Linking Risk and Earned Value Analyses

Theory and Example

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Abstract
Linking Risk and EV

- Show critical to the linkage is the network schedule
  - Discuss the EVMS requirements, misconception of EV
  - Trends in EV policy … risk emphasis growing
- Review the level at which analysis is conducted
  - The Control Account … what level WBS is that?
  - Traditional research at WBS level 1 (or zero)
- Discussion of current linkage efforts

- Discuss new risk indexes
  - For Schedule (time) and Cost (dollars)
  - Synergy with Earned Value indexes

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Acquisition Review Quarterly
Special Edition on Risk - Spring 2003

- **Copy in Print or DAU web page (www.dau.mil)**
- **Editors – LtCol John Driessnack & Noel Dickover**

- **My two cents- quotes from article**

  - **…implementation of risk management is often shallow and not well integrated with other program management tools**
  - **Transparency relative to program status is going to increase as each service expands its information systems, …**
  - **The emphasis on risk, realism, and knowledge-based acquisition has the potential to truly transform the way we view acquisition programs.**
  - **… move beyond standard program baselines with point estimates…transparency into the risks in a program by exposing the *range* in the estimate, given the risks involved, …**

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Risk Management Team

- Team Co-Leads are
  - Gay Infanti (Northrop Grumman)
  - John Driessnack (MCR LLC)
- DAU Community of Practice (CoP) Site

  https://acc.dau.mil/rmevm

- Working Policy, Process and Training

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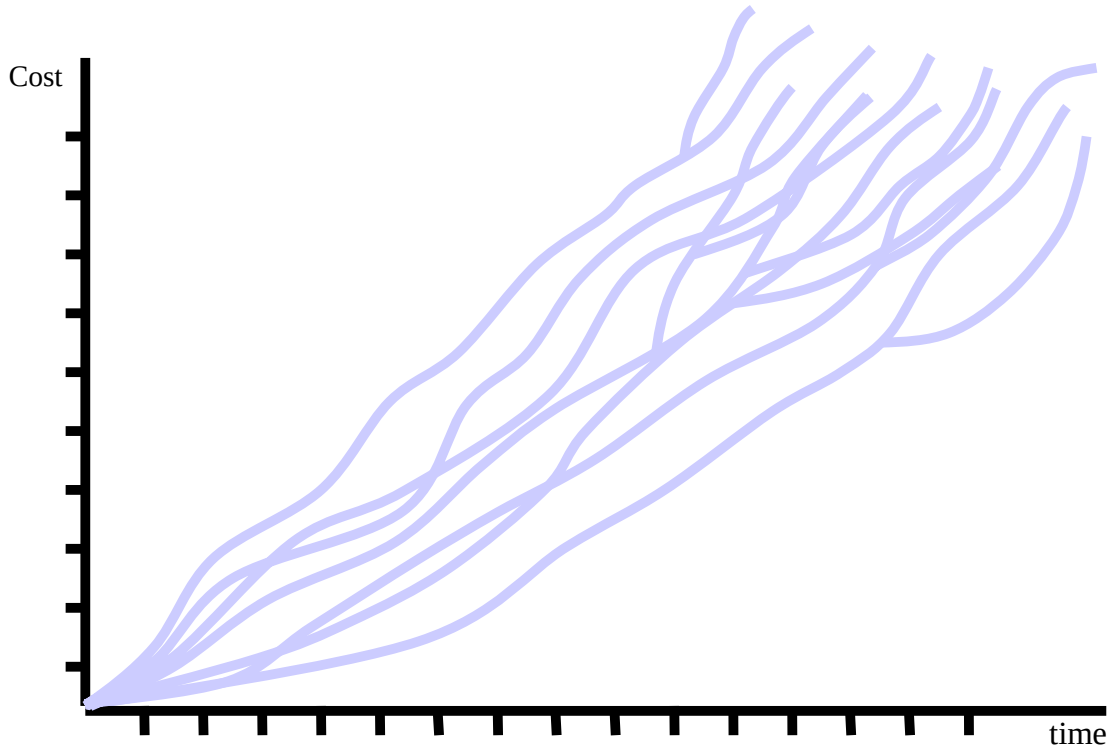
Possible Outcomes

Programs Baseline a path

Many outcome paths are possible
Analyst's distribution represents uncertainty

- **Projects are open systems.**
- **Events out of plan need decisions.**
- **Different decisions give different paths.**



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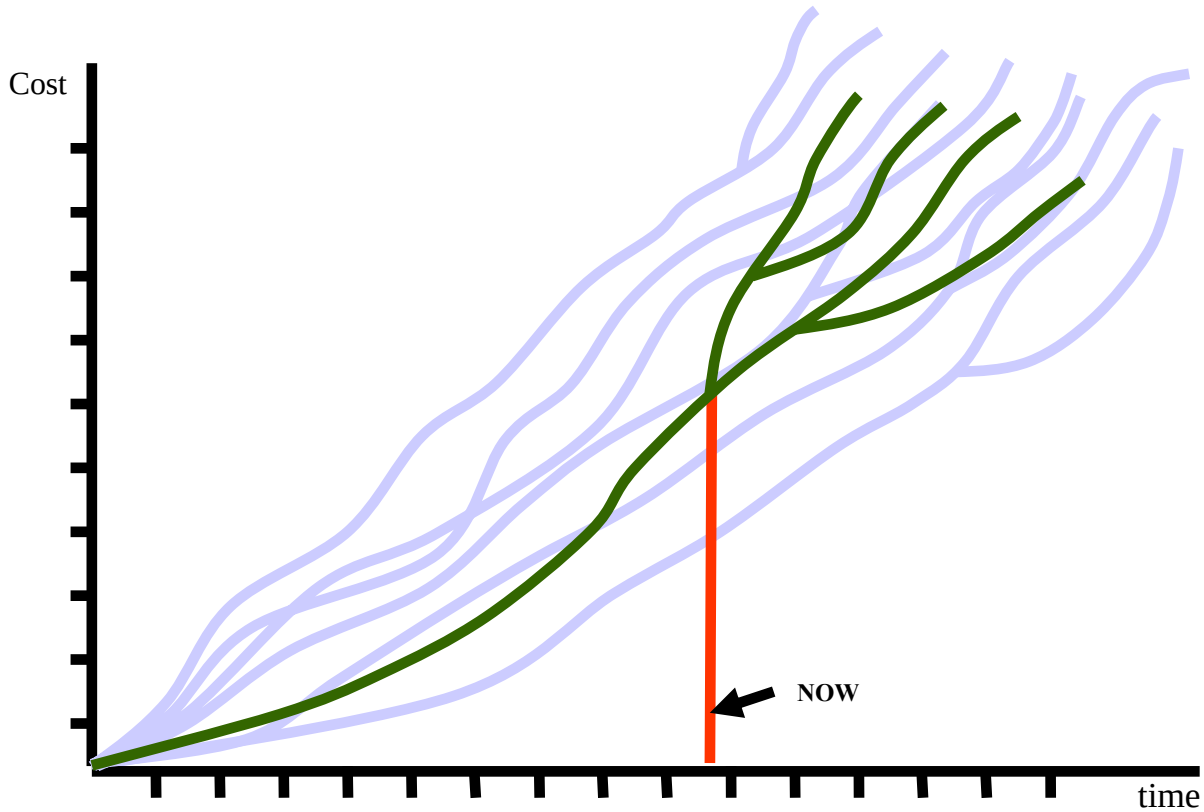
Possible Outcomes

During Execution

During execution, many outcome paths are still possible. Only the past history becomes determined.

- **The number of future branch points is reduced but never becomes zero.**
- **Different decisions still give different paths.**



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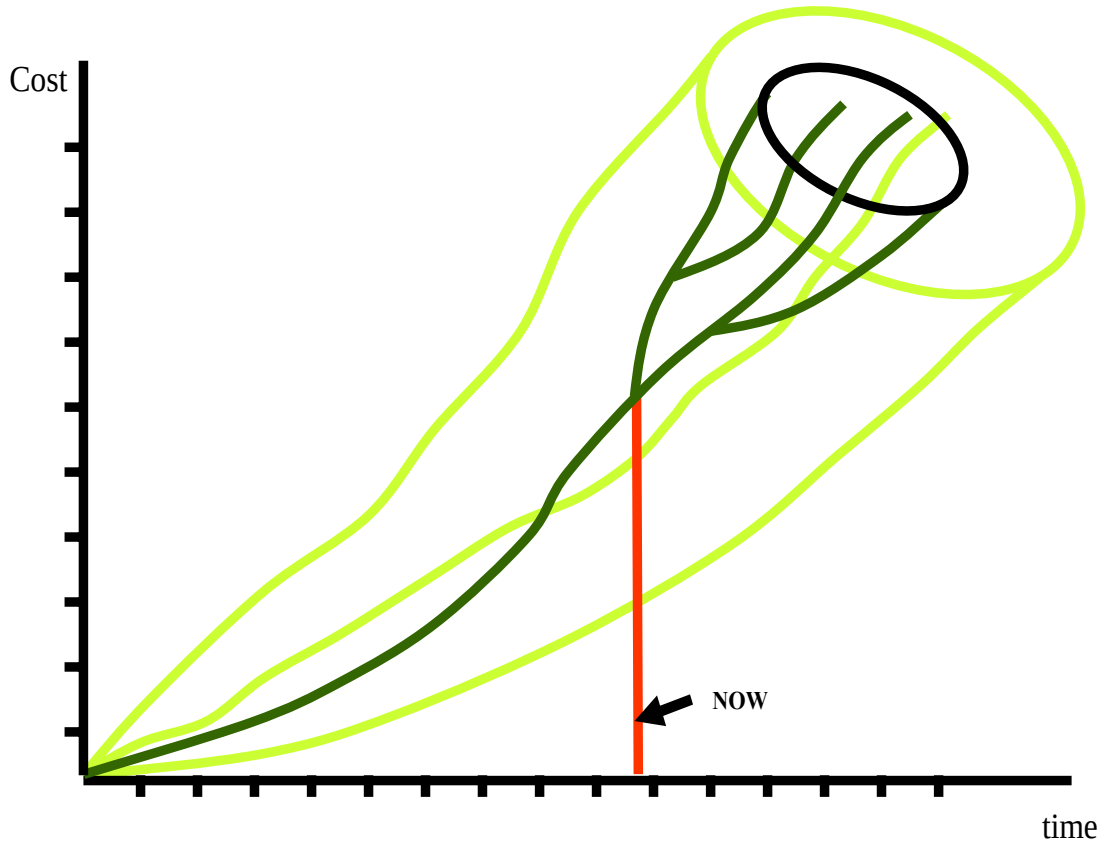
Progress Only Narrows Uncertainty Ellipse

The range of outcomes narrows but doesn't shrink to a point.
The original estimate may shift in the expected 50th percentile outcome. Expect the variance will shrink as the program is executed if all is well.



Need to link Risk and EV ….through IMS and cost estimates to characterize the changing uncertainty

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Charter and Approach

- **Develop and recommend policy, process guidance, and training to support the integration of risk management with earned value management. Work with the risk management community to achieve process integration.**

- **Incorporating integration into various documents**
  - **DoD EV policy, Mar 2005, highlight emphasis on risk analysis**
  - **DoD IMP/IMS guide, Oct 2005, …schedule risk analysis**
  - **NDIA Application Guide, Jan 2006 draft, ..updating with links**
  - **DoD Risk Guide, Mar 2006 draft, …updating with links**
  - **Encourage risk/IMS data in Contract Performance Report**
    - **Format 6 (IMS metrics), Format 7 (Risk register)**

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Process

- Working group identified two process-related issues
  - A need for solutions, i.e., guidance for how to integrate risk management and EVM
  - A major organizational barrier to process integration
    - RM and EVM usually have different process owners/Champion
- Reach out and partner with other communities to create the demand for process integration through cross-functional cooperation and to develop solutions
  - Involve PMI and INCOSE Risk SIGs to gain cooperation
  - Involve Tool suppliers to encourage implementation
  - Develop process solutions to facilitate integration
    - Pilot proposals with programs, gain feedback on usefulness
      - Work group holding CPM conf Practice Symposium sessions, May 06
    - Encourage criteria based risk process similar to Earned Value

MCR is piloting integration using Risk Indexes

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Earned Value Management Definition

ANSI/EIA 748-98A

- EVMS for program management will effectively integrate the work scope of a program with the schedule and cost elements for optimum program planning and control. The primary purpose of the system is to support program management. The system is owned by the company and is governed by company policies and procedures.
- The essence of EVM is that at some level of detail appropriate for the degree of technical, schedule, and cost risk or uncertainty associated with the program, a target planned value (i.e., budget) is established for each schedule element of work

Better support by understanding Uncertainty
Manage at element of work

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Some EVM Principles

ANSI/EIA 748-98A

- Break down the program work scope into finite pieces that can be assigned to a responsible person or organization for control of technical, schedule, and cost objective.
- Integrate program work scope, schedule, and cost objectives into a performance measurement baseline plan against which accomplishments may be measured. Control changes to the baseline.
- Objectively asses accomplishments at the work performance level
- Analyze significant variances from the plan, forecast impacts, and prepare an estimate at completion based on performance to data and work to be performed.
- Use EVMS information in the company's management processes.

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EVM Principles related to Risk Management

- Control of technical, schedule, and cost objective…
  - Understand the uncertainties (how likely will they happen)
  - What are assumptions for the baseline plan?
    - What is the confidence in meeting the objective?
    - How are the risks/opportunities being managed?
- Analyze significant variances …forecast impacts… prepare an estimate at completion (EAC)
  - EAC has a range …best, worse and most likely case
  - What risk/opportunities are assumed in the estimate?
- Use EVMS information in the company's management processes.
  - How does Risk Management use of EVM?

