College of Performance Management

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IPMC 2013

Title: An Analytical Utility For Earned Value And Earned Schedule Management

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The popular technical literature describes various EV parameters as though they have a singular interpretation. Fact is, composition of the internal work package resource mix has a lot to do with the appropriate interpretation mechanics. In this presentation we'll look at some of the techniques needed to modify EV calculations to facilitate these various analyses.

To err is human.

To really screw up requires a computer!

"Earned Value is now for the Masses"

"It's time to take the earned-value concept and move it into the mainstream of project management."

Fleming and Koppelman

"Earned Value Project Management" PMI 1996 & 2000

---The proliferation of EV calculation tools is fulfilling this promise in the commercial world.

Agenda

This presentation focuses on the proper use of EV and ES metrics for project status and forecasting through the use of a prototype analysis calculation utility. The approach demonstrated here exemplifies commercial (non-DoD) environments whose projects are characterized by:

- ❑ Use of Microsoft Project as the core project management tool
- ❑ Blind creation of EV parameters within the software

Hypotheses

- There is a growing interest in using EV parameters to assist in decision making for various project status scenarios
- The current EV literature glosses over the underlying logic of various calculation components in status interpretation
- If current usage trends continue EV will be discredited as a project analytical tool
- In order to embrace a more robust analysis environment a new decision support architecture is needed

Typical Project Management Status Questions

- ❑ How is the project doing now—overall schedule and budget?
- ❑ What areas of the project are not doing well?
- ❑ What is the forecast schedule and cost at completion?
- ❑ Where in the project structure are the most significant negative variances?

Earned Value Key Roles

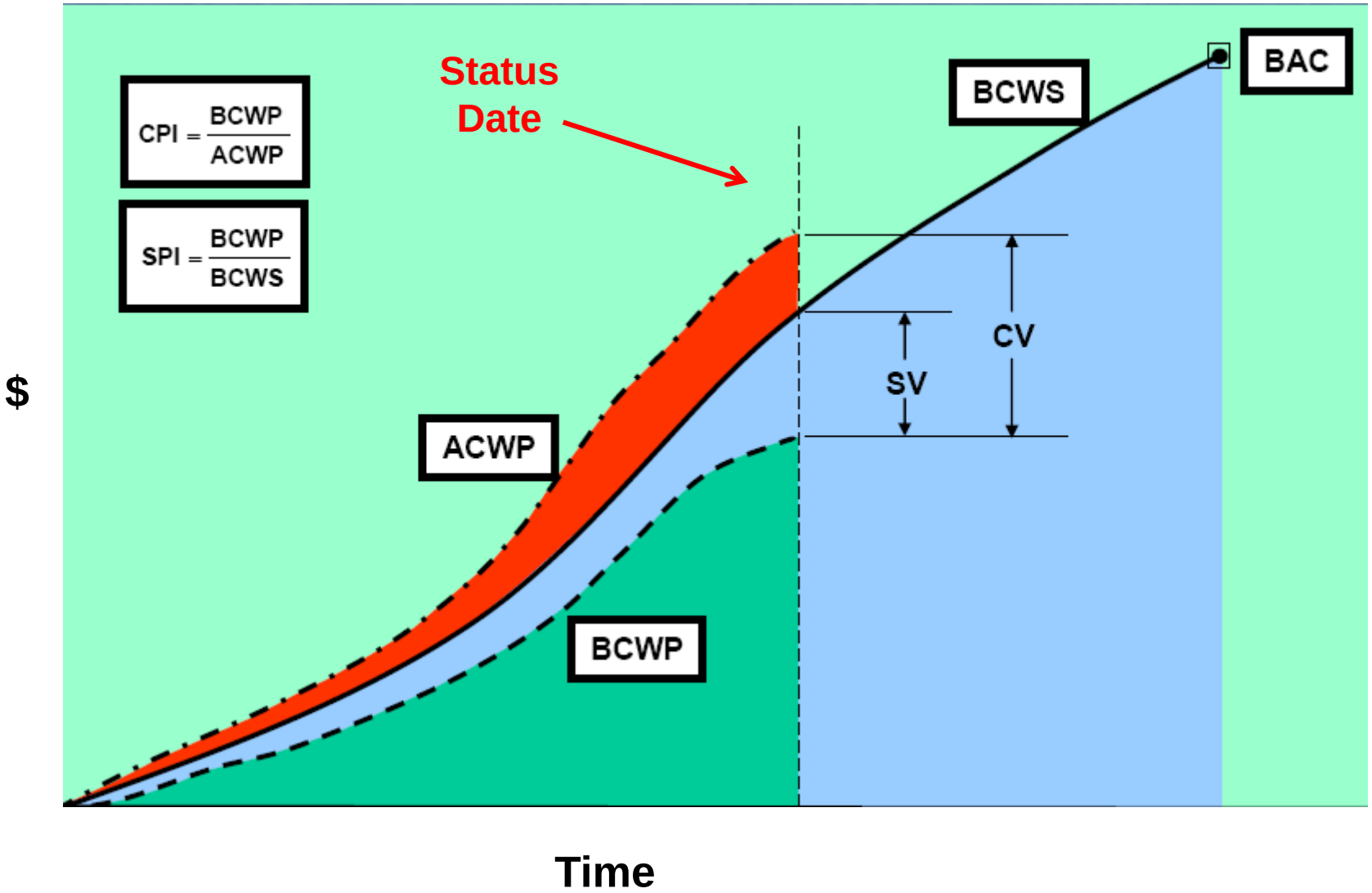
- Budget analysis–- CV and CPI + Reserves
- Schedule and budget forecast at completion—EAC
- Project productivity analysis – Labor segment of Work Packages
- Rate analysis – Labor and material rates
- Ability to recover project from low performance--TCPI

EV to the Rescue?

