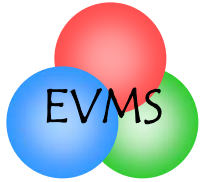


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# Sample BCWP Calculations

(Other samples are on back-up slides)

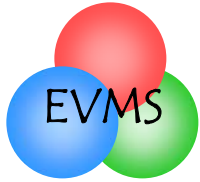




# Interim Milestone

	January	February	March	April	Total Budget
Work Package Milestones	▲ 20%	▲ 40%	▲ 40%		
Resource Plan	200	200	200		600
BCWS	120	240	240		600
BCWP	120	240	240		600
Schedule Variance	0	0	0		0

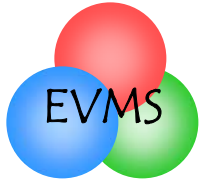
- Milestones should represent work accomplishment and are from the master schedule
- Milestones should have clear definition and criteria for completion
- BCWS is based on milestone weighting (% or \$) and can be different than the resource plan
- Easy to measure progress: earn value of milestone when the milestone is complete
- Ideal to have a milestone every month



# Percent Complete

	January	February	March	April	Total Budget
Work Package Milestones					
Planned work (page count)	40	30	30		
Planned Progress (by month)	40%	30%	30%		100%
BAC					1,500
BCWS	600	450	450		1,500
Reported Progress (by month)	20%	20%	40%	20%	100%
BCWP	300	300	600	300	1,500
Schedule Variance	(300)	(150)	150	300	0

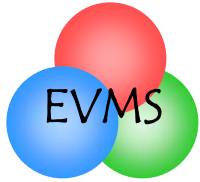
- Can be good at measuring performance or very bad
- Good technique when based on underlying plan and measurable outputs (i.e., page count, drawings)
- Distorts performance when subjective and based on best guess
- Planned progress per month is multiplied by total budget to derive BCWS
- Reported progress per month is multiplied by total budget to derive BCWP



# Level of Effort (LOE)

	January	February	March	April	Total Budget
Work Package Milestones					
BCWS	2,000	4,000	3,000		9,000
BCWP	2,000	4,000	3,000		9,000
Schedule Variance	-	-	-	-	-

- Automatically earn 100% of the planned budget every month (no matter whether any work was done or not!)
- Only measure is time
- Appropriate for only those accounts that cannot be measured in any other way. Should be limited.
- Examples: project management, financial management, etc.



# Earning BCWP on Material

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- **Material and Subcontracts**

- Earned Value: taken no earlier than receipt or progress payments to subcontractors

define

order



receipt or progress payments

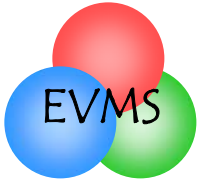
payment

to inventory

usage

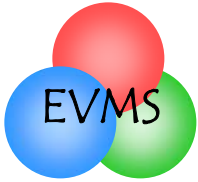


- accurate cost accumulation and assignment to contract



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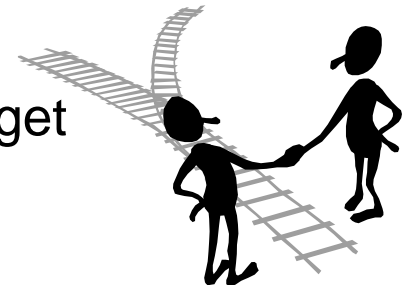
# Maintain the Baseline

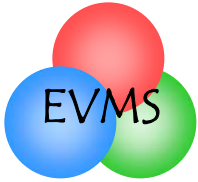


# Authorizing the Work

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- Can only work on work package if it has been opened
  - Charge costs to open work packages only
  - Contractor system sets procedure
- Contractor maintains baseline log which tracks:
  - Distribution of budget
  - Additions of authorized work
  - Total equals value of contract at cost
- Contract changes incorporated in disciplined manner
  - Cannot start work without authorization and budget
  - Baseline changes are controlled



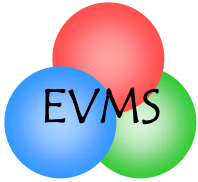


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## *more rules of the road...*