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New DoD EV Policy

- 7 Mar 2005 Ltr
  - Greater than $20M, all types of cost contracts
  - Implement New DiDs and WBS Handbook
  - C/SSR rescinded (except on old contracts)
  - Integrated Baseline Reviews (IBRs) required
  - If on Price contracts, reexamine contract type

- Contract Performance Report (DiD-MGMT-81466)
- Integrated Master Schedule (DiD-MGMT-81650)
- DoD Work Breakdown Structure Handbook,

  MIL-HDBK-881A

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CPR Formats

- Contract Performance Report (DiD-MGMT-81466)
- FORMAT 1 - WORK BREAKDOWN STRUCTURE
  - Current month and cum by Product WBS
- FORMAT 2 - ORGANIZATIONAL CATEGORIES
  - Current month and cum by Organization
- FORMAT 3 – BASELINE
  - Budget Cost of Work Schedule…next 6 months and out
- FORMAT 4 – STAFFING
  - Man Months…next 6 months and out
- FORMAT 5 - EXPLANATIONS AND PROBLEM ANALYSES

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CPR Format 1
DiD MGMT-81466

- Estimated Cost at Completion … present the contractor/s range of estimated costs at completion … express possible cost outcomes…through program-level assessments of factors that may affect the cost, schedule, or technical outcomes…
- Assessments shall include consideration of known or anticipated risk areas, and planned risk reductions or cost containment measures.
- Most Likely … value need not agree with the total of Column (15)…however, any difference shall be explained in Format 5 in such terms as risk, user of MR…

Procedure to link Estimate to Complete by CAM to Risk Management ….mitigation plan, range of estimates, etc…

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CLASSIFICATION (When Filled In)

CONTRACT PERFORMANCE REPORT
FORMAT 1 - WORK BREAKDOWN STRUCTURE

DOLLARS IN

FORM APPROVED
OMB No. 0704-0188

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1. CONTRACTOR
a. NAME
b. LOCATION (Address and ZIP Code)

2. CONTRACT
a. NAME
b. NUMBER
c. TYPE
d. SHARE RATIO

3. PROGRAM
a. NAME
b. PHASE
c. EVMS ACCEPTANCE
NO YES (YYYYMMDD)

4. REPORT PERIOD
a. FROM (YYYYMMDD)
b. TO (YYYYMMDD)

5. CONTRACT DATA

a. QUANTITY	b. NEGOTIATED COST	c. ESTIMATED COST OF AUTHORIZED UNPRICED WORK	d. TARGET PROFIT/ FEE	e. TARGET PRICE	f. ESTIMATED PRICE	g. CONTRACT CEILING	h. ESTIMATED CONTRACT CEILING	i. DATE OF OTB/OTS (YYYYMMDD)

6. ESTIMATED COST AT COMPLETION

	MANAGEMENT ESTIMATE AT COMPLETION (1)	CONTRACT BUDGET BASE (2)	VARIANCE (3)
a. BEST CASE			
b. WORST CASE			
MOST LIKELY			

7. AUTHORIZED CONTRACTOR REPRESENTATIVE
a. NAME (Last, First, Middle Initial)
b. TITLE
c. SIGNATURE
d. DATE SIGNED (YYYYMMDD)

8. PERFORMANCE DATA

ITEM (1)	CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2)	CURRENT PERIOD BUDGETED COST WORK PERFORMED (3)	CURRENT PERIOD ACTUAL COST WORK PERFORMED (4)	CURRENT PERIOD VARIANCE SCHEDULE (5)	CURRENT PERIOD VARIANCE COST (6)	CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7)	CUMULATIVE TO DATE BUDGETED COST WORK PERFORMED (8)	CUMULATIVE TO DATE ACTUAL COST WORK PERFORMED (9)	CUMULATIVE TO DATE VARIANCE SCHEDULE (10)	CUMULATIVE TO DATE VARIANCE COST (11)	REPROGRAMMING ADJUSTMENTS COST VARIANCE (12a)	REPROGRAMMING ADJUSTMENTS SCHEDULE VARIANCE (12b)	REPROGRAMMING ADJUSTMENTS BUDGET (13)	AT COMPLETION BUDGETED (14)	AT COMPLETION ESTIMATED (15)	AT COMPLETION VARIANCE (16)
a. WORK BREAKDOWN STRUCTURE ELEMENT																
b. COST OF MONEY																
c. GENERAL AND																
d. UNDISTRIBUTED BUDGET																
e. SUB TOTAL (PERFORMANCE MEASUREMENT BASELINE)																
f. MANAGEMENT RESERVE																
g. TOTAL																

9. RECONCILIATION TO CONTRACT BUDGET BASE

a. VARIANCE ADJUSTMENT																
b. TOTAL CONTRACT VARIANCE																

DD FORM 2734/1, MAR 05

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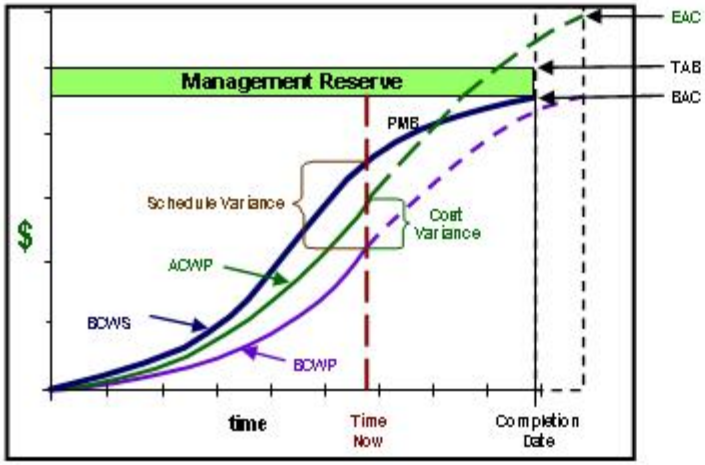
CLASSIFICATION (When Filled In)

Earned Value Management
'Gold Card'
Defense Acquisition University



VARIANCES Favorable is Positive, Unfavorable is Negative

Cost Variance	CV	= BCWP – ACWP	CV % = (CV / BCWP) * 100
Schedule Variance	SV	= BCWP – BCWS	SV % = (SV / BCWS) * 100
Variance at Completion	VAC	= BAC – EAC	

PERFORMANCE INDICES Favorable is > 1.0, Unfavorable is < 1.0

Cost Efficiency	CPI	= BCWP / ACWP
Schedule Efficiency	SPI	= BCWP / BCWS

OVERALL STATUS

% Schedule = $(BCWS_{cum}$ / BAC) * 100

% Complete = $(BCWP_{cum}$ / BAC) * 100

% Spent = $(ACWP_{cum}$ / BAC) * 100

ESTIMATE AT COMPLETION *

EAC = Actuals to Date + [(Remaining Work) / (Efficiency Factor)]

EAC_{CPI} = $ACWP_{cum}$ + [(BAC – $BCWP_{cum}$) / CPI_{cum}] = BAC / CPI_{CUM}

$EAC_{Composite}$ = $ACWP_{cum}$ + [(BAC – $BCWP_{cum}$) / (CPI_{cum} * SPI_{cum})]

TO COMPLETE PERFORMANCE INDEX (TCPI) *

$TCPI_{EAC}$ = Work Remaining / Cost Remaining = (BAC – $BCWP_{cum}$) / (EAC – $ACWP_{cum}$)

* To Determine Either TCPI or EAC; You May Replace BAC with TAB

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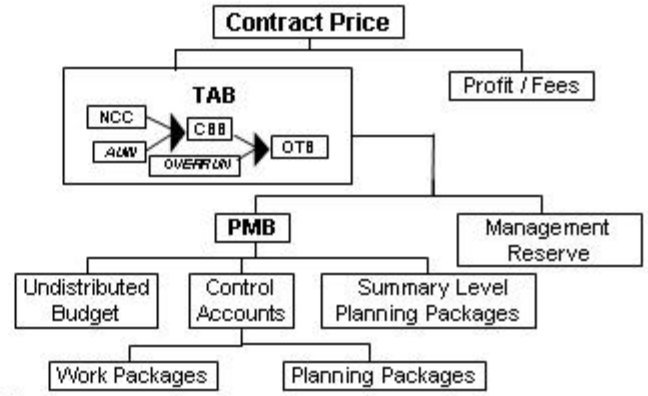

TERMINOLOGY

NCC Negotiated Contract Cost — Contract price less profit / fee(s)

EAC formulas assume fixed BAC

- If risks are realized won't Budget need to change?

- Are positive, non-critical path, tasks counterbalancing negative critical tasks, thus under estimating worse case EAC?
    - Need to correlate risks and opportunities

Standard EAC Formulas
What Value to PM?

- Gold Card EAC Formulas are good oversight tools
  - Research indicates they predict the "floor" … what is the range?
  - Doesn't capture any analysis, known or anticipated risk areas, nor planned risk reductions or cost containment measures
- Need for Cost, Schedule and Risk practitioners to assist the CAMs/PM to develop range of estimate
  - Enlighten management action at element of work
- The primary purpose of EVMS is to support program management, not provide data for oversight

EVMS is a control and measurement system for cost, schedule and technical performance – not just cost

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Integrated Master Schedule
DiD-MGMT-81650

- Detail data on – task, milestone, duration, % complete, relationship, float/slack, critical path, etc
- Identify the – constraints (finish no later than, etc), current schedule, baseline schedule, forecasted starts and finishes, etc
- Schedule Margin – considered part of the baseline!
- Schedule Risk Assessment Prediction with most likely, best/worst case estimates on remaining tasks
  - Assess critical and near critical path, margin erosion, and mitigation plans
  - Risk analysis within the IMS or within a separate risk tool
- Submit prior or concurrent with format 5 on CPR

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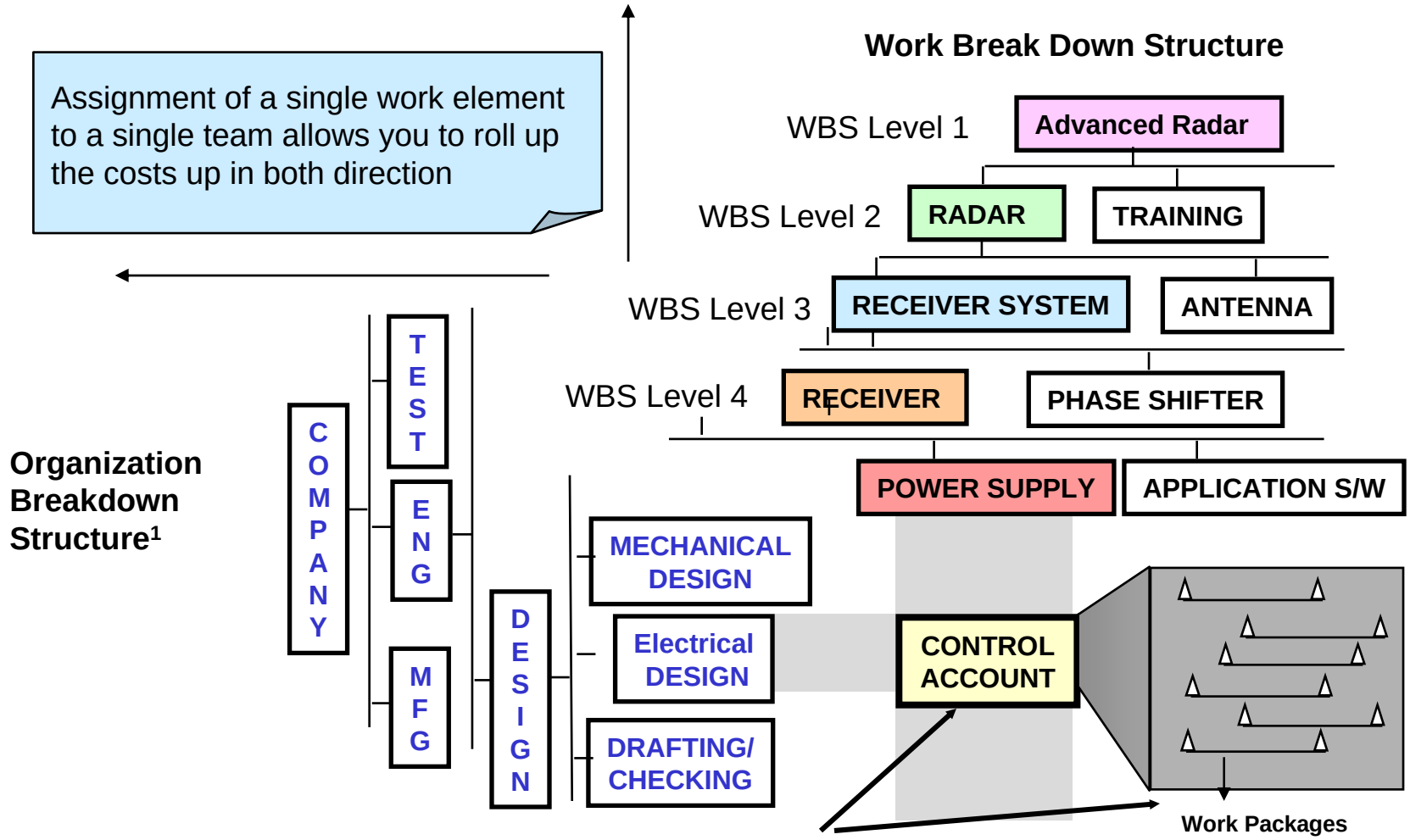
Control Account
OBS and WBS

Assignment of a single work element to a single team allows you to roll up the costs up in both direction



[1]Organization performing the work

This is the level for analysis … cost, schedule, risk

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Control Account Elements

Work Packages

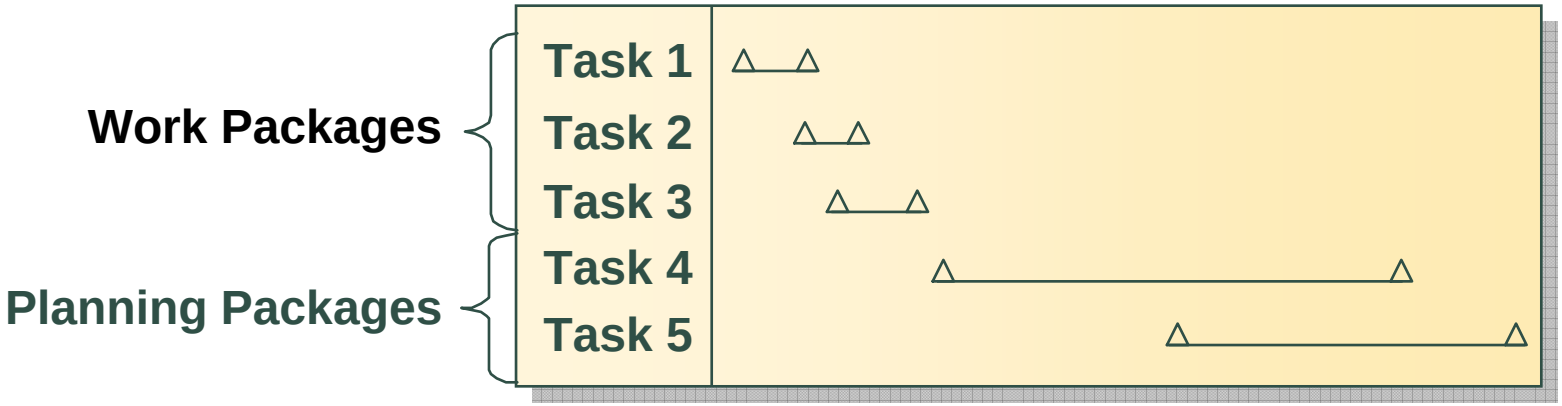
Detailed, short-span tasks, or material items, required to accomplish the CA objectives, typically in the near term

(resources)

Planning Packages

Future work that has not been planned in detail as work packages. They are always scheduled to occur in the future.