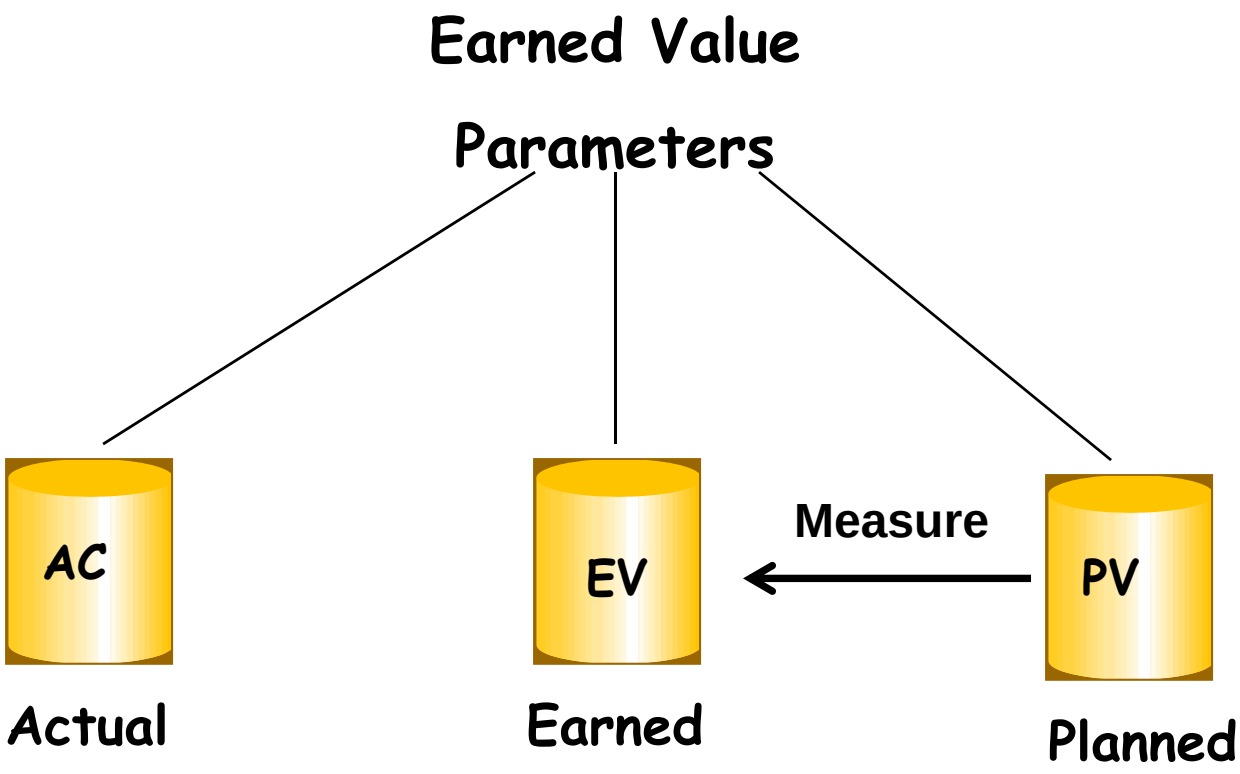
- CPI, CV, SPI and SV for current status
- EAC, ETC and TCPI for forecast completion
- SPI for schedule status and completion

We may have oversold this idea--Current tech journals and popular computer software may be at the heart of the issue!

EV Geometry


$
Time
Status Date
CPI = BCWP / ACWP
SPI = BCWP / BCWS
BCWS
BAC
ACWP
BCWP
SV
CV

Earned Value Components



EV Masking Factors

- Effort driven actual cost calculation (MS Project default method)
- Material cost impact
- LOE (Level of effort) impact
- Direct dollars charged into a Work Package
- Contracts and Outsourcing
- Labor and material rate variances

Summary of Calculation Findings

Example #1

Setup	CPI	SPI	EAC
Normal effort driven	0.82	0.5	$71,341
Manual AC entry	0.63	0.5	$92,887

Example #2

Manual AC entry	0.88	0.67	$78,857
Minus Matl & Dir $	1.23	0.67	$54,000 + $24,000

Example #3

Manual AC entry	0.9	0.84	$70,000
Minus LOE	0.83	0.75	$45,000 + $25,000

Material Costs Kept in Work Package Analysis

(Manual AC)

WP	Item	PV	%Comp	EV	AC
A	Labor	15000	100	15000	25000
	Matl	45000		45000	45000
	Dollars				
B	Labor	15000	50	7500	15000
	Matl	45000		22500	22500
	Dollars				
C	Labor	6480	0	0	0
	Matl	16200		0	
	Dollars			0	
	Totals=	142680		90000	107500