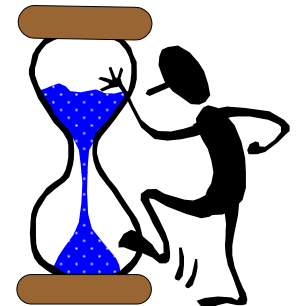
- cannot move budget and work independently
- cannot use management reserve budget to cover overruns
- may replan open work packages as necessary
  - contractor sets internal policy
  - maintain valid performance information
- cannot change budgets or costs for completed work
  - except to fix errors

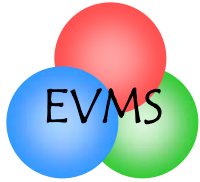


# Status Reporting

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- Report on periodic basic
  - weekly
  - monthly
- Tailor the data to match how you're managing
- Provide performance reports to:
  - Senior management
  - Customer
    - Based on contract terms
- Use data in reports and variance analysis to manage and control project

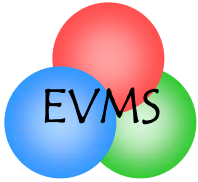




# Sample Earned Value Reports

- Contents
  - header:
    - basic contract information (target, ceiling, name of contractor, etc.)
    - range of final estimates
  - body
    - performance data
    - variances
    - budget at completion, estimate at completion

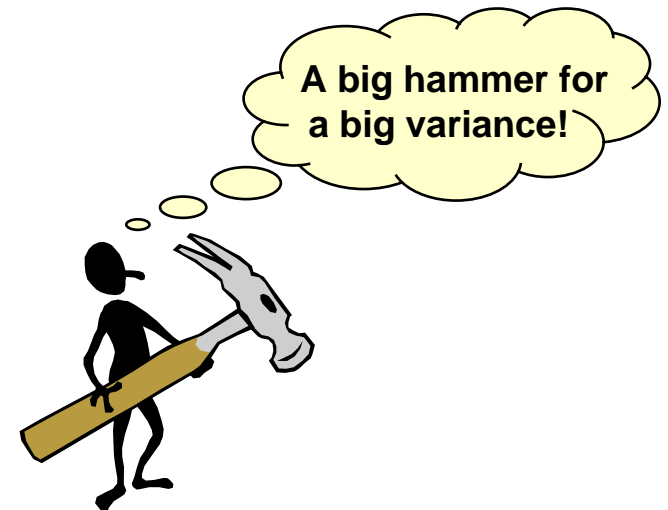
	CURRENT					CUMULATIVE					AT COMPLETION		
	BCWS	BCWP	ACWP	SV	CV	BCWS	BCWP	ACWP	SV	CV	BUDGET	ESTIMATE	VARIANCE
ELEMENT													
ELEMENT													
ELEMENT													
ELEMENT													
ELEMENT													
ELEMENT													
TOTAL													
UB													
PMB													
MR													
TOTAL													

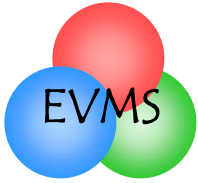


# Variance Explanations

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- **Variance analysis should address:**
  - separate discussion of CV, SV (current and cum) and VAC
  - clear description of reason for variance
  - quantity variances (e.g., price vs. usage)
  - be specific
  - discuss needed corrective action
  - technical, schedule, and cost impacts
  - impact to estimate at completion
  - should be written by CAM!

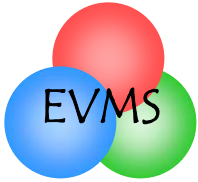




# Basic Concepts of Analysis

or

figuring out where the problems are



# Looking Forward

**PAST**

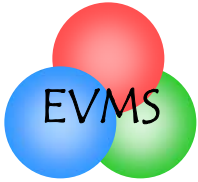
**PRESENT**

**FUTURE**

Are we on schedule?  
Are we on cost?  
What are the significant variances?  
Why do we have variances?  
Who is responsible?  
What is the trend to date?  
What risks have been reduced or added?

What is the “to go” plan?  
How is it resourced?  
When will we finish?  
What will it cost at the end?  
How can we control the trend?  
How do we adjust for risk?

**We analyze the past performance.....to help us control the future**

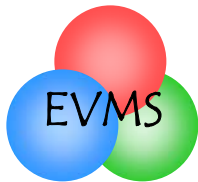


# Basic Analysis Techniques

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- Find significant variances
  - eliminate almost complete, just starting, etc.
- Graph and analyze trends
- Look at comparative data
  - e.g. cumulative performance vs. projected performance
- Examine written analysis by contractor
  - does it answer why?
  - adequacy of corrective action plans
- Analysis of schedule trends, critical path
- Analysis of EAC realism

what are the drivers?  
what can we do about them?