(budget)



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Cost/Schedule Analysis
should include Risk Analysis

- **WBS-Element are Uncertain in Dollars/Time**
- **Baseline should consider the effects of uncertainty**
  - **Not a risk or opportunity till baseline is set**
  - **Should model WBS-Element as Random Variables with a Distribution of values**
  - **Combine Element Distributions to Generate Cumulative Distribution of Total System …in time and dollars**
  - **Determine confidence from Cumulative Distribution to establish baseline needed to cover Risk at an Acceptable Level**

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Uncertainties are Correlated

- Impacts on one WBS item often means impact on other WBS items
  - **For example, technical risks in radar subsystem will induce weight (and therefore) cost growth in power, platform, software, and other subsystems**
  - **Schedule slippage due to problems in one WBS element lead to cost growth in other elements ("standing army effect")**
  - **Hardware problems discovered late in program often have to be circumvented by making expensive last-minute fixes to the software (which then show up as software cost overruns)**
- Inter WBS item correlation increases the variance of the total probability distribution
- Numerical values of correlations are difficult to estimate, but not impossible to guess or determine from data
  - **Schedule network find the critical paths, strongest interactions**

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Worked Examples

- Small program of 12 identical WBS items estimated at 3M$ low, 4M$ most likely and 5M$ high:

WBS item	L	ML	H
1	3	4	5
2	3	4	5
3	3	4	5
4	3	4	5
5	3	4	5
6	3	4	5
7	3	4	5
8	3	4	5
9	3	4	5
10	3	4	5
11	3	4	5
12	3	4	5

Example Cases	Correlation
Case 1	0
Case 2	0.2
Case 3	1
Case 4	WBS items ## 1,2,3 1.0 others at 0.2

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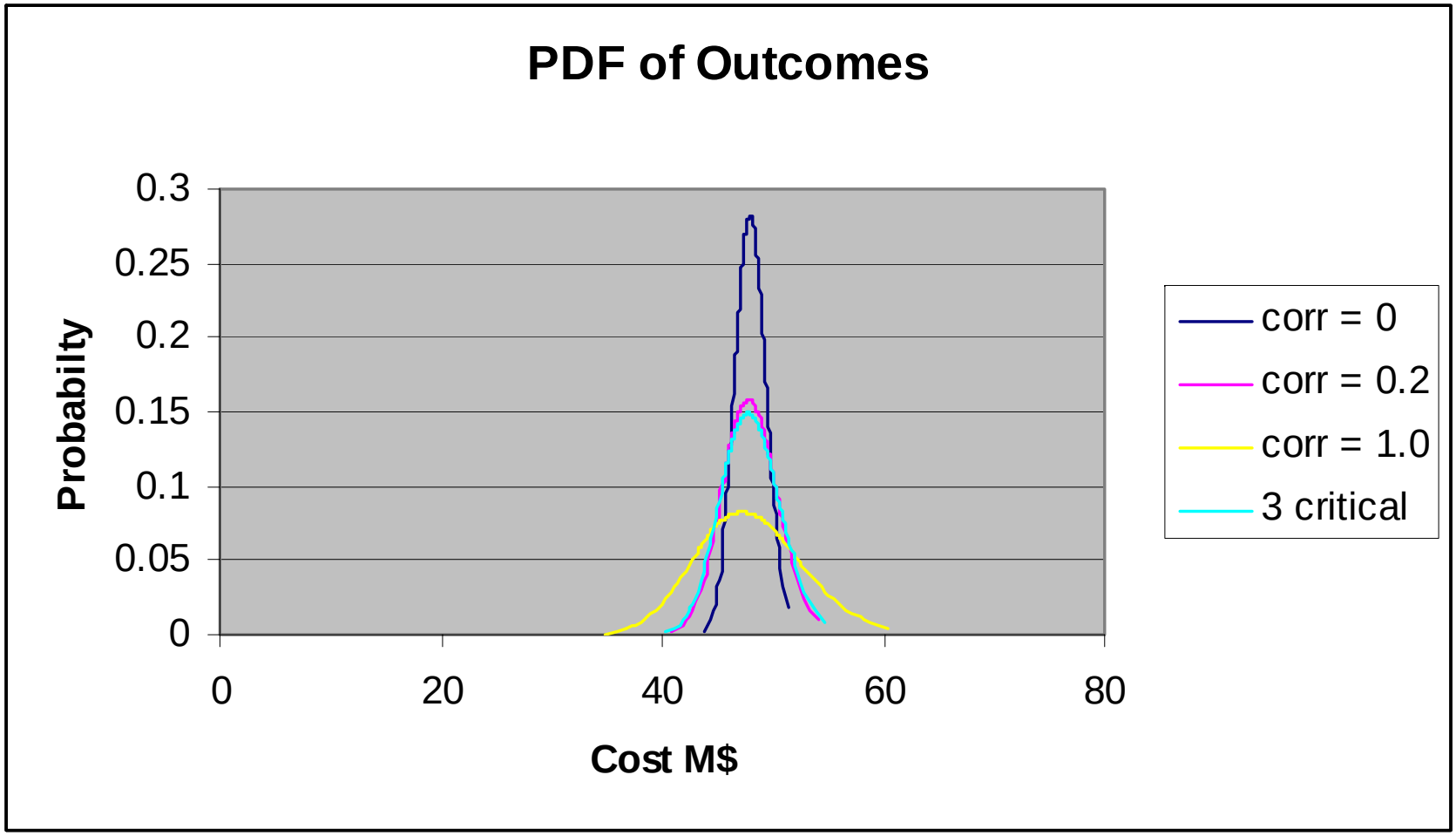
Distribution of outcomes



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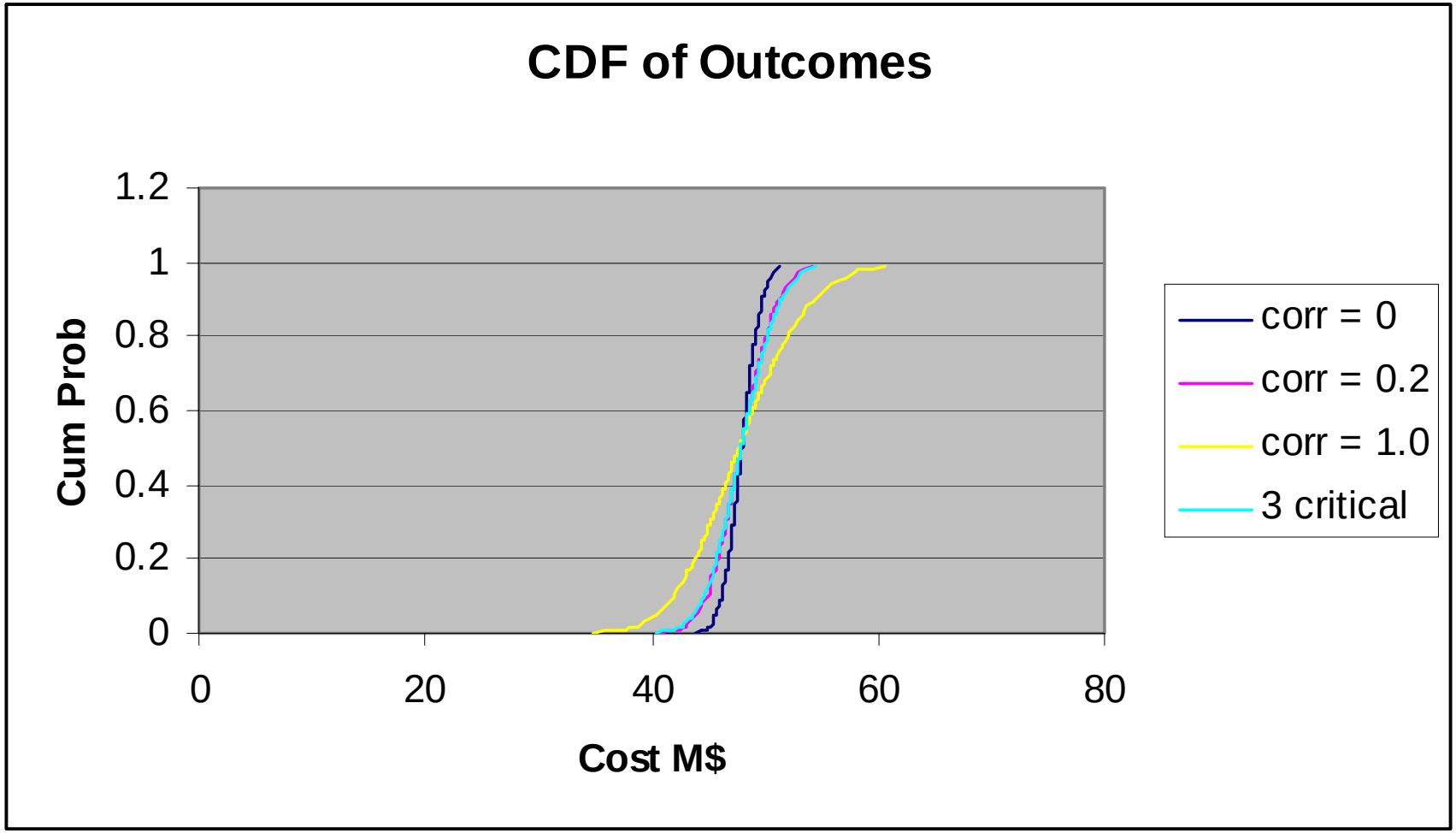
Cumulative Distribution of Outcomes



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Budgetary Bottom Line

- For our examples correlation makes a factor of 3 difference in management reserve (at 75% confidence):

Example Cases	Correlation	ML Cost	MR	Budget
Case 1	0	48	1	49
Case 2	0.2	48	2	50
Case 3	1	48	3	51
Case 4	WBS items ## 1,2,3 1.0 others at 0.2	48	2	50

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Expand Analysis

- The Earned Value (EV) analysts work without broader analytical insights
  - Understand the possible ranges of the Budgeted Cost of Work Scheduled (BCWS) (the plan) but.....
  - Lack insight into the risks that drive the range…how might those effect the baseline
- So then
  - The EV analyst calculate the EAC as the sum of most likelies at the control account level which tends to make the point estimate overly optimistic
  - When required, other analysts often update estimates without the EV detail plan and performance

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Expand Analysis (Cont'd)

- **CAM and many Analysts don't understand the cumulative probability distribution (CPD) around the selected PMB**
  - **There is no visibility as to which risks are accounted for and which are not**
- **Documentation from various analysis needs to be mapped to identify disconnects**
  - **Comparison at Work Breakdown Structure (WBS) level 3 or 4 can identify potential disconnects between analyses**

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Linking What Each Analyst Does

- Bringing Analysts together to provide synergistic support
- EV data … the Actuals and future BCWS and ETC
  - Should be the most relevant and reliable basis to estimate the program cost and schedule
  - Extrapolate ETC from Actuals today
  - Can use other methodologies as crosschecks
- Add uncertainties at Control Acct/work package
  - Capture possibilities of cost/schedule range
  - Develop ranges at various levels of WBS
- Accomplish when updating ETC

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One Way to Get There on Cost

- **Use standard EAC formulas at the lowest level to set ranges**
  - **Moving 3 month average**
  - **Moving 6 month average**
  - **Latest Revised Estimate**
  - **Others????**
- **Set correlation coefficients between elements**
  - **Never assume no correlation**
  - **When in doubt, use 0.2**
  - **Ideally, derive the correlations from actual trends**
- **Use simulation software or an analytic method to get the cumulative probability distribution for the EAC**