Matl @45K X 3L

CPI= 0.84

SPI= 0.63

EAC= $169,857

Removing Material and Dollar from WP

WP	PV	%Comp	EV	AC
A	15000	100	15000	25000
B	7500	50	7500	15000
C	6480	0	0	0
Totals=	36480		22500	40000

WO $ & Matl

CPI= 0.56

SPI= 0.63

EAC= 65,142 +106,200= $171,342

Efficiency Analysis Error:
CPI diff = --0.28
SPI diff = 0
EAC diff = ~0

Use and Rate Variances

	Earned Value (EV)	Actual Cost (AC)	Cost Variance (CV)
Cumulative Hours	680 hrs.	960 hrs.	-280 hrs.
Cumulative $	$75,480	$90,000	-$14,520

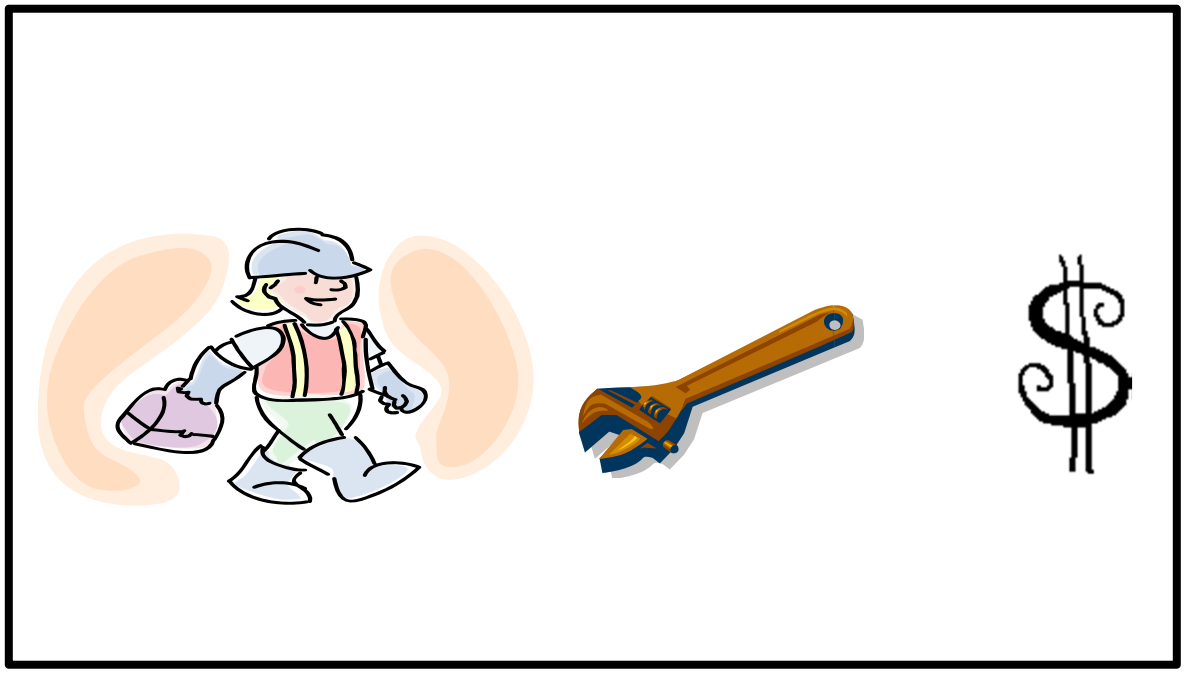
Negative CV says that work is more expensive than planned

Bid rate = 75,480/680 = $111/hour
Actual rate = 90000/960 = $93.75/hour (actual rate is cheaper than bid)

Rate variance = (111.00—93.75) X 960 = $16,560
Use variance = (680—960) X 111.00 = --$31,080
CV = 16560 – 31,080 = -- $14,520