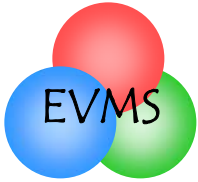
# Where are the significant problems?

sorted by CV \$

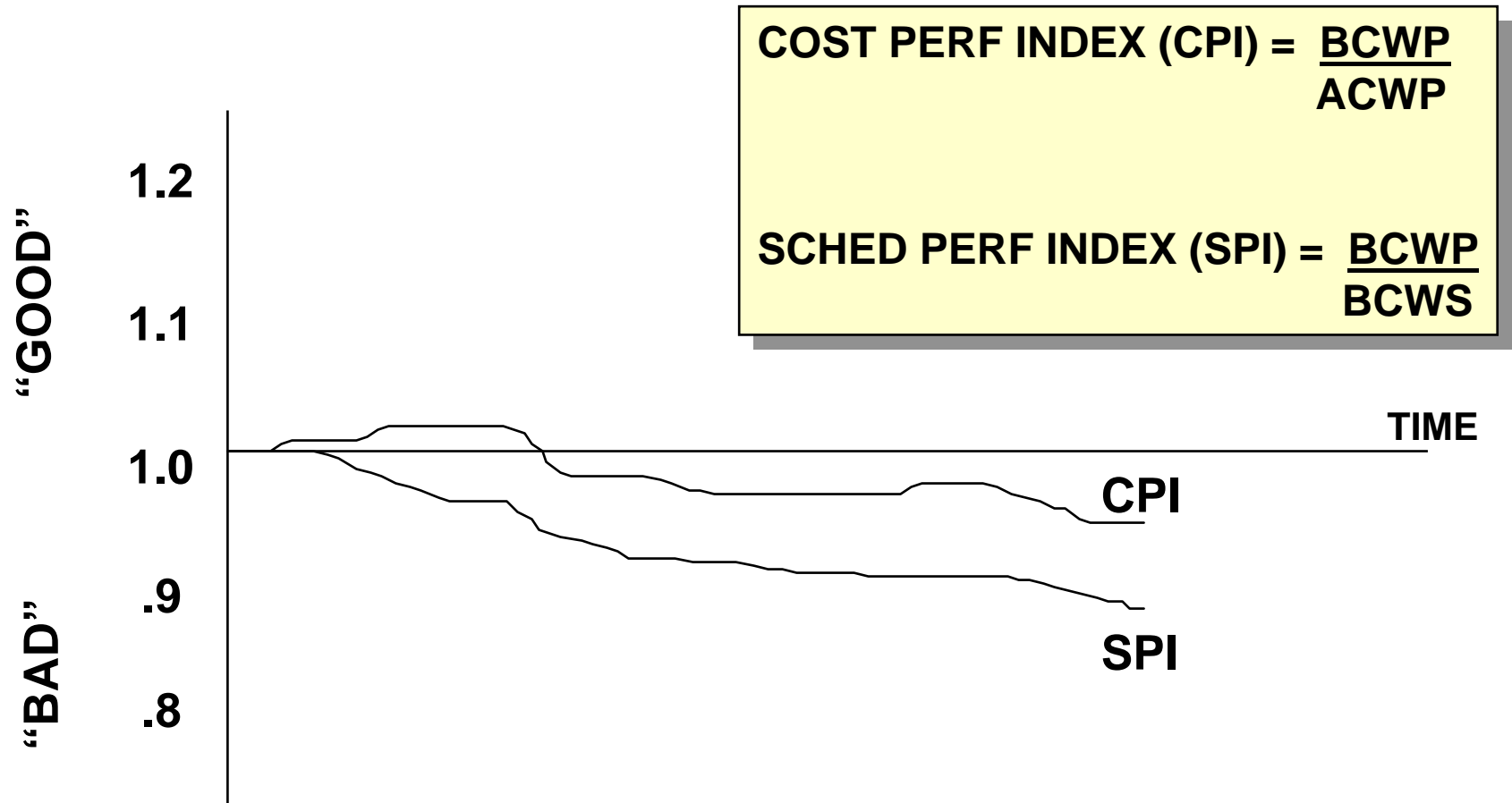


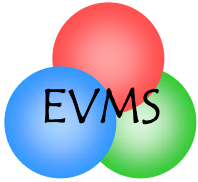
	WBS	DESCRIPTION	Proj Ofcr	%Comp	%Spent	CPI	CV	CV	CV %	VAC	VAC
1	3600	PCC	Zepka	28.99	34.09	0.850	↑	-296.2	-17.62	↔	-187.2
2	3200	COMMUNICATIONS	Tideman	34.63	41.03	0.844	↓	-130.8	-18.49	↔	-87.0
3	G&A	GEN & ADMIN		33.67	36.11	0.932	↓	-45.2	-7.26	↔	-36.8
4	2200	SYS ENGINEERING	Price	85.04	94.35	0.901	↓	-26.4	-10.95	↔	0.0
5	3800	I & A	Troop	35.40	37.08	0.955	↓	-24.2	-4.75	↔	-24.8
6	2100	PROJ MANAGEMENT	Brown	45.70	48.51	0.942	↔	-17.4	-6.16	↔	-3.2
7	2300	FUNC INTEGRA	Price	71.62	75.23	0.952	↓	-17.4	-5.03	↔	-30.8
8	5200	MANAGEMENT DATA	Simmons	84.18	98.10	0.858	↓	-13.2	-16.54	↑	-16.0
9	3100	SENSORS	Smith	20.87	21.49	0.971	↓	-10.6	-2.94	↔	-21.6
10	4000	SPARES	Blair	17.87	18.90	0.945	↑	-7.8	-5.78	↔	-6.2
11	6200	SYSTEM TEST	Hall	60.82	61.66	0.986	↑	-5.6	-1.38	↔	-2.0
12	5100	ENG DATA	Novak	38.51	52.80	0.729	↓	-4.6	-37.10	↔	0.0