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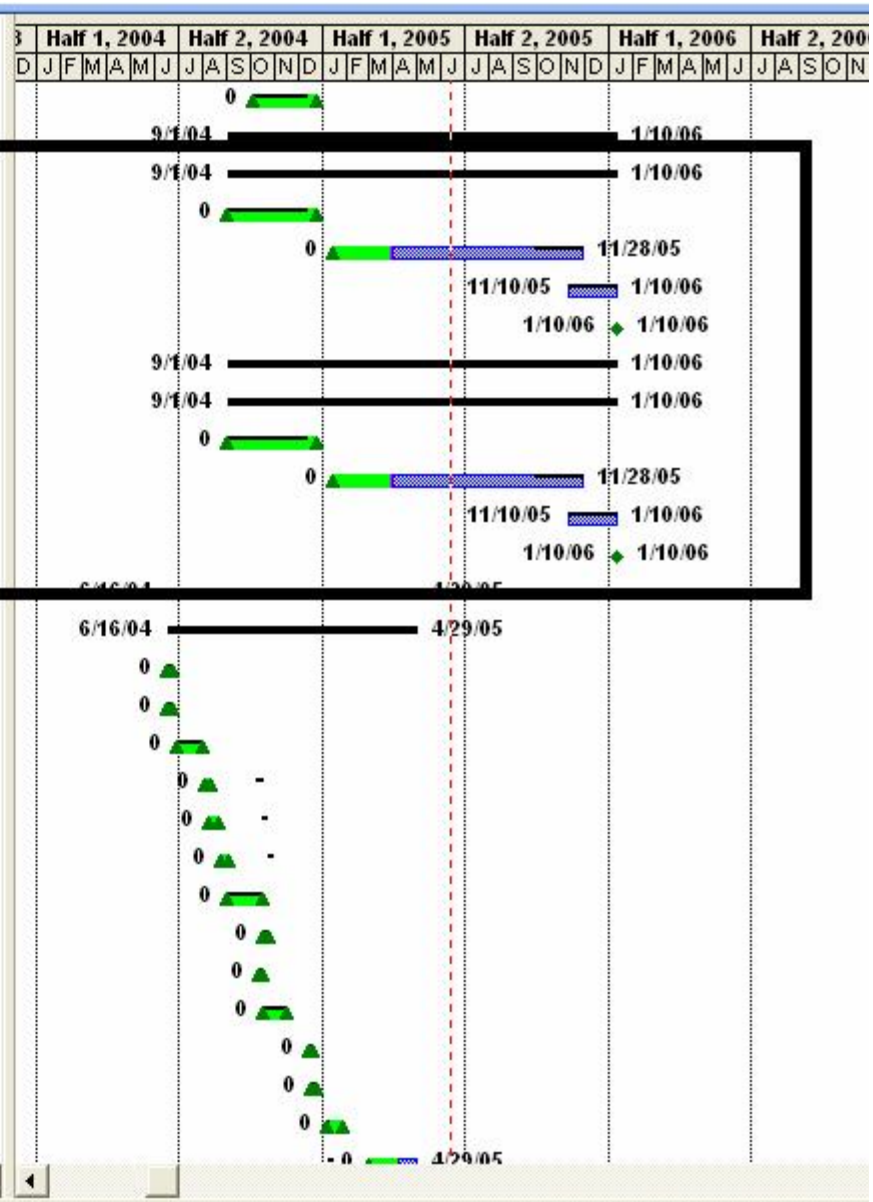
	CWBS	EV Method	Baseline Start	Baseline Finish	Start	Finish
56	1.3.1.2	P	Mon 10/4/04	Fri 12/10/04	Mon 10/4/04	Thu 12/23/04
57	1.3.1.3		Wed 9/1/04	Tue 1/10/06	Wed 9/1/04	Tue 1/10/06
5	1.3.1.3	P	Wed 9/1/04	Tue 1/10/06	Wed 9/1/04	Tue 1/10/06
5	1.3.1.3	P	Wed 9/1/04	Fri 12/10/04	Wed 9/1/04	Thu 12/23/04
6	1.3.1.3	P	Tue 9/27/05	Mon 11/28/05	Fri 1/14/05	Mon 11/28/05
6	1.3.1.3	P	Thu 11/10/05	Tue 1/10/06	Thu 11/10/05	Tue 1/10/06
6	1.3.1.3		Tue 1/10/06	Tue 1/10/06	Tue 1/10/06	Tue 1/10/06
6	1.3.1.4		Wed 9/1/04	Tue 1/10/06	Wed 9/1/04	Tue 1/10/06
6	1.3.1.4	P	Wed 9/1/04	Tue 1/10/06	Wed 9/1/04	Tue 1/10/06
6	1.3.1.4	P	Wed 9/1/04	Fri 12/10/04	Wed 9/1/04	Thu 12/23/04
6	1.3.1.4	P	Tue 9/27/05	Mon 11/28/05	Fri 1/14/05	Mon 11/28/05
6	1.3.1.4	P	Thu 11/10/05	Tue 1/10/06	Thu 11/10/05	Tue 1/10/06
6	1.3.1.4		Tue 1/10/06	Tue 1/10/06	Tue 1/10/06	Tue 1/10/06
6						
70	1.3.1.5	P	Wed 6/16/04	Thu 1/13/05	Wed 6/16/04	Fri 4/29/05
71	1.3.1.5	P	Wed 6/16/04	Tue 6/22/04	Wed 6/16/04	Tue 6/22/04
72	1.3.1.5	P	Wed 6/16/04	Wed 6/23/04	Wed 6/16/04	Tue 6/22/04
73	1.3.1.5	P	Tue 6/29/04	Fri 7/30/04	Tue 6/29/04	Fri 7/30/04
74	1.3.1.5	P	Thu 10/7/04	Thu 10/14/04	Mon 8/2/04	Mon 8/9/04
75	1.3.1.5	P	Thu 10/14/04	Thu 10/21/04	Mon 8/9/04	Fri 8/20/04
76	1.3.1.5	P	Fri 10/22/04	Fri 10/29/04	Mon 8/23/04	Wed 9/1/04
77	1.3.1.5	P	Wed 9/1/04	Fri 10/15/04	Wed 9/1/04	Fri 10/15/04
78	1.3.1.5	P	Fri 10/15/04	Fri 10/22/04	Fri 10/15/04	Fri 10/22/04
79	1.3.1.5	P	Tue 10/12/04	Fri 10/15/04	Tue 10/12/04	Fri 10/15/04
80	1.3.1.5	P	Fri 10/15/04	Tue 11/16/04	Fri 10/15/04	Tue 11/16/04
81	1.3.1.5	P	Mon 12/13/04	Fri 12/17/04	Mon 12/13/04	Fri 12/17/04
82	1.3.1.5	P	Fri 12/17/04	Thu 12/23/04	Fri 12/17/04	Thu 12/23/04
83	1.3.1.5	P	Thu 1/6/05	Thu 1/6/05	Thu 1/6/05	Wed 1/26/05
84	1.3.1.5	P	Fri 1/7/05	Thu 1/13/05	Tue 3/1/05	Fri 4/29/05



	WBS	LVL	Lowe	VAR	BCWS	BCWP	ACWP	SvTrCum	SV	CvTrCum	CV	BAC	SpiCum	CPI	TCPI-BAC	TCPI-LRE
152	1.03	2		scSC	11,618.2	9,017.9	10,776.3	↓	-2,600.3	↓	-1,758.4	88,279.8	0.776	0.837	1.023	1.035
153	1.3.1	3		scCV	574.6	560.6	677.1	↓	-14.0	↓	-116.5	666.1	0.976	0.828	-9.591	1.461
154	1.3.1.1	4	√	scSC	241.3	211.8	266.9	↓	-29.5	↓	-55.1	259.4	0.878	0.794	-6.347	-3.552
155	1.3.1.2	4	√	CV	100.0	100.0	62.6	↔	0.0	↔	37.3	100.0	1.000	1.596	0.000	0.000
156	1.3.1.3	4	√	cSCV	21.8	25.8	33.1	↔	4.0	↓	-7.3	36.1	1.183	0.779	3.433	1.020
157	1.3.1.4	4	√	cSCV	21.9	25.9	37.5	↔	4.0	↓	-11.6	34.2	1.183	0.691	-2.515	0.664
158	1.3.1.5	4	√	cCV	43.5	42.4	64.4	↔	-1.1	↓	-22.0	43.5	0.975	0.658	-0.053	0.136
159	1.3.1.6	4	√	cSCV	11.9	16.1	70.3	↔	4.2	↓	-54.2	37.4	1.353	0.229	-0.647	0.720
160	1.3.1.7	4	√	cSCV	13.6	18.0	49.0	↔	4.4	↓	-31.0	34.9	1.324	0.367	-1.199	0.668
161	1.3.1.9	4	√	CV	119.7	119.7	92.3	↔	0.0	↔	27.4	119.7	1.000	1.297	0.000	0.000
162	1.3.10	3		scSC	67.9	13.3	9.4	↔	-54.6	↓	3.9	10,098.4	0.196	1.415	1.000	1.037
163	1.3.10.1	4	√	scSC	67.9	13.3	9.4	↔	-54.6	↓	3.9	10,098.4	0.196	1.415	1.000	1.037
164	1.3.11	3		c	965.8	963.6	1,035.6	↔	-2.2	↓	-72.0	4,755.7	0.998	0.930	1.019	1.066
165	1.3.11.1	4	√	c	965.8	963.6	1,035.6	↔	-2.2	↓	-72.0	4,755.7	0.998	0.930	1.019	1.066
166	1.3.12	3		sSC	132.4	90.5	77.6	↔	-41.9	↔	12.9	822.2	0.684	1.166	0.983	0.980
167	1.3.12.1	4	√	sSC	88.1	75.1	66.2	↓	-13.0	↔	8.9	649.0	0.852	1.134	0.985	0.998
168	1.3.12.2	4	√	SC	44.3	15.4	11.4	↔	-28.9	↔	4.0	173.2	0.348	1.351	0.975	0.920
169	1.3.13	3		scSC	484.9	390.3	220.7	↓	-94.6	↔	169.6	7,152.1	0.805	1.768	0.976	0.978
170	1.3.13.1	4	√	cC	170.5	170.5	26.6	↔	0.0	↔	143.9	574.1	1.000	6.410	0.737	0.749
171	1.3.13.2	4	√	scS	210.8	123.9	115.0	↓	-86.9	↑	8.9	5,872.3	0.588	1.077	0.998	0.998
172	1.3.13.3	4	√	sC	103.6	95.9	79.1	↓	-7.7	↓	16.8	453.7	0.926	1.212	0.955	0.970

File Edit View Insert Format Tools Project Risk Analysis Collaborate Window Help

Type a question for help

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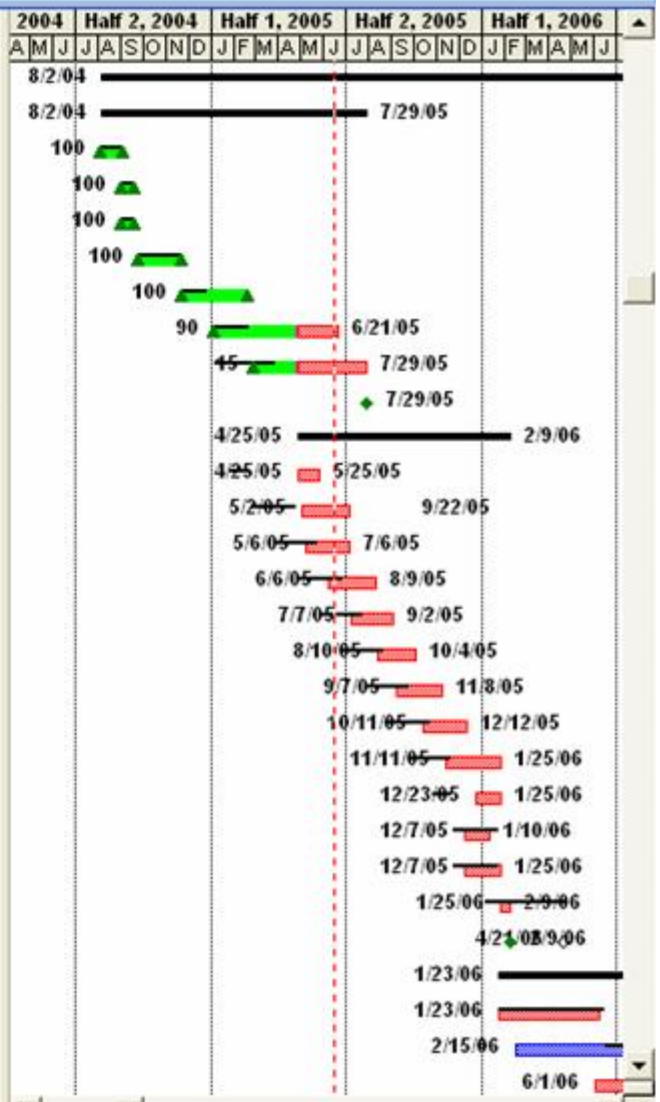
Tasks | Resources | Track | Report

1.3.3.2

	CWBS	Total Slack	Free Slack		% Complete	Predecessors	Successors
190	1.3.3.2	34 days	34 days		13%		
191	1.3.3.2	0 days	0 days	6002306283200	71%		
192	1.3.3.2	0 days	0 days	6002306283200	100%	184FS-26 days	193SS+22 days
193	1.3.3.2	0 days	0 days	6002306283200	100%	192SS+22 days	194SS
194	1.3.3.2	0 days	0 days	6002306283200	100%	193SS	195FS+4 days
195	1.3.3.2	0 days	0 days	6002306283200	100%	194FS+4 days	196
196	1.3.3.2	0 days	0 days	6002306283200	100%	195	197FF+86 days
197	1.3.3.2	0 days	0 days	6002306283200	66%	196FF+86 days	198FF+26 days
198	1.3.3.2	0 days	0 days	6002306283200	38%	197FF+26 days	
199		0 days	0 days		0%	198	
200	1.3.3.2	0 days	0 days	6002306283207	0%		
201	1.3.3.2	0 days	0 days	6002306283207	0%	198SS+41 days	202FS-18 days
202	1.3.3.2	0 days	0 days	6002306283207	0%	201FS-18 days	203SS+4 days
203	1.3.3.2	0 days	0 days	6002306283207	0%	202SS+4 days	204FS-21 days
204	1.3.3.2	0 days	0 days	6002306283207	0%	203FS-21 days	205FS-24 days
205	1.3.3.2	0 days	0 days	6002306283207	0%	204FS-24 days	206FS-18 days
206	1.3.3.2	0 days	0 days	6002306283207	0%	205FS-18 days	207FS-20 days
207	1.3.3.2	0 days	0 days	6002306283207	0%	206FS-20 days	208FS-21 days
208	1.3.3.2	0 days	0 days	6002306283207	0%	207FS-21 days	209FS-20 days
209	1.3.3.2	0 days	0 days	6002306283207	0%	208FS-20 days	210FS-18 days
210	1.3.3.2	0 days	0 days	6002306283207	0%	209FS-18 days	211FS-30 days
211	1.3.3.2	0 days	0 days	6002306283207	0%	210FS-30 days	212FS-19 days
212	1.3.3.2	0 days	0 days	6002306283207	0%	211FS-19 days	213FS-1 day
213	1.3.3.2	0 days	0 days	6002306283207	0%	12FS-1 day,44FS+2 days	6FS-14 days,217FS+3 days
214	1.3.3.2	1 day	0 days		0%	213	8FS-12 days
215	1.3.3.2	0 days	0 days	1.3.3.2MS01	0%		
216	1.3.3.2	0 days	0 days	1.3.3.2MS1A	0%	213FS-14 days	FF+49 days,218FS-22 days
217	1.3.3.2	13 days	12 days	1.3.3.2MS1B	0%	213FS+3 days	555FF+52 days
218	1.3.3.2	0 days	0 days	1.3.3.2MS1C	0%	216FS-22 days	219,559FF+20 days