***** Cheaper rate, but less productive***

Work Package Contents

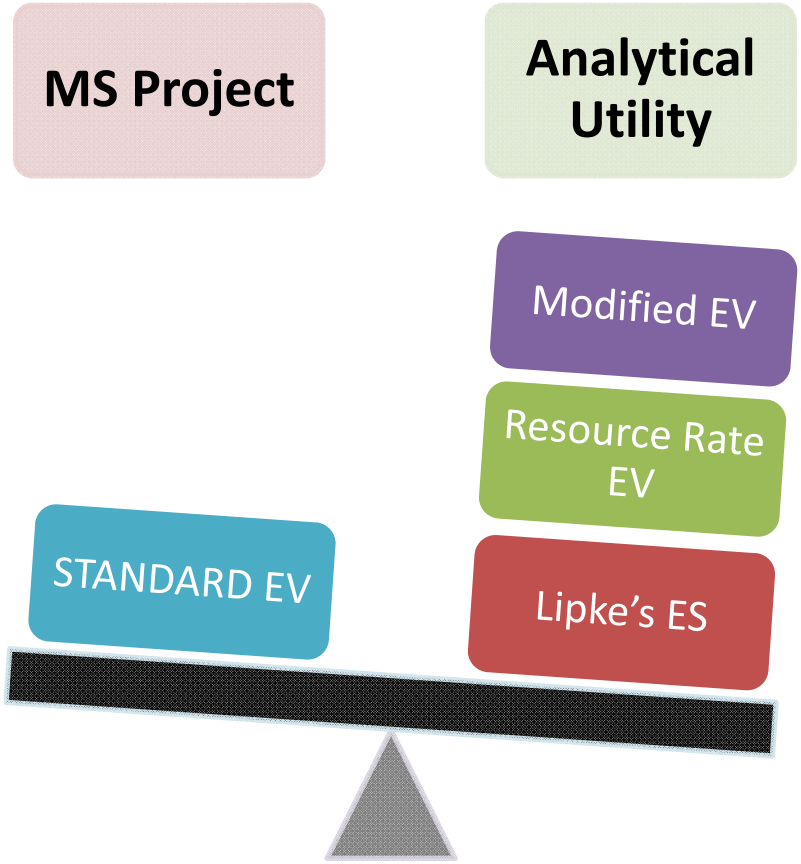


1. Human labor creates cost through rates and time
2. Material creates cost through inventory or allocation
3. Dollars ($) are added by miscellaneous charges (i.e., travel)
4. Other resource types

Sample Issues Affecting Proper Analysis

- Proper EAC should be derived from component values
- ES consideration is important to understand
- Risk and Scope additions will further complicate this process
- Padding task times distort the interpretation of EV parms
- Resource rate implications not normally considered

MS PROJECT VS ANALYTICAL UTILITY



DATA MODEL

ANALYTICAL UTILITY

Analysis

Extracted Data

MS Project (manipulation)