13	MR	MGT RESERVE		0.00	0.00			0.0		↔	439.2
14	UB	UNDIST BUDGET						0.0			0.0
15	COM	COST OF MONEY						0.0			0.0
16	3700	DATA DISPLAY	Troop	41.13	41.13	1.000	↔	0.0	0.00	↔	0.0
17	OV	OVERHEAD						0.0			0.0
18	6100	TEST FACILITIES	Smart	100.00	98.02	1.020	↔	2.0	1.98	↔	0.0
19	3500	COMP PROGRAMS	Pino	46.46	44.66	1.040	↓	3.4	3.87	↔	-1.4
20	6300	PCC TEST	Bond	23.13	22.64	1.021	↓	4.2	2.10	↔	0.0
21	3400	ADPE	Zepka	41.89	39.79	1.053	↓	12.6	5.02	↔	4.6
22	3300	AUX EQUIP	Tideman	27.57	24.33	1.133	↓	78.2	11.73	↓	8.4





# Performance Indices



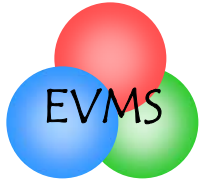


# Mutual Goal: Effective Variance Analysis

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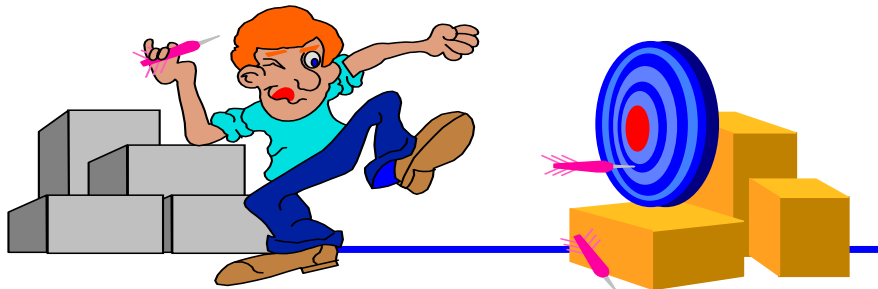
- Make it meaningful
  - avoid routine explanations
- Make it timely
- Make it streamlined
  - significant variances
- Make it right
  - work with contractor to get the information we need
- Get the information to the managers
- Use the information to control the project