Ready

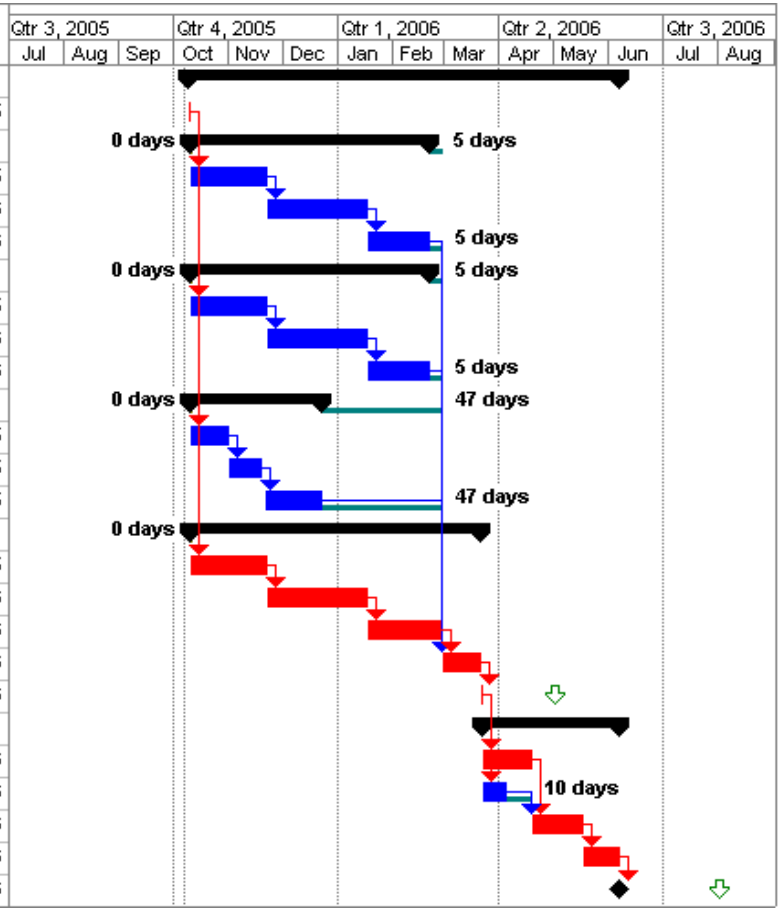
start | conference training ... | 2 Microsoft Office ... | Inbox - Microsoft Ou...

	WBS	D	LVL	BCWS	BCWP	ACWP	SvTrCum	SvTrCur	SV	CvTrCur	CvTrCum	CV	BAC	SpiCum	CPI	TCPI-BAC
184	1.3.2	S	3	1,985.2	1,600.4	1,825.0	↓	↓	-384.8	↑	↔	-224.6	10,291.1	0.806	0.877	1.027
185	1.3.2.1	S	4	388.1	371.3	620.2	↔		-16.8		↔	-248.9	388.1	0.957	0.599	-0.072
186	1.3.2.2	S	4	1,597.1	1,229.1	1,204.8	↓	↓	-368.0	↑	↑	24.3	7,254.9	0.770	1.020	0.996
187	1.3.2.3	S	4	0.0	0.0	0.0			0.0			0.0	1,686.3	0.000	0.000	1.000
188	1.3.2.4	S	4	0.0	0.0	0.0			0.0			0.0	961.8	0.000	0.000	1.000
189	1.3.3	[	3	560.2	328.4	495.7	↓	↓	-231.8	↓	↓	-167.3	3,943.1	0.586	0.662	1.049
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].047
191	1.3.3.2	[	4	445.0	220.5	225.6	↓	↓	-224.5	↓	↓	-5.1	3,827.9	0.496	0.977	[illegible].001
192	1.3.4	(	3	455.9	254.9	345.1	↓	↓	-201.0	↓	↓	-90.2	2,920.8	0.559	0.739	1.035
193	1.3.4.1	(	4	104.2	83.1	162.3	↑		-21.1	↑	↔	-79.2	104.2	0.798	0.512	-0.363
194	1.3.4.2	(	4	351.7	171.8	182.8	↓	↓	-179.9		↓	-11.0	2,816.6	0.488	0.940	1.004
195	1.3.5	F	3	802.4	589.6	669.0	↓	↓	-212.8		↓	-79.4	3,846.7	0.735	0.881	1.025
196	1.3.5.1	F	4	322.2	303.0	349.6	↓	↓	-19.2		↓	-46.6	326.4	0.940	0.867	-1.009
197	1.3.5.2	F	4	480.2	286.6	319.4	↓	↓	-193.6		↓	-32.8	3,520.3	0.597	0.897	1.010
198	1.3.6	M	3	3,439.7	2,372.9	3,114.7	↓	↓	-1,066.8		↓	-741.8	17,307.4	0.690	0.762	1.052
199	1.3.6.1	M	4	1,853.1	1,643.3	2,216.1	↓	↓	-209.8		↓	-572.8	2,232.4	0.887	0.742	36.141
200	1.3.6.2	M	4	1,586.6	729.6	898.6	↓	↓	-857.0		↓	-169.0	15,075.0	0.460	0.812	1.012
201	1.3.7	F	3	67.9	55.4	65.6	↓	↓	-12.5	↓	↓	-10.2	8,821.0	0.816	0.845	1.001
202	1.3.7.1	S	4	67.9	55.4	65.6	↓	↓	-12.5	↓	↓	-10.2	8,821.0	0.816	0.845	1.001
203	1.3.8	F	3	781.6	563.1	804.3	↓	↓	-218.5	↓	↓	-241.2	5,080.5	0.720	0.700	1.056
204	1.3.8.1	F	4	257.7	244.5	425.5	↔		-13.2		↔	-181.0	257.7	0.949	0.575	-0.079
205	1.3.8.2	F	4	523.9	318.6	378.8	↓	↓	-205.3	↓	↓	-60.2	4,822.8	0.608	0.841	1.014
206	1.3.9	E	3	237.7	176.7	280.1	↓	↓	-61.0		↓	-103.4	709.1	0.743	0.631	1.241
207	1.3.9.1	E	4	99.3	95.0	194.4	↔		-4.3		↓	-99.4	99.3	0.957	0.489	-0.045
208	1.3.9.2	X	4	138.4	81.7	85.7	↓	↓	-56.7		↓	-4.0	609.8	0.590	0.953	1.008
209	1.04	M	2	2,507.0	2,474.5	1,751.2	↓	↓	-32.5	↓	↔	723.3	38,273.0	0.987	1.413	0.980

Ready

Example Schedule
Use Risk +

ID		Task Name	Duration	Finish Slack	Start	Finish
1		**Project**	**172 days**	**0 days**	**Mon 10/10/05**	**Tue 6/6/06**
2		Release Work Order	1 day	0 days	Mon 10/10/05	Mon 10/10/05
3		**Unit A Control Account (Risk)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
4		Design Unit A	30 days	5 days	Tue 10/11/05	Mon 11/21/05
5		Builid Unit A	40 days	5 days	Tue 11/22/05	Mon 1/16/06
6		Test Unit A	25 days	5 days	Tue 1/17/06	Mon 2/20/06
7		**Unit B Control Account (Opportunity)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
8		Design Unit B	30 days	5 days	Tue 10/11/05	Mon 11/21/05
9		Builid Unit B	40 days	5 days	Tue 11/22/05	Mon 1/16/06
10		Test Unit B	25 days	5 days	Tue 1/17/06	Mon 2/20/06
11		**Unit C Control Account (Risk short)**	**53 days**	**47 days**	**Tue 10/11/05**	**Thu 12/22/05**
12		Design Unit C	15 days	47 days	Tue 10/11/05	Mon 10/31/05
13		Builid Unit C	14 days	47 days	Tue 11/1/05	Fri 11/18/05
14		Test Unit C	24 days	47 days	Mon 11/21/05	Thu 12/22/05
15		**Unit D control Account (Opp Long)**	**115 days**	**0 days**	**Tue 10/11/05**	**Mon 3/20/06**
16		Design Unit D	30 days	0 days	Tue 10/11/05	Mon 11/21/05
17		Builid Unit D	40 days	0 days	Tue 11/22/05	Mon 1/16/06
18		Test Unit D	30 days	0 days	Tue 1/17/06	Mon 2/27/06
19		Customer Review of Test Data	15 days	0 days	Tue 2/28/06	Mon 3/20/06
20		Customer Review before Integration	1 day	0 days	Tue 3/21/06	Tue 3/21/06
21		**Integration**	**55 days**	**0 days**	**Wed 3/22/06**	**Tue 6/6/06**
22		Integrate Units A and C	20 days	0 days	Wed 3/22/06	Tue 4/18/06
23		Integrate Units B and C	10 days	10 days	Wed 3/22/06	Tue 4/4/06
24		Integrate System	20 days	0 days	Wed 4/19/06	Tue 5/16/06
25		Test System	15 days	0 days	Wed 5/17/06	Tue 6/6/06
26		Delivery to Customer	0 days	0 days	Tue 6/6/06	Tue 6/6/06



Various risk and opportunities profiles for each Unit

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Schedule Min/Max Dates

Identification of % on critical path

ID	Task Name	Duration	Finish	Min Rdur	ML Rdur	Max Rdur
1	**Project**	**172 days**	**Tue 6/6/06**	**0 days**	**0 days**	**0 days**
2	Release Work Order	1 day	Mon 10/10/05	0 days	0 days	0 days
3	**Unit A Control Account (Risk)**	**95 days**	**Mon 2/20/06**	**0 days**	**0 days**	**0 days**
4	Design Unit A	30 days	Mon 11/21/05	25 days	30 days	55 days
5	Builid Unit A	40 days	Mon 1/16/06	35 days	40 days	65 days
6	Test Unit A	25 days	Mon 2/20/06	20 days	25 days	50 days
7	**Unit B Control Account (Opportunity)**	**95 days**	**Mon 2/20/06**	**0 days**	**0 days**	**0 days**
8	Design Unit B	30 days	Mon 11/21/05	20 days	30 days	35 days
9	Builid Unit B	40 days	Mon 1/16/06	30 days	40 days	45 days
10	Test Unit B	25 days	Mon 2/20/06	15 days	25 days	30 days
11	**Unit C Control Account (Risk short)**	**53 days**	**Thu 12/22/05**	**0 days**	**0 days**	**0 days**
12	Design Unit C	15 days	Mon 10/31/05	12 days	15 days	30 days
13	Builid Unit C	14 days	Fri 11/18/05	12 days	14 days	28 days
14	Test Unit C	24 days	Thu 12/22/05	22 days	24 days	48 days
15	**Unit D control Account (Opp Long)**	**115 days**	**Mon 3/20/06**	**0 days**	**0 days**	**0 days**
16	Design Unit D	30 days	Mon 11/21/05	15 days	30 days	35 days
17	Builid Unit D	40 days	Mon 1/16/06	20 days	40 days	45 days
18	Test Unit D	30 days	Mon 2/27/06	15 days	30 days	35 days
19	Customer Review of Test Data	15 days	Mon 3/20/06	10 days	15 days	30 days
20	Customer Review before Integration	1 day	Tue 3/21/06	0 days	0 days	0 days
21	**Integration**	**55 days**	**Tue 6/6/06**	**0 days**	**0 days**	**0 days**
22	Integrate Units A and C	20 days	Tue 4/18/06	15 days	20 days	25 days
23	Integrate Units B and C	10 days	Tue 4/4/06	8 days	10 days	30 days
24	Integrate System	20 days	Tue 5/16/06	15 days	20 days	40 days
25	Test System	15 days	Tue 6/6/06	10 days	15 days	25 days
26	Delivery to Customer	0 days	Tue 6/6/06	0 days	0 days	0 days

Critical path on Unit A 97% of the time – has the risks

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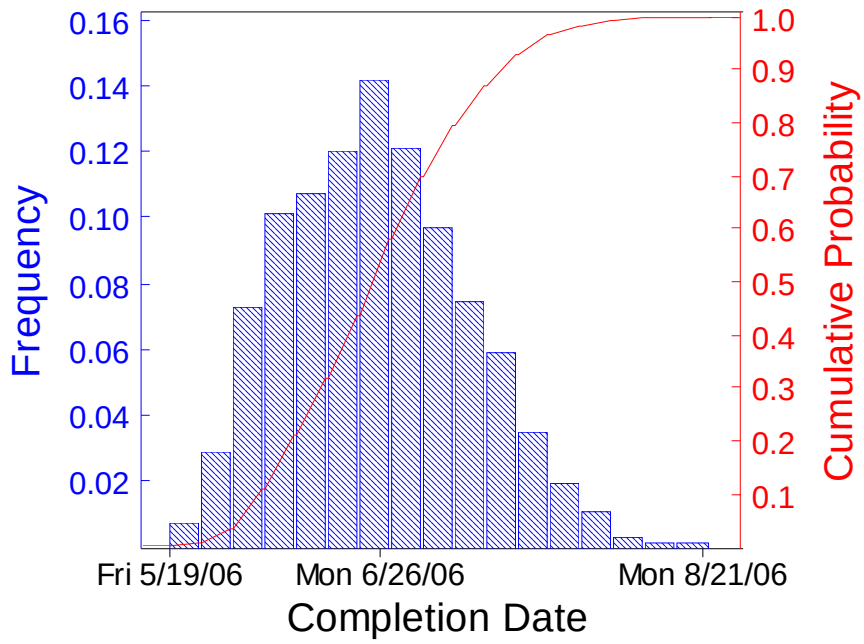
Risk + Analysis
Impact of uncertainty in durations

