EVM Analytics™ Instructions
(Version 1.4)

INTRODUCTION

Thank you for your purchase of the EVM Analytics™ Excel workbook. This workbook will provide you traditional EVM (earned value management) data analysis plus a deeper analysis using concepts that have emerged within the last decade or so. These additional analysis concepts make use of Excel's powerful analytical and statistical functions. All that is required to use the workbook is your basic EVM data. You will need to provide:

- Budget at complete (BAC)
- Start date and periodic (monthly, weekly, etc.) dates
- Current (periodic) values of PV (BCWS), EV (BCWP), and AC (ACWP)

This workbook is EIA-748 compliant to the extent that EIA-748 addresses data calculations. For example, all BAC must be planned, and CV and SV are computed per EIA -748. This workbook cannot address processes, forms, and procedures that are part of EIA-748.

This workbook, worksheets, and charts are locked and password protected. This is to ensure the accuracy and correctness of the analysis, and to avoid inadvertent altering of the template. Cells requiring user input are unlocked. You cannot select cells that are locked.

You may copy charts and paste them into other Office documents for use in reports and presentations.

Data validation and color coding are used to assist in entering data and alerting you to possibly incorrect values.

EVM Analytics only analyzes the data for one control account, project, program, WBS, or OBS data set. It does not consider the project OBS and WBS hierarchy. The user can choose what level within their project/program they wish to perform the analysis by using the EVM data from that level.

It does not produce EVM reports such as the CPR and IPMR.

As with any use of EVM data, project/program management decisions should be based upon a number of sources and discussions including sources other than EVM data and its analysis.

The section below will get you started.

GETTING STARTED

Use of macros

The EVM Analytics workbook uses Microsoft Office VBA (Visual Basic for Applications) macros. You will need to "enable" macros for the workbook to completely open and operate.

Opening and registering the workbook

1. Double click on the EVM Analytics.xslm file.
2. If macros are NOT enabled your workbook will open a screen that says macros are not enabled.
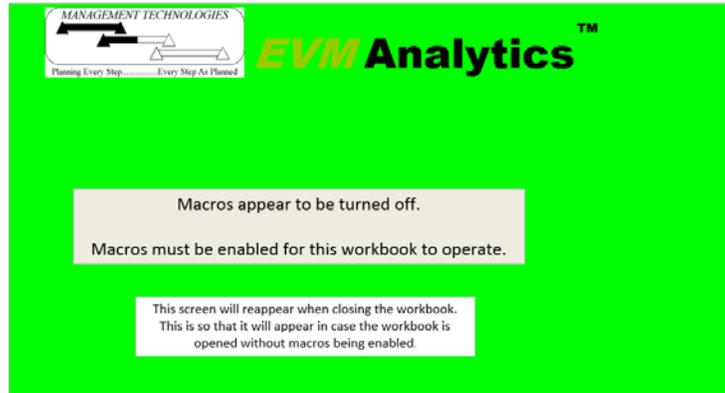
3. If macros are enabled your workbook will open showing
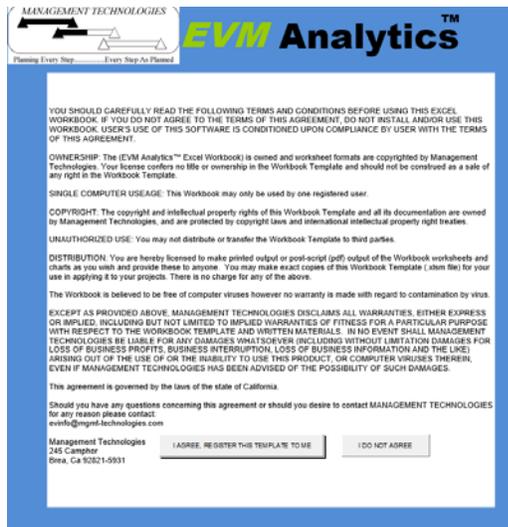
4. Please review the agreement and click on "I agree, register this template to me." You will be taken through five dialog boxes. You will be asked to enter:
   a. Your name
   b. A user name (case sensitive)
   c. A password (case sensitive)
   d. A question of your choosing to recover you username and password
   e. The answer to your question (not case sensitive)

5. The username and password will be needed to open the workbook and any copies of the workbook you create for your projects. You may also be asked to enable macros when you open any of the workbook copies the first time.