**make this a  
mutual goal  
between contractor  
and  
customer**

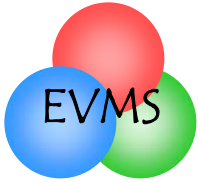


# What will be the final cost?

- **Estimate at Completion (EAC)**
  - **defined as actual cost to date + estimate to complete (ETC)**
  - contractor develops comprehensive EAC at least annually
    - reported by WBS in cost performance report
  - should examine on monthly basis
  - consider the following in EAC generation
    - performance to date
    - impact of approved corrective action plans
    - known/anticipated downstream problems
    - best estimate of the cost to complete remaining work



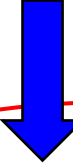
$$\text{EAC} = \text{ACWP} + \text{ETC}$$



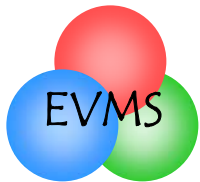
# Basic Formula for “Math” EACs

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$$\text{EAC} = \text{ACWP} + \text{estimate to complete}$$


$$\text{EAC} = \text{ACWP} + \frac{\text{BCWR}^*}{\text{performance factors}}$$

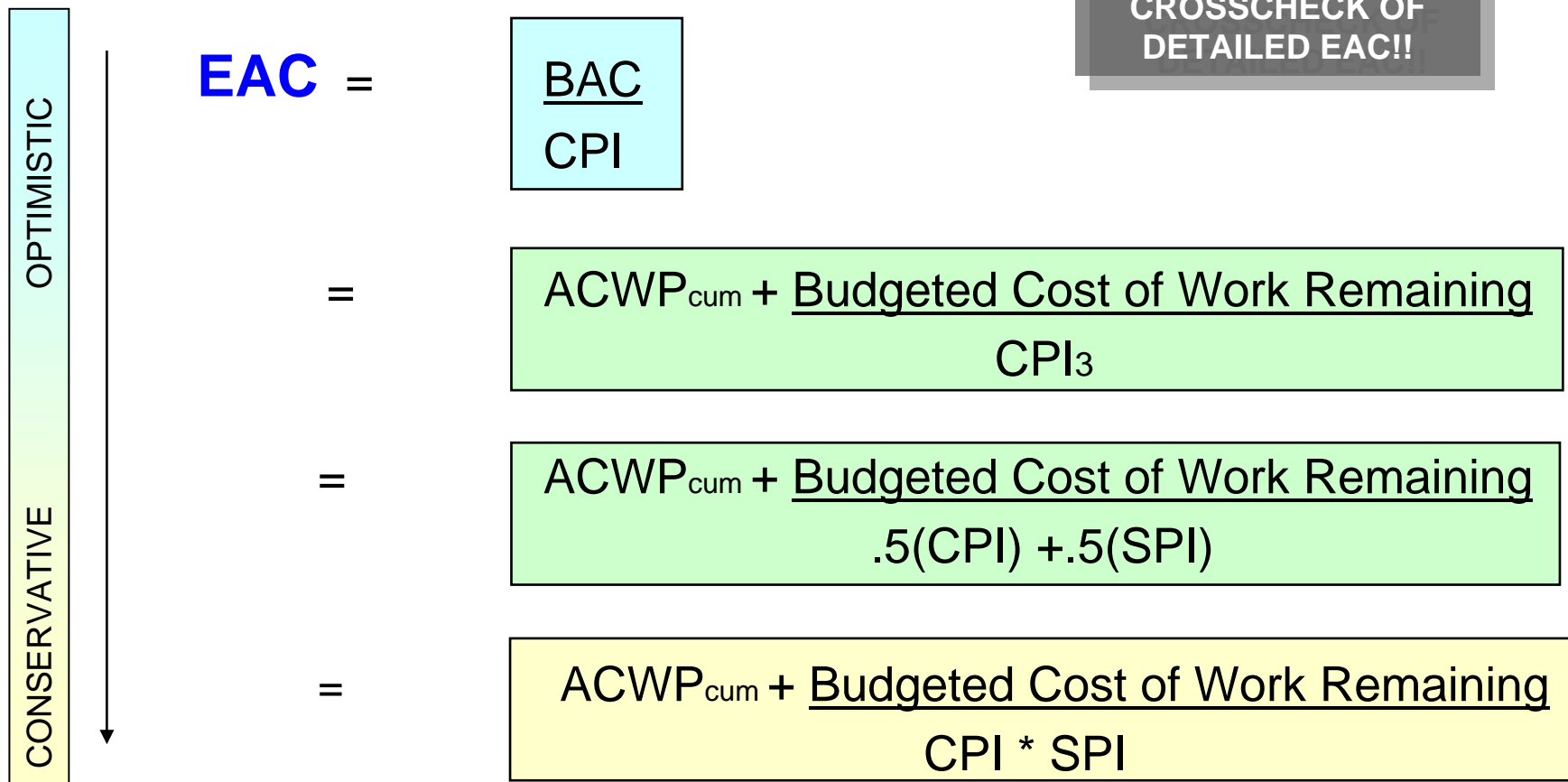
\*Budgeted Cost for Work Remaining = BAC – BCWP