Date: 10/8/2005 4:04:42 PM
Samples: 2500
Unique ID: 32
Name: Delivery to Customer

Completion Std Deviation: 11.42 days
95% Confidence Interval: 0.45 days
Each bar represents 4 days



Completion Probability Table

Prob	Date	Prob	Date
0.05	Thu 6/1/06	0.55	Tue 6/27/06
0.10	Mon 6/5/06	0.60	Wed 6/28/06
0.15	Wed 6/7/06	0.65	Fri 6/30/06
0.20	Fri 6/9/06	0.70	Tue 7/4/06
0.25	Tue 6/13/06	0.75	Thu 7/6/06
0.30	Thu 6/15/06	0.80	Mon 7/10/06
0.35	Mon 6/19/06	0.85	Wed 7/12/06
0.40	Tue 6/20/06	0.90	Mon 7/17/06
0.45	Thu 6/22/06	0.95	Mon 7/24/06
0.50	Fri 6/23/06	1.00	Mon 8/21/06

Schedule data is 6/6/2006 – only 10-15% chance
75% chance estimated to be 1 Month slip – 7/6/2006

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Sensitivity Analysis

ID	Task Name	Early Finish	Late Finish	Range
24	Integrate System	Fri 5/26/06	Fri 6/30/06	25 days
4	Design Unit A	Fri 6/2/06	Fri 6/30/06	20 days
5	Builid Unit A	Fri 6/2/06	Fri 6/30/06	20 days
6	Test Unit A	Fri 6/2/06	Fri 6/30/06	20 days
19	Customer Review o1	Fri 5/26/06	Fri 6/23/06	20 days
25	Test System	Fri 5/26/06	Fri 6/16/06	15 days
16	Design Unit D	Fri 5/26/06	Fri 6/9/06	10 days
17	Builid Unit D	Fri 5/26/06	Fri 6/9/06	10 days
18	Test Unit D	Fri 5/26/06	Fri 6/9/06	10 days
22	Integrate Units A anc	Fri 5/26/06	Fri 6/9/06	10 days
23	Integrate Units B anc	Fri 6/2/06	Fri 6/16/06	10 days
2	Release Work Order	Fri 6/2/06	Fri 6/2/06	0 days
8	Design Unit B	Fri 6/2/06	Fri 6/2/06	0 days
9	Builid Unit B	Fri 6/2/06	Fri 6/2/06	0 days
10	Test Unit B	Fri 6/2/06	Fri 6/2/06	0 days
12	Design Unit C	Fri 6/2/06	Fri 6/2/06	0 days
13	Builid Unit C	Fri 6/2/06	Fri 6/2/06	0 days
14	Test Unit C	Fri 6/2/06	Fri 6/2/06	0 days
20	Customer Review before	Fri 6/2/06	Fri 6/2/06	0 days

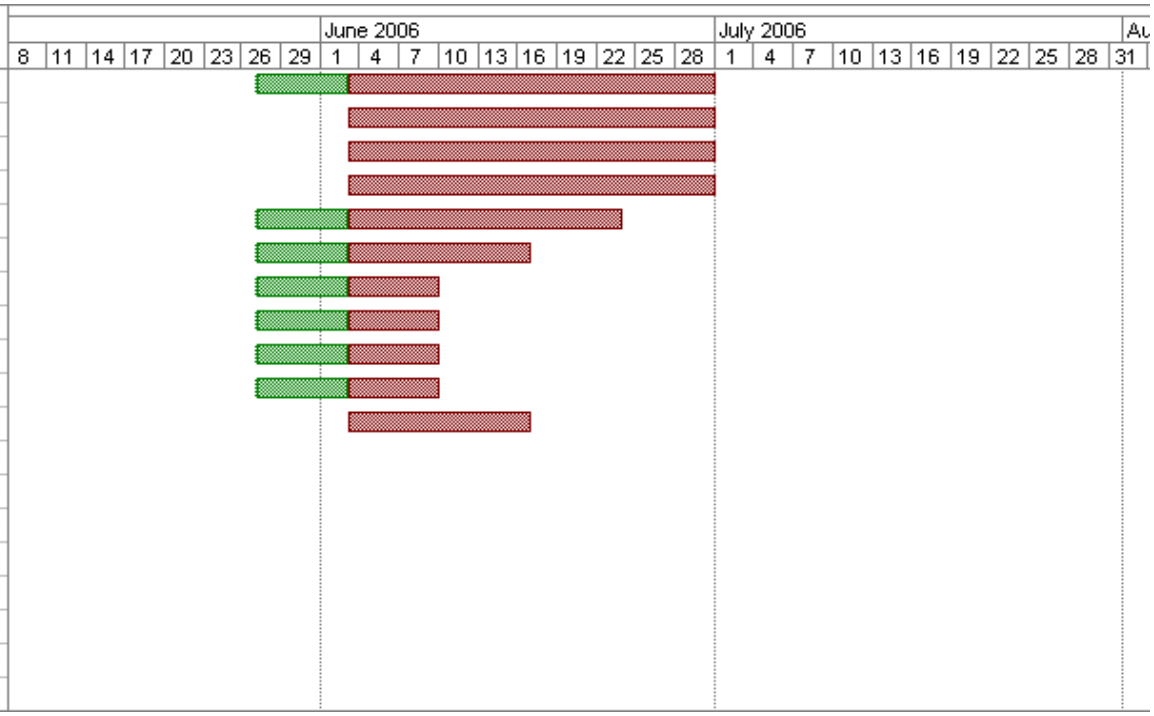

Chart indicates the drives in the schedule.

- Unit A as riskier activities rank high
- Unit D on critical path and opportunities are significant

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Abstract
Linking Risk and EV

- Show critical to the linkage is the network schedule
  - Discuss the EVMS requirements, misconception of EV
  - Trends in EV policy … risk emphasis growing
- Review the level at which analysis is conducted
  - The Control Account … what level WBS is that?
  - Traditional research at WBS level 1 (or zero)
- Discussion of current linkage efforts

- **Discuss new risk indexes**
  - **For Schedule (time) and Cost (dollars)**
  - **Synergy with Earned Value indexes**

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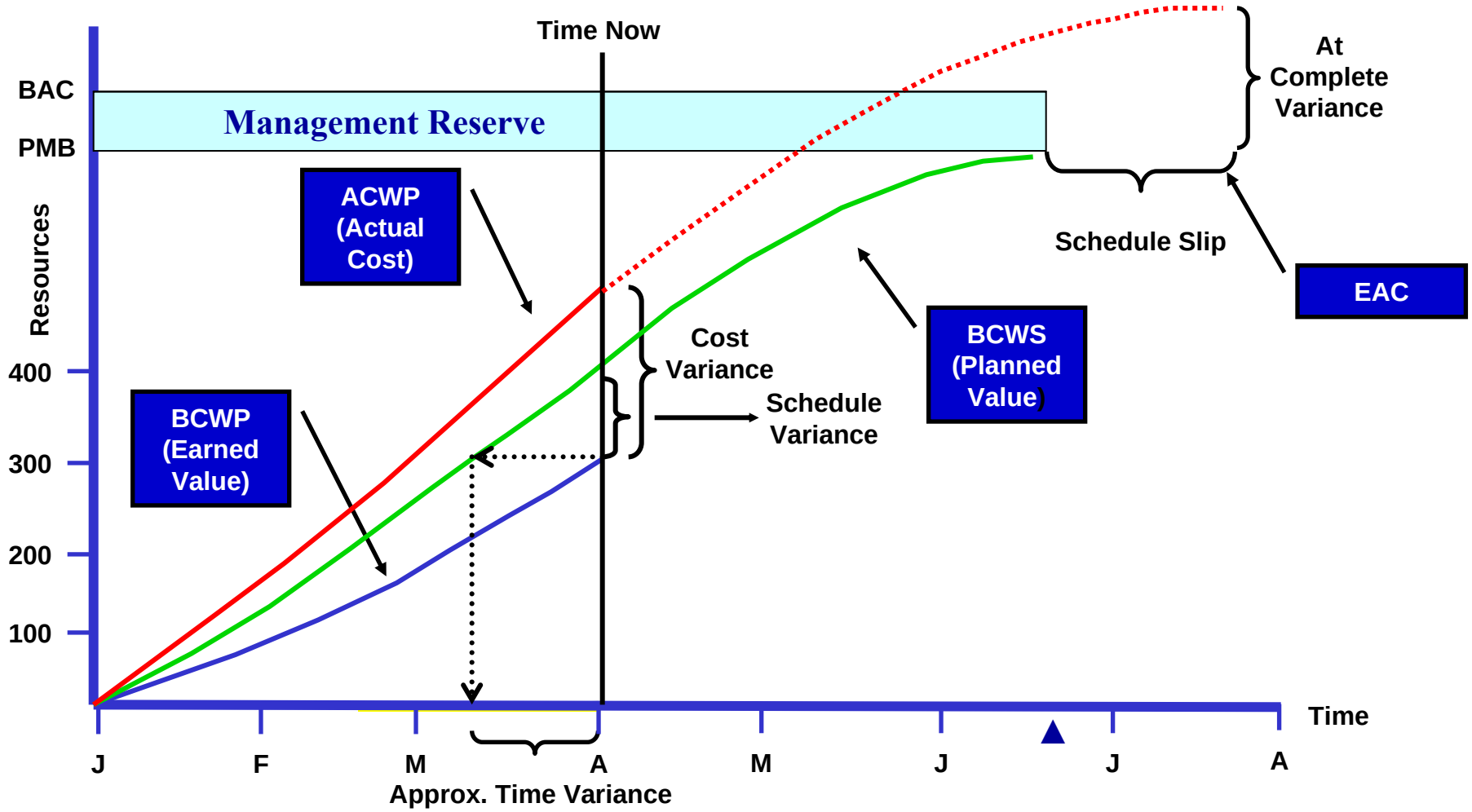
EVM Graphic Analysis:
Cumulative Performance Trends



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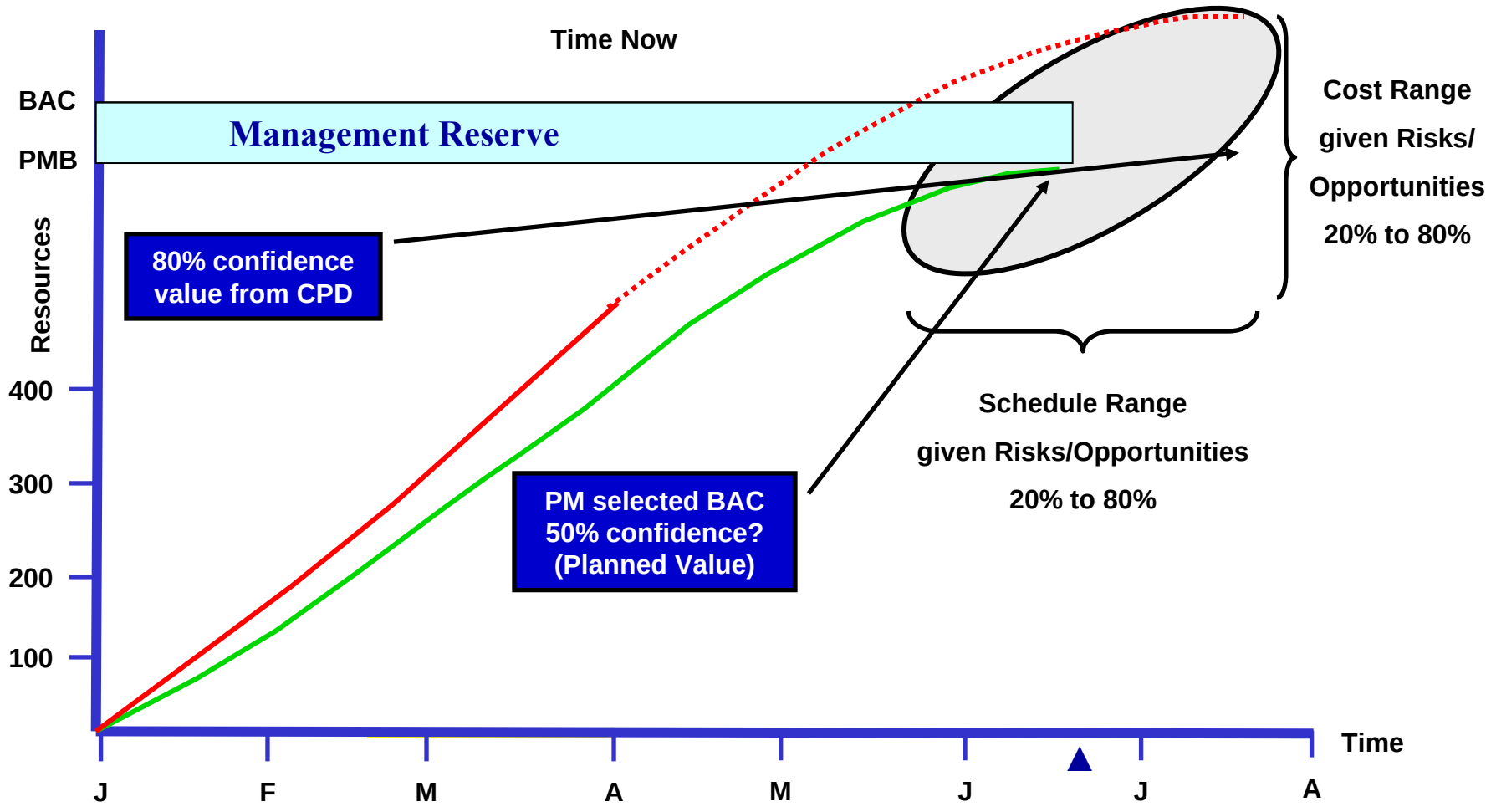
Characterize
Range of Estimates