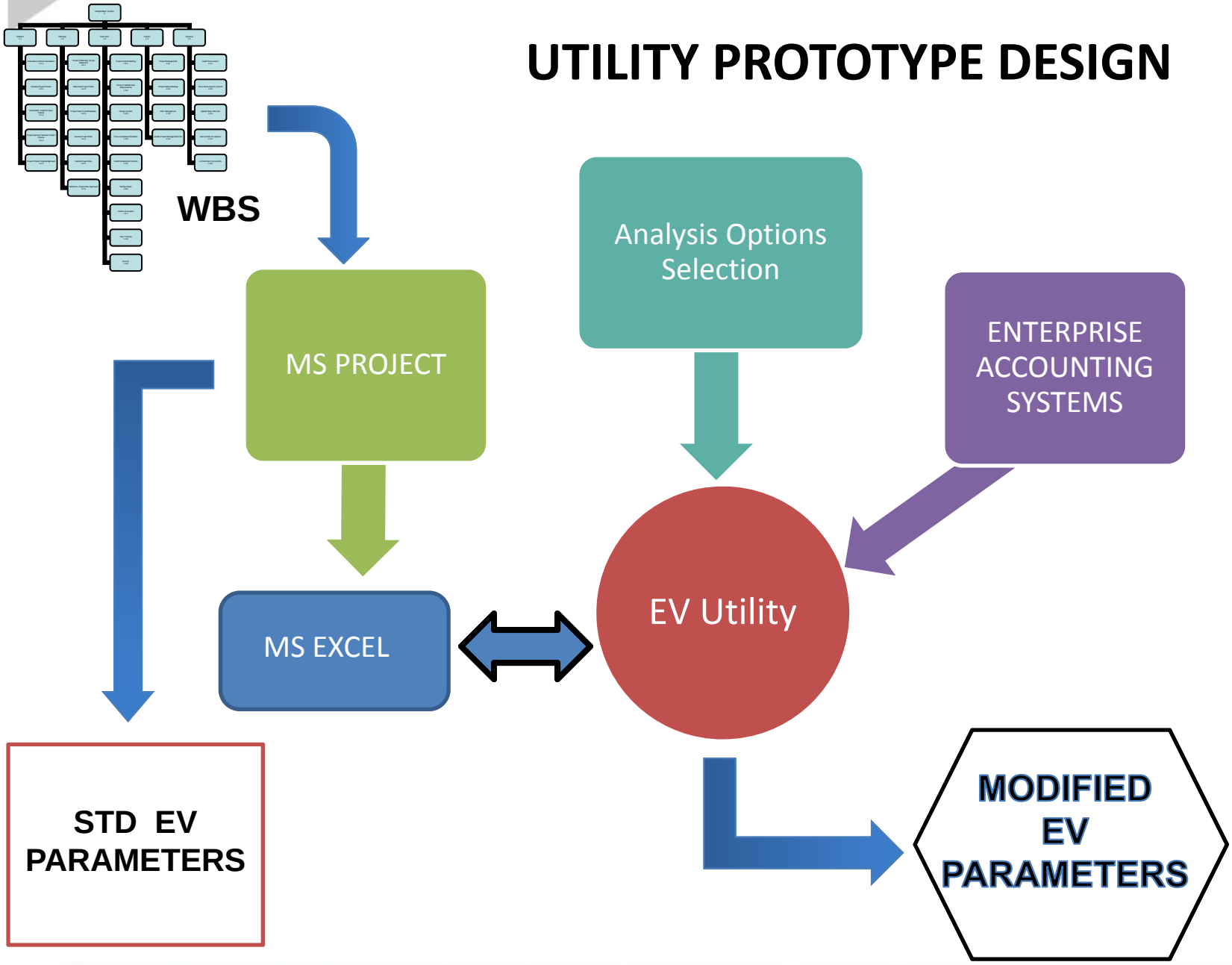
Calculated Data

- MS Access
- MS Excel

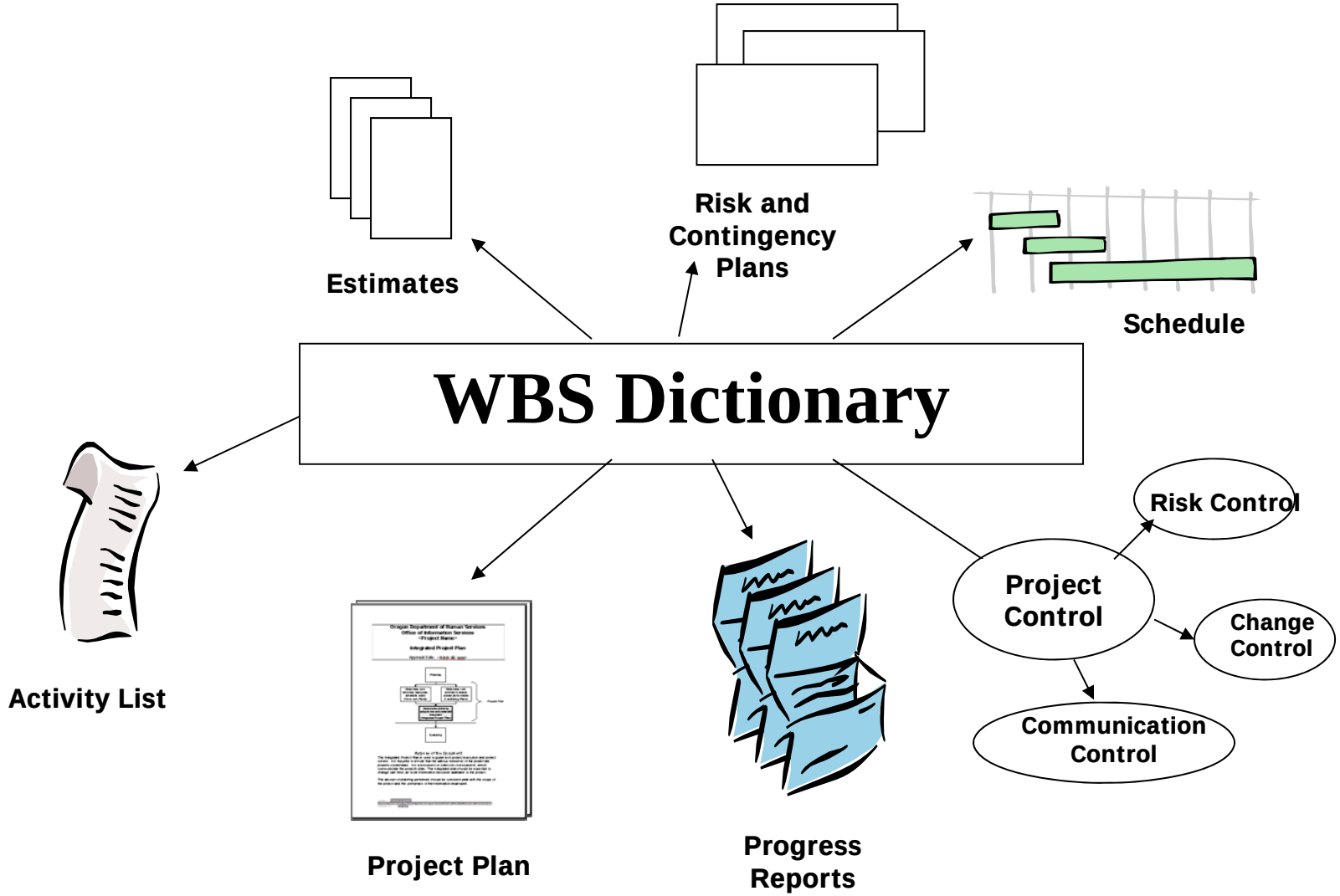
Actuals

- Accounting Systems
- Live Project

UTILITY PROTOTYPE DESIGN



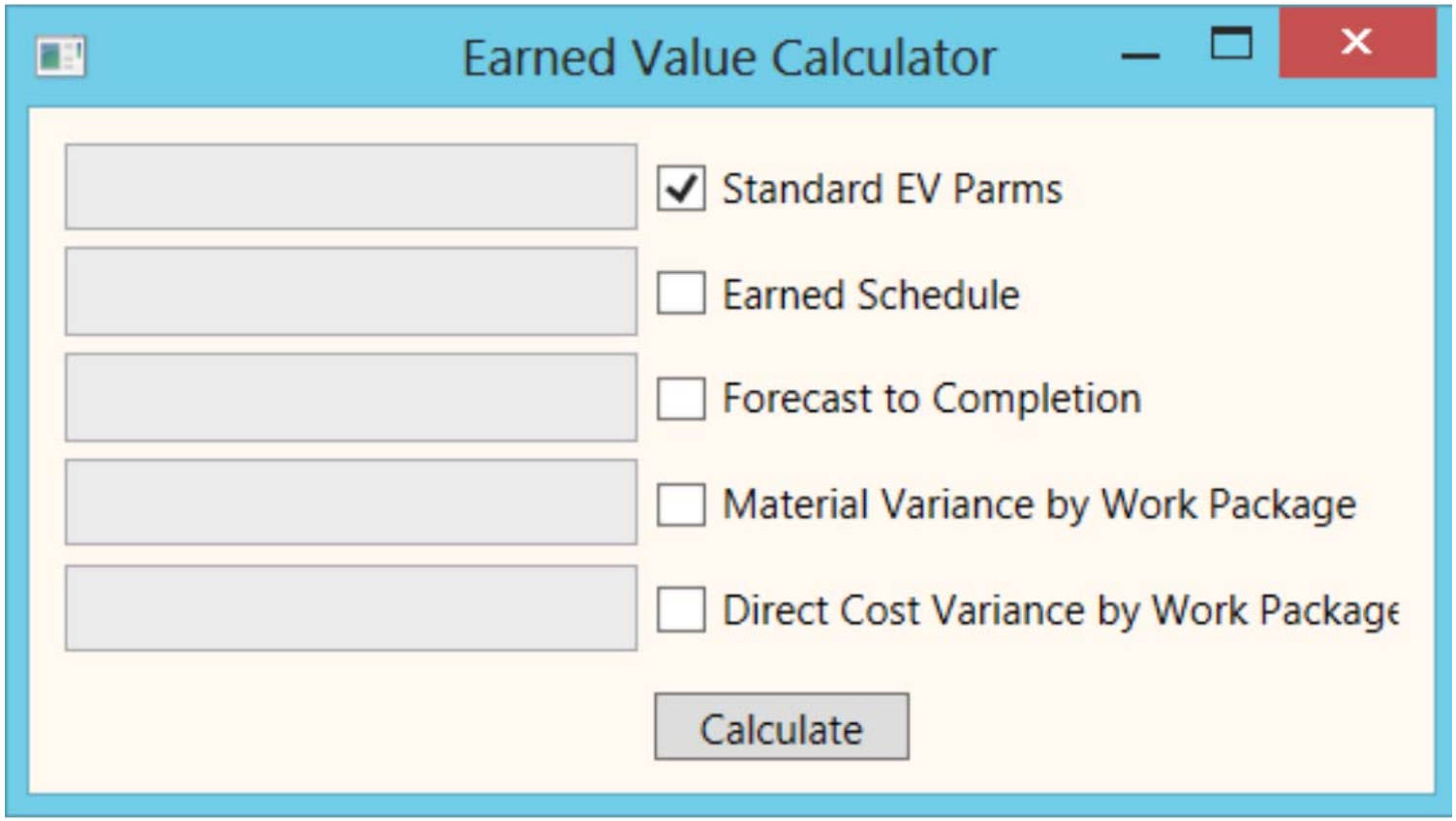
Linkages


Estimates
Risk and Contingency Plans
Schedule
WBS Dictionary
Activity List
Project Plan
Progress Reports
Project Control
Risk Control
Change Control
Communication Control

EV Driver Utility

This prototype utility consists of a SQL-like data repository linked to multiple EV calculation algorithms that collectively define various aspects of a project's performance.

Option Selection GUI



STANDARD EV PARAMETERS

Name	BCWS	BCWP	AC	CPI	SPI	CV	SV
5.2 Car Problem First Cut	819515.18	734387.29	831065.80	0.88	0.90	-96678.51	-85127.88
Planning & Project Initiation	104000.00	104000.00	135500.00	0.77	1.00	-31500.00	0.00
Charter	10000.00	10000.00	12500.00	0.80	1.00	-2500.00	0.00
Stakeholders Identification	2000.00	2000.00	2500.00	0.80	1.00	-500.00	0.00
Scope Definition	54000.00	54000.00	72000.00	0.75	1.00	-18000.00	0.00