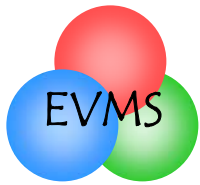


# Common “Math” EACs

## Common EAC Formulae:

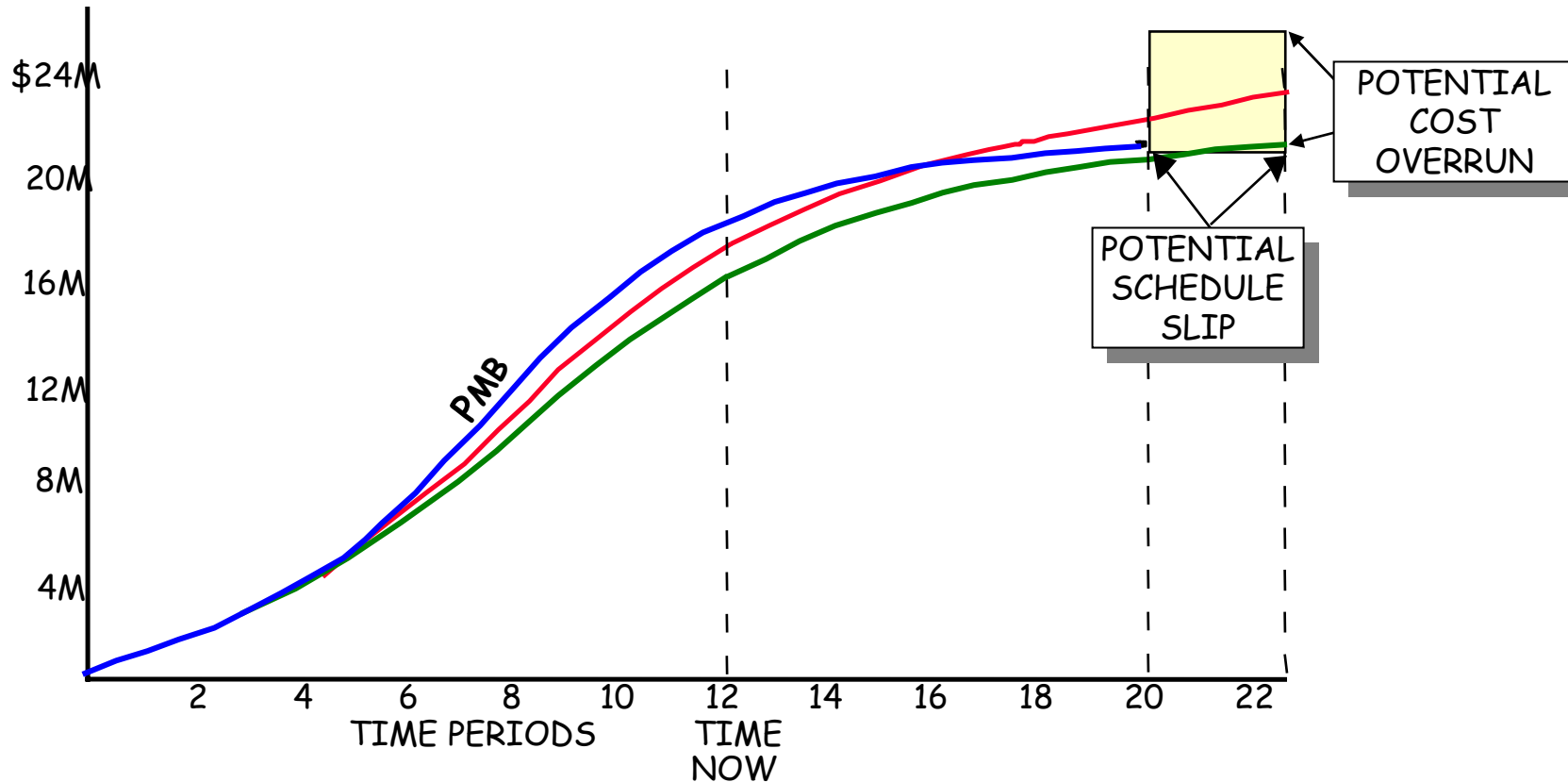
USE AS  
CROSSCHECK OF  
DETAILED EAC!!