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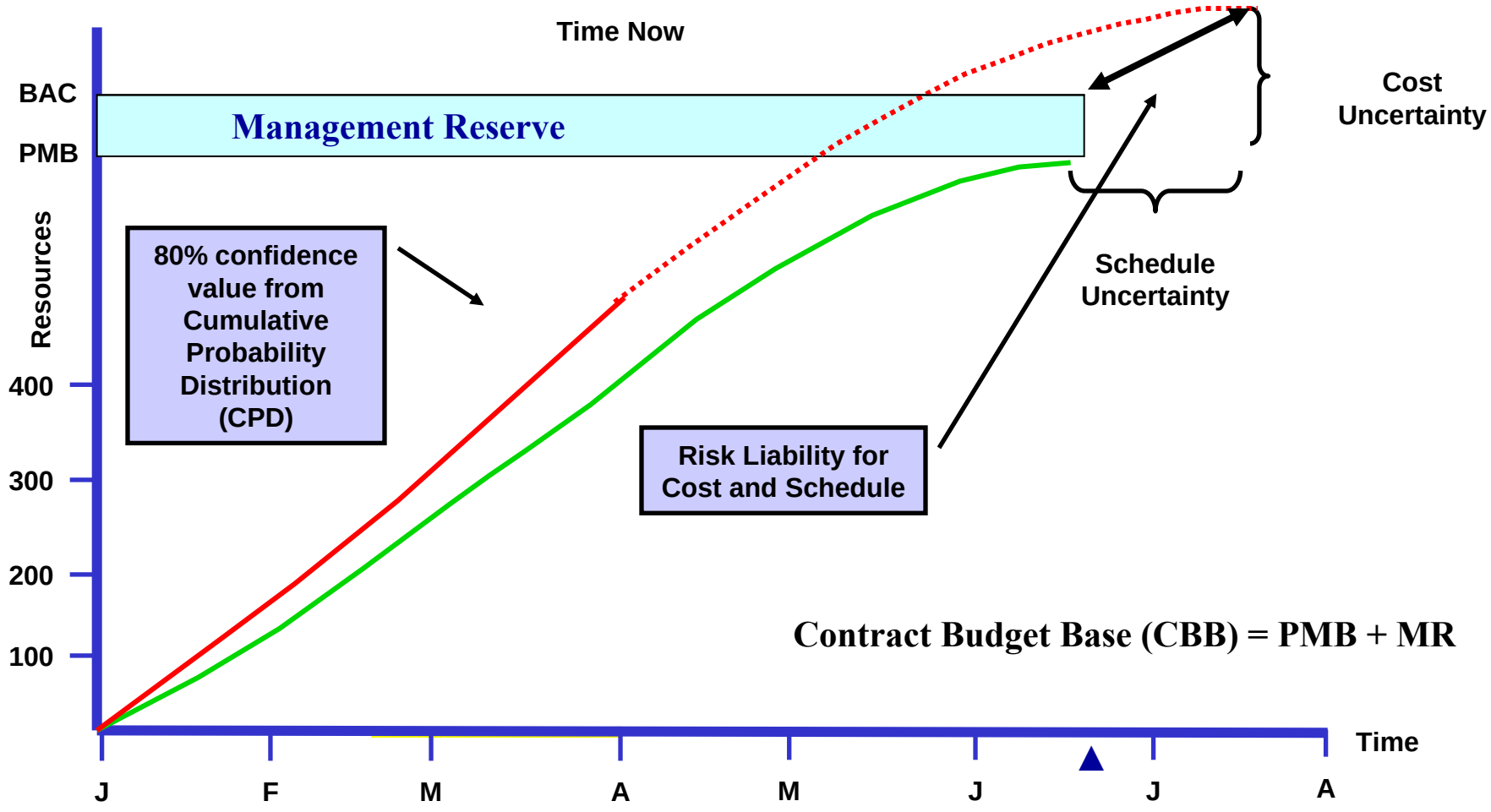
EVM – Need to Characterize the Range of Estimates



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MCR's Risk Indexes "RANGE"

- Figure Range given the calculated distribution
- Realistic range defined between 20% to 80%
  - A set range should be utilized for comparisons, common understanding of the "Risk Indexes"
- $CPD_{80\%} - CPD_{20\%}$ = <u>Range</u> of Estimate
  - Cost Risk Range (CRR) in dollars
  - Schedule Risk Range (SRR) in time
  - The wider the range, the riskier (more uncertain) the program

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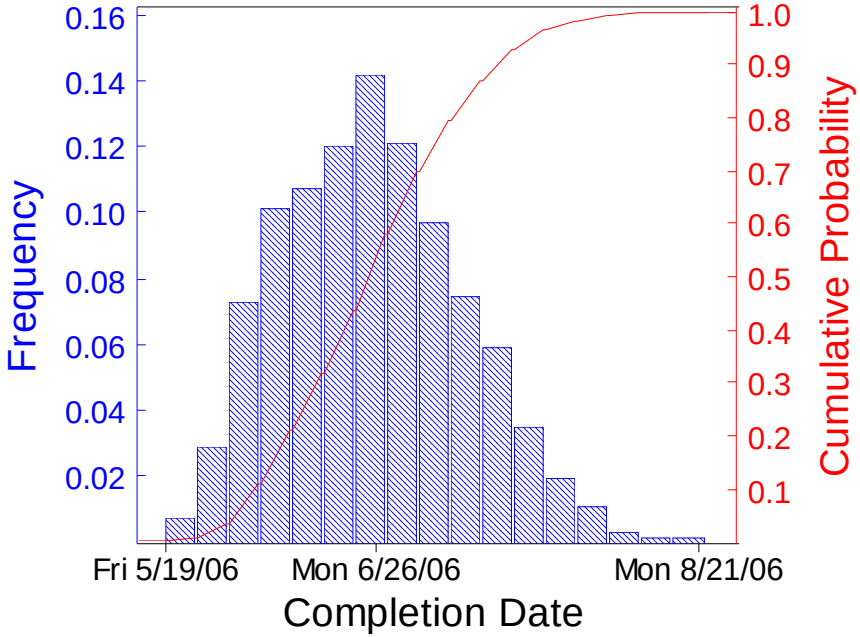
Risk + Analysis
Provide Range of Possibilities

Date: 10/8/2005 4:04:42 PM
Samples: 2500
Unique ID: 32
Name: Delivery to Customer

Completion Std Deviation: 11.42 days
95% Confidence Interval: 0.45 days
Each bar represents 4 days



Completion Probability Table

Prob	Date	Prob	Date
0.05	Thu 6/1/06	0.55	Tue 6/27/06
0.10	Mon 6/5/06	0.60	Wed 6/28/06
0.15	Wed 6/7/06	0.65	Fri 6/30/06
0.20	Fri 6/9/06	0.70	Tue 7/4/06
0.25	Tue 6/13/06	0.75	Thu 7/6/06
0.30	Thu 6/15/06	0.80	Mon 7/10/06
0.35	Mon 6/19/06	0.85	Wed 7/12/06
0.40	Tue 6/20/06	0.90	Mon 7/17/06
0.45	Thu 6/22/06	0.95	Mon 7/24/06
0.50	Fri 6/23/06	1.00	Mon 8/21/06

Range is Jun 9 (20%) to 10 July (80%) – 28 days, 4 weeks

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MCR's Risk Indexes
"RISK LIABILITY"

- Determine were PM/CA falls in the range (distribution)
  - Assume CBB/CA (PMB + MR) equal or less than 80% confidence level
  - Program Manager decide how much <u>opportunity</u> to seek by moving towards 20% confidence on the distribution
  - MR is inherently risk based given knowledge from probability distribution in cost and schedule
  - Determine Risk Liability given the selected PMB/CA and CPD
- $CPD_{80\%}$ - CBB = <u>Risk Liability Baseline</u>
  - Given baseline, what is the liability !
    - Cost <u>Risk Liability Baseline</u> (RLB_{cost}) in dollars
    - Schedule <u>Risk Liability Baseline</u> (RLB_{sched}) in time
  - Liability should decrease as program progresses

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Risk + Analysis
Provide Range of Possibilities

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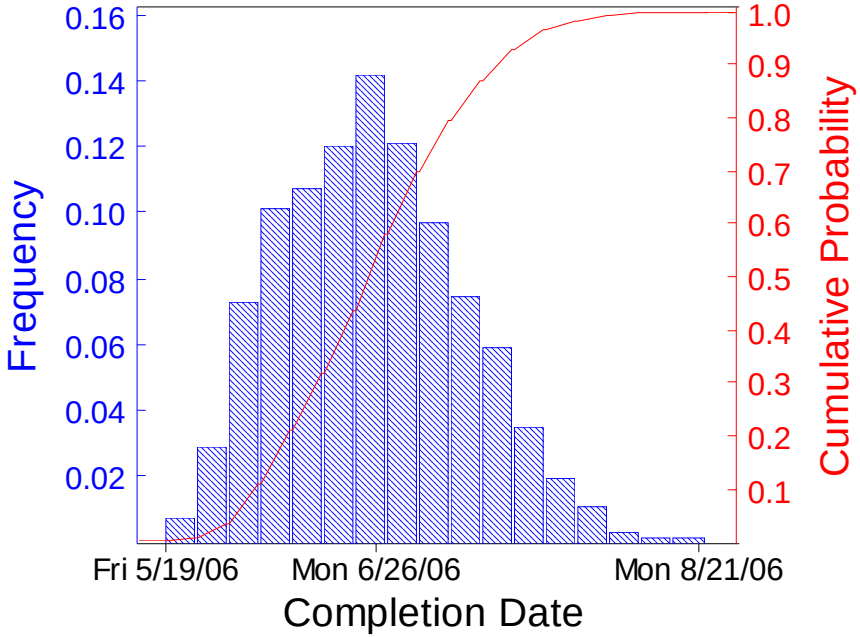

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0.30	Thu 6/15/06	0.80	Mon 7/10/06
0.35	Mon 6/19/06	0.85	Wed 7/12/06
0.40	Tue 6/20/06	0.90	Mon 7/17/06
0.45	Thu 6/22/06	0.95	Mon 7/24/06
0.50	Fri 6/23/06	1.00	Mon 8/21/06

Set PMB/CA at 50% or 23 Jun …liability is 14 days, 2 weeks

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MCR's Risk Indexes "EXPOSURE"

- Ratio of Risk Liability (RLB)/CBB sets "EXPOSURE" to risk/opportunities given the selected PMB and MR
  - Higher the index the more the program is exposed to risk
  - Index, the exposure, will recede to zero at program completion
  - Will go negative (as RLB goes negative) if program projected to under run
  - Contract Budget Base for Schedule is contractual end of contract

$$\frac{RLB_{cost}}{CBB_{cost}} = \text{Cost Exposure Index (CEI)}$$

$$\frac{RLB_{sched}}{CBB_{sched}} = \text{Schedule Exposure Index (SEI)}$$

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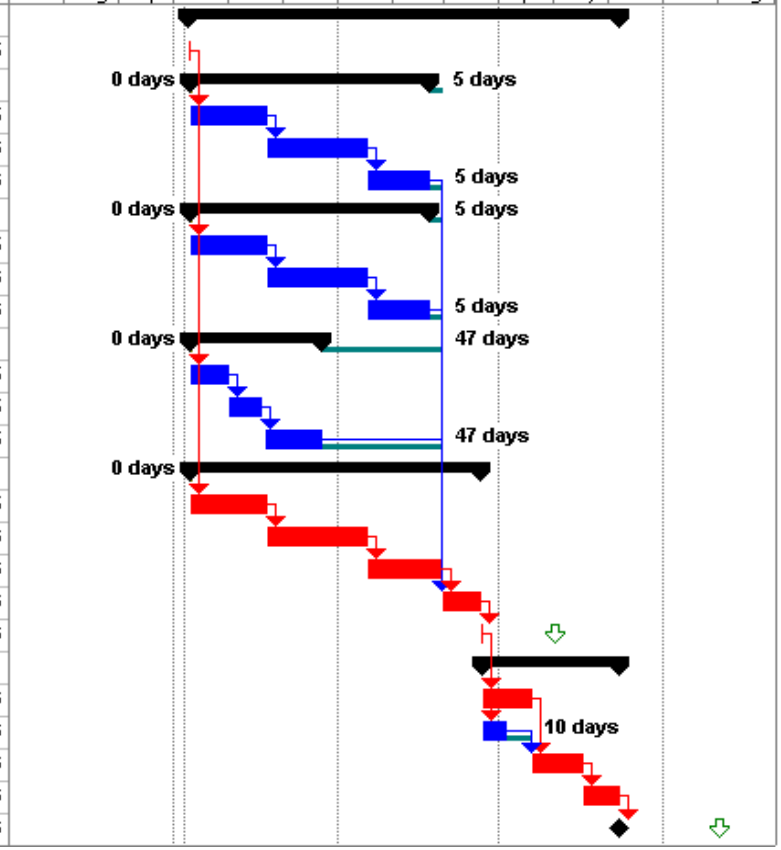
What is the Exposure to risk