Schedule Development	18000.00	18000.00	22500.00	0.80	1.00	-4500.00	0.00
Risk Assessment	10000.00	10000.00	13250.00	0.75	1.00	-3250.00	0.00
Budget Definition	6000.00	6000.00	7750.00	0.77	1.00	-1750.00	0.00
Management Charter Approv	2000.00	2000.00	2500.00	0.80	1.00	-500.00	0.00
Set baseline	2000.00	2000.00	2500.00	0.80	1.00	-500.00	0.00

MODIFIED EV PARAMETERS

Name	BCWS 3	BCWP 3	AC	CPI 3	SPI 3	CV	SV
5.2 Car Problem First Cut	895,638.38	627033.85	1424915.8	0.44	0.70	-797882	-268604.53
Planning & Project Initiation	104,200.00	104200	0	0.00	1.00	104200	0
Charter	10,000.00	10000	12500	0.80	1.00	-2500	0
Stakeholders Identification	2,000.00	2000	2500	0.80	1.00	-500	0
Scope Definition	54,000.00	54000	72000	0.75	1.00	-18000	0
Schedule Development	18,000.00	18000	22500	0.80	1.00	-4500	0
Risk Assessment	10,000.00	10000	13250	0.75	1.00	-3250	0
Budget Definition	6,200.00	6200	7750	0.80	1.00	-1550	0
Management Charter Approval	2,000.00	2000	2500	0.80	1.00	-500	0
Set baseline	2,000.00	2000	2500	0.80	1.00	-500	0