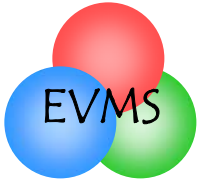


# The "Box of Uncertainty"

(courtesy Swedish Defense Material Administration)

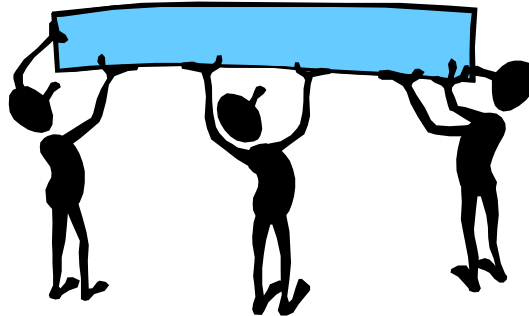


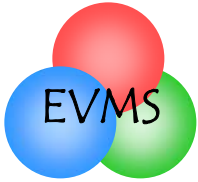
**BOX OF UNCERTAINTY SHOWS POTENTIAL RANGE OF COST OVERRUN AND SCHEDULE SLIP**



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# Managing with Earned Value Data

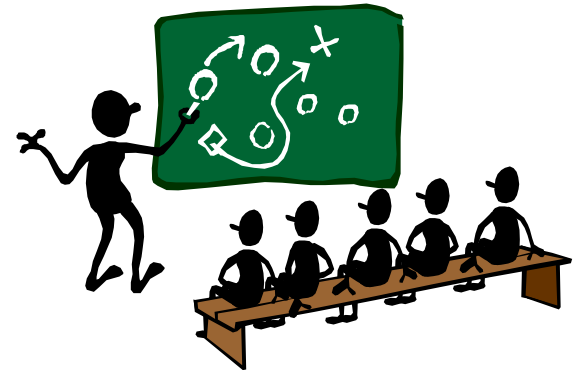


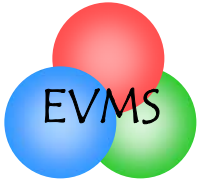


# Project Manager Responsibilities

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- Assign integrated responsibility to teams
- Demand accountability
- Ask tough questions
  - project office
  - contractor
- Look ahead – manage the risks
- Integrated analysis and reviews
  - EVMS
  - Integrated Master Schedule
  - Risk Plan
- Manage to the baseline
  - Control statement of work growth
  - Lead assessment of baseline realism
    - Integrated Baseline Review (IBR)
- Call for realistic estimates

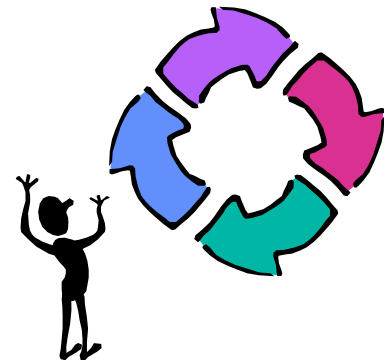


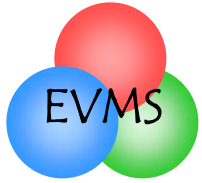


# Summary

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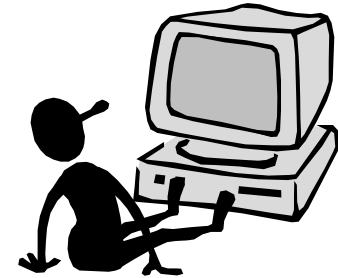
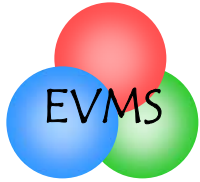
- Be careful to establish correct value for reported BCWP (earned value)
- Set up and maintain system discipline
- Maintain a realistic baseline
- Analyze earned value data
- Calculate a realistic estimate at completion
- Manage with earned value data