Given 28 Jun baseline

ID		Task Name	Duration	Finish Slack	Start	Finish
1		**Project**	**172 days**	**0 days**	**Mon 10/10/05**	**Tue 6/6/06**
2		Release Work Order	1 day	0 days	Mon 10/10/05	Mon 10/10/05
3		**Unit A Control Account (Risk)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
4		Design Unit A	30 days	5 days	Tue 10/11/05	Mon 11/21/05
5		Builid Unit A	40 days	5 days	Tue 11/22/05	Mon 1/16/06
6		Test Unit A	25 days	5 days	Tue 1/17/06	Mon 2/20/06
7		**Unit B Control Account (Opportunity)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
8		Design Unit B	30 days	5 days	Tue 10/11/05	Mon 11/21/05
9		Builid Unit B	40 days	5 days	Tue 11/22/05	Mon 1/16/06
10		Test Unit B	25 days	5 days	Tue 1/17/06	Mon 2/20/06
11		**Unit C Control Account (Risk short)**	**53 days**	**47 days**	**Tue 10/11/05**	**Thu 12/22/05**
12		Design Unit C	15 days	47 days	Tue 10/11/05	Mon 10/31/05
13		Builid Unit C	14 days	47 days	Tue 11/1/05	Fri 11/18/05
14		Test Unit C	24 days	47 days	Mon 11/21/05	Thu 12/22/05
15		**Unit D control Account (Opp Long)**	**115 days**	**0 days**	**Tue 10/11/05**	**Mon 3/20/06**
16		Design Unit D	30 days	0 days	Tue 10/11/05	Mon 11/21/05
17		Builid Unit D	40 days	0 days	Tue 11/22/05	Mon 1/16/06
18		Test Unit D	30 days	0 days	Tue 1/17/06	Mon 2/27/06
19		Customer Review of Test Data	15 days	0 days	Tue 2/28/06	Mon 3/20/06
20		Customer Review before Integration	1 day	0 days	Tue 3/21/06	Tue 3/21/06
21		**Integration**	**55 days**	**0 days**	**Wed 3/22/06**	**Tue 6/6/06**
22		Integrate Units A and C	20 days	0 days	Wed 3/22/06	Tue 4/18/06
23		Integrate Units B and C	10 days	10 days	Wed 3/22/06	Tue 4/4/06
24		Integrate System	20 days	0 days	Wed 4/19/06	Tue 5/16/06
25		Test System	15 days	0 days	Wed 5/17/06	Tue 6/6/06
26		Delivery to Customer	0 days	0 days	Tue 6/6/06	Tue 6/6/06



Exposure is 14 days over 188 or .074 or 7.4%

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MCR's Risk Indexes "SUSCEPTIBILITY"

- Ratio of MR/Risk Liability (RLB) sets "SUSCEPTIBILITY" to risk given the selected PMB and MR
  - Similar to CPI and SPI, index close to "1" or higher is best, estimating no susceptibility to risk
    - CSI means program has $1 of MR for each $1 of liability
    - SSI means program has a day for each day of liability
  - Index recedes to near zero as program increases susceptibility to risk exposure

$$\frac{MR_{cost}}{RLB_{cost} + MR_{cost}} = \text{Cost Susceptibility Index (CSI)}$$

$$\frac{MR_{sched}}{RLB_{sched} + MR_{sched}} = \text{Schedule Susceptibility Index (SSI)}$$

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What is the Exposure to risk

Given 23 Jun baseline

ID		Task Name	Duration	Finish Slack	Start	Finish
1		**Project**	**172 days**	**0 days**	**Mon 10/10/05**	**Tue 6/6/06**
2		Release Work Order	1 day	0 days	Mon 10/10/05	Mon 10/10/05
3		**Unit A Control Account (Risk)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
4		Design Unit A	30 days	5 days	Tue 10/11/05	Mon 11/21/05
5		Builid Unit A	40 days	5 days	Tue 11/22/05	Mon 1/16/06
6		Test Unit A	25 days	5 days	Tue 1/17/06	Mon 2/20/06
7		**Unit B Control Account (Opportunity)**	**95 days**	**5 days**	**Tue 10/11/05**	**Mon 2/20/06**
8		Design Unit B	30 days	5 days	Tue 10/11/05	Mon 11/21/05
9		Builid Unit B	40 days	5 days	Tue 11/22/05	Mon 1/16/06
10		Test Unit B	25 days	5 days	Tue 1/17/06	Mon 2/20/06
11		**Unit C Control Account (Risk short)**	**53 days**	**47 days**	**Tue 10/11/05**	**Thu 12/22/05**
12		Design Unit C	15 days	47 days	Tue 10/11/05	Mon 10/31/05
13		Builid Unit C	14 days	47 days	Tue 11/1/05	Fri 11/18/05
14		Test Unit C	24 days	47 days	Mon 11/21/05	Thu 12/22/05
15		**Unit D control Account (Opp Long)**	**115 days**	**0 days**	**Tue 10/11/05**	**Mon 3/20/06**
16		Design Unit D	30 days	0 days	Tue 10/11/05	Mon 11/21/05
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20		Customer Review before Integration	1 day	0 days	Tue 3/21/06	Tue 3/21/06
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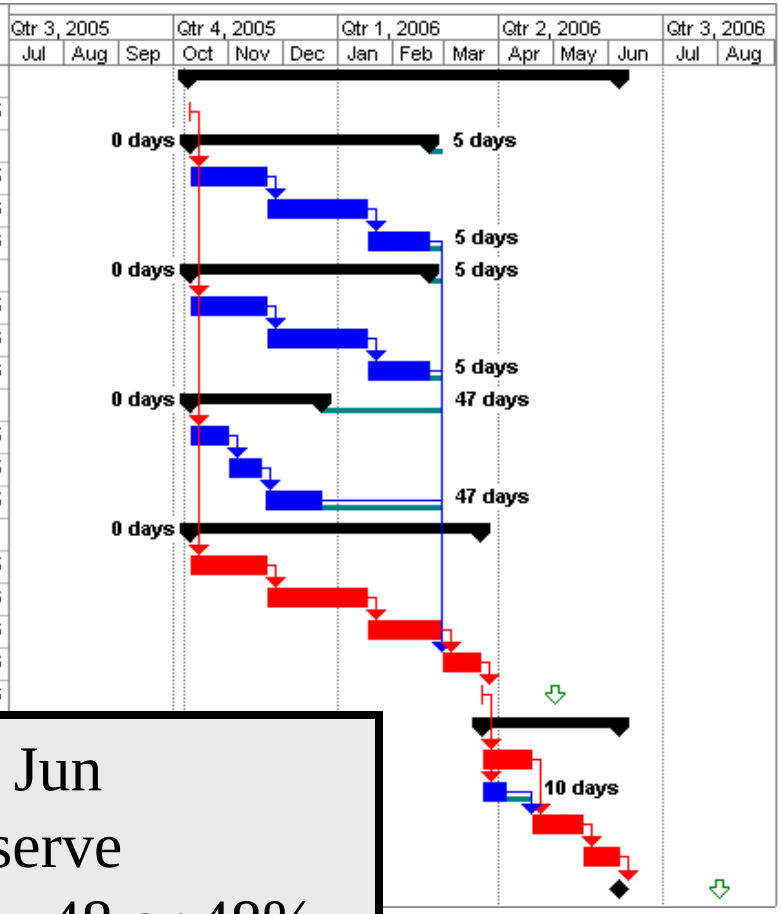

Baseline is 28 Jun, but schedule is 6 Jun
- so have 13 day of management reserve

Susceptibility to risks is 13/14 +13 = .48 or 48%
- so MR cover 48% of risk at 80% confidence

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MCR's Risk Indexes
"OPPORTUNITY POSSIBLITIES"

- CBB - CPD $_{20\%}$ = Opportunity Possibility Baseline
  - Given baseline, what is the opportunities !
    - Cost <u>Opportunity Possibility Baseline</u> (OPB_{cost}) in dollars
    - Schedule <u>Opportunity Possibility Baseline</u> (OPB_{sched}) in time
  - Opportunities should decrease as program progresses

- Example…23 Jun – 9 Jun = 14 days
  - We picked 50%...so 2 week on each side of baseline
- Sched Opportunity Index 14/14 = 1 or 100%
  - So opportunities equal risks one for one

Opportunities indexed to Risk, Risk indexed to Baseline

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MCR's EV Risk Indexes "OPPORTUNITY"

- Ratio of Opportunity (OPB)/Risk Liability (RLB) sets "OPPORTUNITY" vis Risk given the selected PMB and MR
  - Similar to CPI and SPI, index close to "1" or higher is best, estimating no susceptibility to risk
    - COI = 1 means program has $1 of opportunity for each $1 of liability
    - SOI = 1 means program has an opportunity for a possible day reduction for each day of liability

$$\frac{OPB_{cost}}{RLB_{cost}} = \text{Cost Opportunity Index (COI)}$$

$$\frac{OPB_{sched}}{RLB_{sched}} = \text{Schedule Opportunity Index (SOI)}$$

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Example for Costs

- Program Cost Estimate range is PCE $_{20\%}$ = \$.8B PCE $_{80\%}$ = \$1.5B (this represents the Cumulative Probability Distribution (CPD)
- Contract Budget Base (CBB) = \$1B with \$150M in fee
- Risk <u>Liability</u> Baseline is PCE $_{80\%}$ - CBB = \$1.5 – \$1B = .5B
- Cost <u>Exposure</u> Index = RLB/CBB = .5/1 = .5
  - So program have 50 cents of liability for every dollar on contract given 80% confidence
- PM decides on 100M Management Reserve so PMB = \$.9B
- Cost <u>Susceptibility</u> Index = MR/RLB+MR = .1/.5+.1 = .167
  - So program has .17 cents of MR to handle potential risk
- Opportunity Possibility Baseline (OPB) PCE $_{20\%}$ - CBB = 1B - .8B = .2B
- Cost <u>Opportunity</u> Index (COI) = OPB/RLB + MR = .2/.5 = .40
  - So program has 40 cents of opportunity compared to each \$1 of risk

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Summary
Linking Risk and EV

- **Show critical to the linkage is the <u>network schedule</u>**
  - **Discuss the EVMS requirements, misconception of EV**
  - **Trends in EV policy … risk emphasis growing**
- **Review the <u>level at which analysis</u> is conducted**
  - **The Control Account … what level WBS is that?**
  - **Traditional research at WBS level 1 (or zero)**
- **Discussion of current linkage efforts**
- **Discuss new <u>risk indexes</u>**
  - **For Schedule (time) and Cost (dollars)**
  - **Synergy with Earned Value indexes**

Networked schedule with Risks/Opp at Control Account

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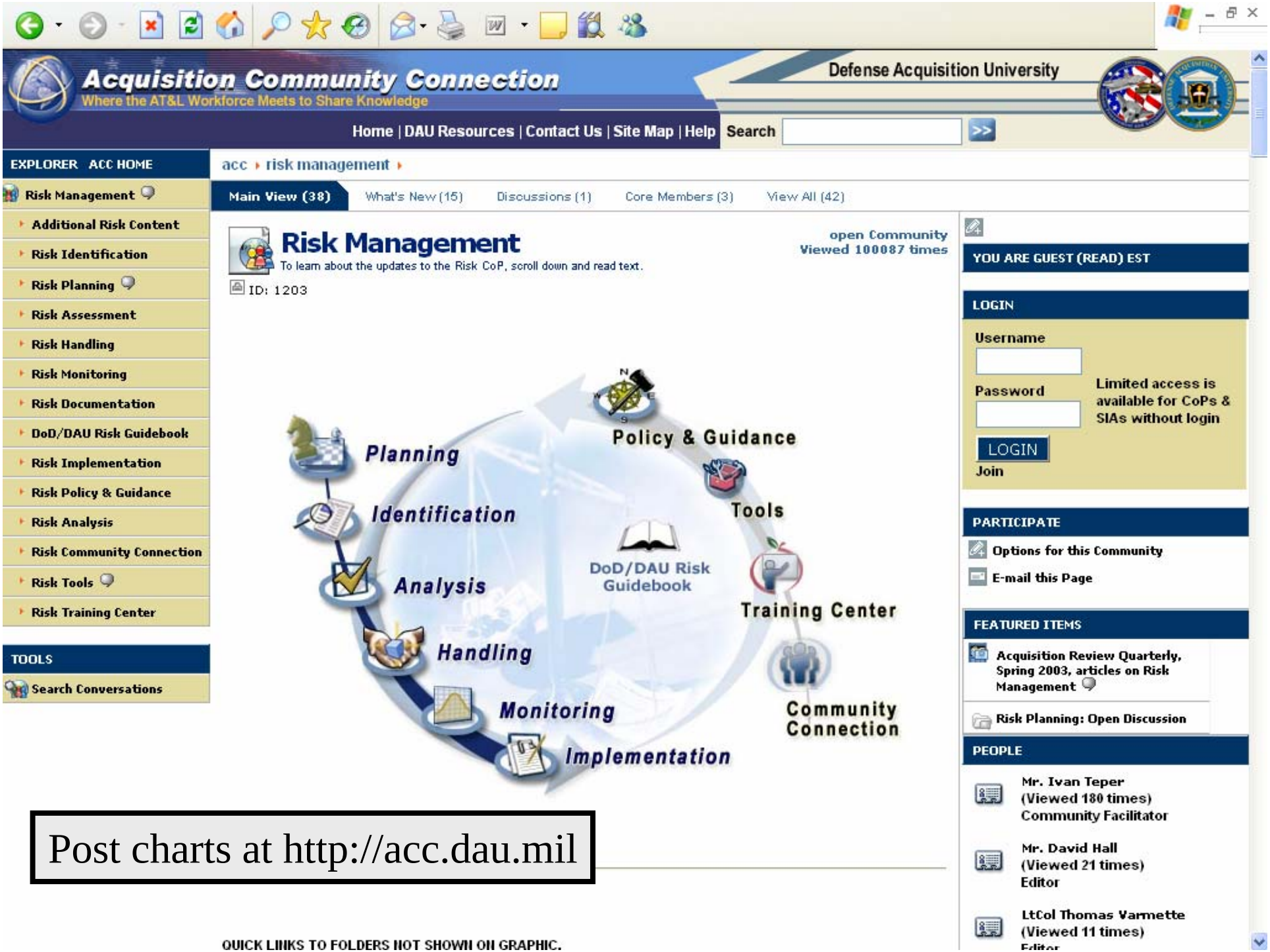

Post charts at http://acc.dau.mil

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