TEAM PERFORMANCE

Name	AC_Labor	BCWS	BCWP	CPI_labor	SPI_labor
5.2 Car Problem First Cut	412440	453,684.01	329952	0.8	0.73
Planning & Project Initiation	0	0.00	0	0	0.00
Charter	12500	10,000.00	10000	0.8	1.00
Stakeholders Identification	2500	2,000.00	2000	0.8	1.00
Scope Definition	30000	24,000.00	24000	0.8	1.00
Schedule Development	22500	18,000.00	18000	0.8	1.00
Risk Assessment	6250	5,000.00	5000	0.8	1.00
Budget Definition	7500	6,000.00	6000	0.8	1.00
Management Charter Approval	2500	2,000.00	2000	0.8	1.00
Set baseline	2500	2,000.00	2000	0.8	1.00

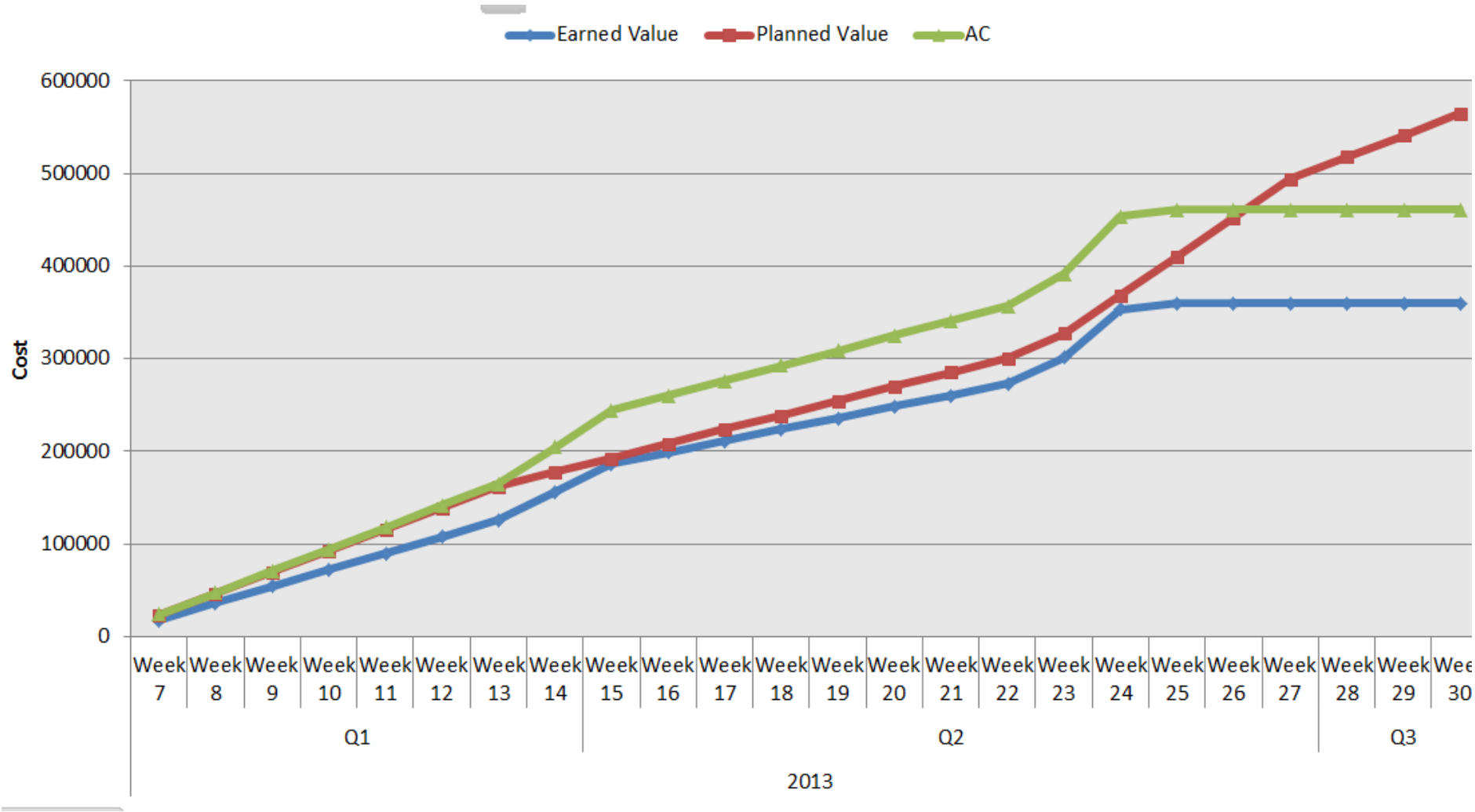
MATERIAL EV

Name	AC_Matl	BCWS	BCWP	CPI_Matl	SPI_Matl
5.2 Car Problem First Cut	960603	943,449.40	686145	0.71	0.73
Planning & Project Initiation	0	0.00	0	0.00	0.00
Charter	0	0.00	0	0.00	0.00
Stakeholders Identification	0	0.00	0	0.00	0.00
Scope Definition	42000	30,000.00	30000	0.71	1.00
Schedule Development	0	0.00	0	0.00	0.00
Risk Assessment	7000	5,000.00	5000	0.71	1.00
Budget Definition	0	0.00	0	0.00	0.00
Management Charter Approval	0	0.00	0	0.00	0.00
Set baseline	0	0.00	0	0.00	0.00