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# Back-Ups



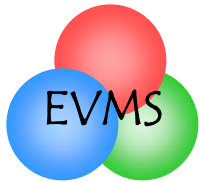
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## Additional References

<http://www.pmi-cpm.org>

<http://www.acq.osd.mil/pm>




[https://acc.dau.mil/simplify/ev\\_en.php?ID=8681\\_201&ID2=DO\\_TOPIC](https://acc.dau.mil/simplify/ev_en.php?ID=8681_201&ID2=DO_TOPIC)



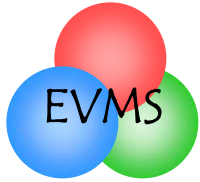
# Weighted Milestones (50/50)

Legend

Baseline work package schedule

	January	February	March	April	Total Budget
Work Package Milestones					
Resource Plan	500	500			1,000
BCWS	500	500			1,000
BCWP	500	0	500		1,000
Schedule Variance	0	(500)	500	0	0

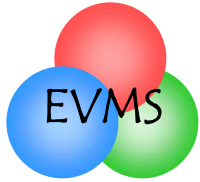
- Used for work packages less than 2 months in length
- Easy to measure: automatically earn 50% when the work package is opened and 50% when the work is complete (package closed)
- Can result in schedule variance if effort takes longer than 2 months
- Must use same method to phase budget



# Weighted Milestones (0/100)

	January	February	March	April	Total Budget
Work Package Milestones					
Resource Plan	1,000				1,000
BCWS	1,000				1,000
BCWP	0	1,000			1,000
Schedule Variance	(1,000)	1,000	0	0	0

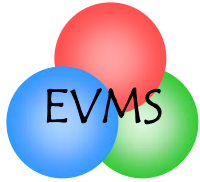
- Used for work packages less than 1 month in length (e.g., material receipt)
- Easy to measure: automatically earn 100% only when the work is complete and the work package closed
- Can result in schedule variance if effort takes longer than 1 month
- Must use same method to phase budget



# Units Completed

	January	February	March	April	Total Budget
Work Package Milestones					
Planned Units	4	5	5		14
Estimated cost/unit: \$100					
BCWS	400	500	500		1,400
Units Completed	3	3	4	4	14
BCWP	300	300	400	400	1,400
Schedule Variance	(100)	(200)	(100)	400	0

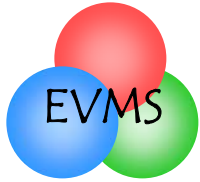
- Planned budget is identical for each unit
- Appropriate when typical output is counted and measured, e.g., construction or manufacturing operations
- Progress is measured by counting output and multiplying by budgeted value per unit



# Equivalent Units

	January	February	March	April	Total Budget
Work Package Milestones					
Planned Units	4	5	5		14
Estimated cost for component A (35 standard hours): \$1,200				<u>#/unit</u> 3	<u>Total cost per unit</u> 3,600
Estimated cost for component B (4 standard hours): \$120				4	480
					<u>\$ 4,080</u>
BCWS	16,320	20,400	20,400		57,120
Units Completed	3 complete, 1 partial	3 complete, 2 partial	4 complete	balance	14
BCWP	13,680	18,720	16,320	8,400	57,120
Schedule Variance	(2,640)	(1,680)	(4,080)	8,400	0

- Appropriate when typical output is manufacturing and assembly of units, with planned standard hours or unit standards per component
- Progress is measured by determining completed components per assembly and multiplying by appropriate budget value per standard
- Can be complicated to plan and track



# AppORTIONED

	January	February	March	April	Total Budget
Work Package Milestones					
BCWS for Base Work Package (Assembly)	2,000	4,000	3,000		9,000
% for AppORTIONED Package (Inspection)					7%
BCWS (Inspection)	140	280	210		630
Reported BCWP (Assembly)	1,000	2,500	3,200	2,300	9,000
BCWP (Inspection)	70	175	224	161	630
Schedule Variance	(70)	(105)	14	161	-

- Established relationship between discrete work package (base) and the dependent work package
- BCWS and BCWP are calculated by applying a factor (%) to the discrete work package
- Percentage factor should be derived from history