Duplicating your master workbook

Once you have registered your EVM Analytics workbook you should Save it before entering any data. This will create your Master Workbook. You can then duplicate this workbook (xlsm file), retitle it for your specific project, and enter project data.

Logging into your workbooks

When you open your Master Workbook or any derived workbook you will see the following dialog (you may need to enable macros first):

Getting help

Throughout the workbook there are comments and data validity checks to help make your use of the workbooks easy. Placing your mouse over any question mark ("?") in column one will show a comment related to that row's contents.

The HELP tab, on the far right list of tabs also shows this information.

Creating your control account, project, or program Performance Measurement Baseline (PMB)

The EVM Analytics workbook can address projects with up to 52 periods. Thus a year long project can provide weekly data, and a four year project can provide monthly data.

Adding columns

If you need additional columns a macro is available to properly add the columns. Columns are added starting at the penultimate column, and to the right. Formulas are propagated as needed for the new columns.

Before adding columns save your workbook in case you do not get the desired result.

The macro is "Add_columns" and may be executed by clicking on the "Developer" menu, and the clicking on "Macros" button. Select "Add_columns". You will have to confirm your

intention to add to the number of columns and then you will be asked to provide the number of columns needed.

Once the columns are added you will have to input or correct the dates in row 1. Save your workbook with a new name so you can return to the prior version if needed.

You can only access cells which require your input. All data entry is done on the "Analysis" tab.

Data error testing

The workbook performs basic EVM data error testing. Testing is performed on current values of PV, EV, and AC. Values which are shaded yellow may be incorrect based simply upon the mean and standard deviation of the all prior values entered. You may set the sensitivity in cell C4. Entry is limited to "1", "2", or "3". Three is least sensitive. Values within the number (1 ,2 or 3) of standard deviations is considered acceptable, otherwise they are colored yellow. Generally lower values may be used for projects that are familiar, well defined, have limited risks, and use experienced staff and known technologies.

Required data

You should have the following information available to create your PMB:
- Budget at Complete (BAC)
- Start date (first or last day of the month or accounting month). This is date the project starts. On this date NO work is planned to be completed. It is the "zero" point.
- Incremental Planned Value (PV, BCWS) for each period. (The workbook will compute the cumulative PV)

Your performance measurement data is not protected or locked. Use caution that you do not accidently change the PV (BCWS) data values during your project's execution as this will alter your PMB.

Entering the budget at complete

Click on the "Analysis" tab (worksheet)
Enter the budget at complete in cell E1.

Entering the reporting dates.

All planned reporting dates are entered in F1 and cells to the right. You want to enter your entire project duration. You can key them in, or provide the start date and use the Excel Series to populate the cells to the right. You may also paste values from another worksheet, perhaps an output from your EVMS tool. Do not just paste the data, PASTE VALUES, this will preserve important formatting and data validation.

Entering the PV

Enter the incremental Planned Value (PV, BCWS) for each period, starting in cell G3 and continuing until the end of the project. (The workbook will compute the cumulative PV).

Important: The value entered in G3 cannot be zero.

<u>Important:</u> The cumulative PV, calculated from the incremental values, must equal the BAC. The workbook will determine when the project is planned to complete by finding the month (period) where the cumulative PV equals BAC, or is closest to the BAC without exceeding it. (This allows for round off or decimal differences to be ignored.)

Verifying data entry and workbook analysis

Check that your baseline has been entered correctly. Examine the following items:

- Are there dates in row one that continue at least to the column where the cumulative PV in row 7 is equal to the BAC?
- Is there a value for current period PV in the first period?
- Is the project end date (C3) correct? Look in row 7, find where the cumulative PV value is equal to your BAC value in cell E1?
- Is the project duration (days) in E2 approximately correct? Don't count days, just look for reasonableness?
- Click on the PMB tab and see that your PMB (S-curve) looks as you would expect, with the BAC value being the end point of the PV and this point is on the correct date.

Here is a sample of what you should have entered on the Analysis sheet.