LABOR RATE ANALYSIS

WBS	Name	AC_Labor	PV_labor	EV_labor	CPI_labor	SPI_labor
1	5.2 Car Problem First Cut	412440	453,684.01	329952	0.8	0.73
1.1	Planning & Project Initiation	0	0.00	0	0	0.00
1.1.1	Charter	12500	10,000.00	10000	0.8	1.00
1.1.2	Stakeholders Identification	2500	2,000.00	2000	0.8	1.00
1.1.3	Scope Definition	30000	24,000.00	24000	0.8	1.00
1.1.4	Schedule Development	22500	18,000.00	18000	0.8	1.00
1.1.5	Risk Assessment	6250	5,000.00	5000	0.8	1.00
1.1.6	Budget Definition	7500	6,000.00	6000	0.8	1.00
1.1.7	Management Charter Approval	2500	2,000.00	2000	0.8	1.00
1.1.8	Set baseline	2500	2,000.00	2000	0.8	1.00

ES Calculations



ES With Lipke Calculator

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Week	EVcum	PVcum	Pc=>Sc	Numerato	enominat	InterpVal	EScum	ESwk	SPI(t)wk	SPI(t)cum	AT	SV(t)wk	SV(t)cum
21	260933.34	285666.67	13	6183.34	15458.33	0.4000	13.4000	0.8000	0.8000	0.8933	15	-0.2000	-1.6000
22	273300.01	301125.00	14	3091.67	15458.33	0.2000	14.2000	0.8000	0.8000	0.8875	16	-0.2000	-1.8000
23	301498.68	327109.09	16	373.67	25984.09	0.0144	16.0144	1.8144	1.8144	0.9420	17	0.8144	-0.9856
24	353445.35	368881.82	17	26336.25	41772.73	0.6305	17.6305	1.6161	1.6161	0.9795	18	0.6161	-0.3695
25	359676.78	410654.55	17	32567.69	41772.73	0.7796	17.7796	0.1492	0.1492	0.9358	19	-0.8508	-1.2204
26	359676.78	452427.28	17	32567.69	41772.73	0.7796	17.7796	0.0000	0.0000	0.8890	20	-1.0000	-2.2204
27	359676.78	494200.00	17	32567.69	41772.73	0.7796	17.7796	0.0000	0.0000	0.8466	21	-1.0000	-3.2204
28	359676.78	517700.00	17	32567.69	41772.73	0.7796	17.7796	0.0000	0.0000	0.8082	22	-1.0000	-4.2204
29	359676.78	541200.00	17	32567.69	41772.73	0.7796	17.7796	0.0000	0.0000	0.7730	23	-1.0000	-5.2204
30	359676.78	564700.00	17	32567.69	41772.73	0.7796	17.7796	0.0000	0.0000	0.7408	24	-1.0000	-6.2204

Interpreting the Table Results

- EV @ week 30 = PV between week 23 and 24 =~ 6.5 time periods
- AT value @ week 30 gives integer value for ES
- SV(t) cum @ week 24 indicates near on time performance
- SPI(t) = 0.74 at week 30, down from 0.98 at week 24

Lipke ES Analysis Terminology

Metrics	Earned Schedule	ES_{cum}	ES = C + I number of complete periods (C) plus an incomplete portion (I)
	Actual Time	AT_{cum}	AT = number of periods executed
Indicators	Schedule Variance	SV(t)	SV(t) = ES - AT
	Schedule Performance Index	SPI(t)	SPI(t) = ES / AT
	To Complete Schedule Performance Index	TSPI(t)	TSPI(t) = (PD – ES) / (PD – AT)
			TSPI(t) = (PD – ES) / (ED – AT)
Predictors	Independent Estimate at Completion (time)	IEAC(t)	IEAC(t) = PD / SPI(t)
			IEAC(t) = AT + (PD – ES) / PF(t)

Key Conclusions

1. Blindly extracting EV parms from a software model is worse than not using them at all (false indicators) and will erode credibility of the metric.

1. Using zero variance and index values (1.0) as indicators of good performance is an erroneous productivity indicator and will result in longer project cycles

2. Labor resource rate analysis is the key project management productivity analysis consideration

3. A WBS Dictionary oriented data store is needed to provide flexible data views for various EV oriented analysis

4. Project managers must learn how the various Work Package resource elements should be used to evaluate various aspects of project status and forecasting.

Sample Future Research Areas

- Add new analysis options—e.g., rate variance
- Improve computation integration across all processes
- Use of raw table data for other analyses
- ES for both task level and critical path evaluation
- Add logic to handle risk, scope and rebaselining

Questions?

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