	B	C	D	E	F	G	H	I	J	K	L
	EVM **Analytics**										
	PROJECT END DATE ->	12/1/2019	AUTH. BUDGET->	250000	1/1/2018	2/1/2018	3/1/2018	4/1/2018	5/1/2018	6/1/2018	7/1/2018
			PLAN DURATION (Days) ->	699	0	1	2	3	4	5	6
	CURRENT PERIOD DATA			PV - CURRENT PERIOD (BCWS)		5687.5	3295.0	4717.2	6489.3	8578.3	10896.4
	DATA ERROR TESTING SENSITIVITY->	3		EV - CURRENT PERIOD (BCWP)							
	(1= most, 3 least)	Data Valid?		AC - CURRENT PERIOD (ACWP)							
	CUMULATIVE PERIOD DATA			PV - CUMULATIVE (BCWS)		5687.5	8982.6	13699.8	20189.2	28767.4	39663.8
				EV - CUMULATIVE (BCWP)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
				AC - CUMULATIVE (ACWP)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Entering monthly (periodic data)

Monthly (periodic) EVM data may be entered manually or imported from Excel files exported from your EVMS software. The following elements are needed at the close of each month (period)

- *Incremental* Earned Value (EV, BCWS)
- *Incremental* Actual Cost (AC, BCWS)

You can only access cells which require your input. Click on the Analysis worksheet tab if not already selected.

Enter the incremental EV in row four and the incremental AC in row five. The workbook will create the cumulative values of all EVM parameters.

Note that values must be positive, not zero or less. You cannot reduce prior reported EV or AC. If values have been incorrectly entered in past months simply enter correct data in the appropriate period (permitted by EIA-748). If past reported progress was overstated you will

need to retroactively correct past values rather than enter a negative incremental EV to correct the current cumulative value.

If your project is continuing past the planned compilation date you may need to enter additional month (period) ending dates in row 1, to the right of the final completion date as needed. The dates entered will form the timeline on charts so you may wish to just add a few additional dates rather than fill the entire row.

When you have entered your EV and AC values you worksheet should look like:

	D	E	F	G	H	I	J	K	L
AUTH. BUDGET->	250000		1/1/2018	2/1/2018	3/1/2018	4/1/2018	5/1/2018	6/1/2018	7/1/2018
DURATION (Days) ->	699		0	1	2	3	4	5	6
PV - CURRENT PERIOD (BCWS)			0	5687.5	3295.0	4717.2	6489.3	8578.3	10896.4
EV - CURRENT PERIOD (BCWP)			0	530.6	5486.2	2692.2	4642.7		
AC - CURRENT PERIOD (ACWP)			0	809.2	3683.9	5351.8	5854.7		

Reviewing analysis

Analysis is performed on a progressive basis. If data is not available then NA will appear in the analysis row. Some analysis is deferred until sufficient history is available, for example ETC (Estimate To Complete) is not computed until three periods of data are available. Most analysis is performed after the third period. (See the vertical dashed line between period three and four.)

Cumulative Data
The cumulative values of PV, EV, and AC are computed in rows 7-9. These are the data that is used to plot the PMB chart. The largest value of PV must be equal to BAC.

Variances
Traditional current and cumulative cost variance (CV) and schedule variance (SV) are computed. These data are the source of data for the charts showing current and cumulative SV and CV.

Earned Schedule Analysis
Earned Schedule Analysis provides an alternative to the traditional view of schedule variance. It looks at the PMB along the time axis and determine when the current amount of completed work was planned to be completed. This yields a variance in dates versus a variance in budget amounts. The resulting analysis yields an SPT(t) using time; as an alternative to using budget and obtaining SPI($). SPI($) will always end up as 1.0 at the end of the project and begins to loose value as a metric about two-thirds into the project. SPI(t) does not behave in this manner but remains useful to the project's end. Therefore wherever SPI is used as a factor in the EVM Analytics workbook SPI(t) is used.

Earned Schedule analysis produces the following metrics shown in the Analysis worksheet:
- Earned schedule (ES) date: the date corresponding to the amount of work completed
- Earned schedule days: the number of days into the project represented by the amount of work completed
- Actual time (AT): the number of days the project has been in execution
- Planned duration of remaining work: the number of days of work that need to be completed
- Time remaining: the number of days remaining before the planned completion date
- Schedule variance: the difference between the AT and the ES; $SV = ES-AT$
- Cumulative SPI (t): $SPI (t) = ES/AT$
- Monthly SPI (t): $SPI (t) = ES/AT$, using last period's performance (ET) and the number of days between the last two periods (AT)}

The following diagram illustrates earned schedule:
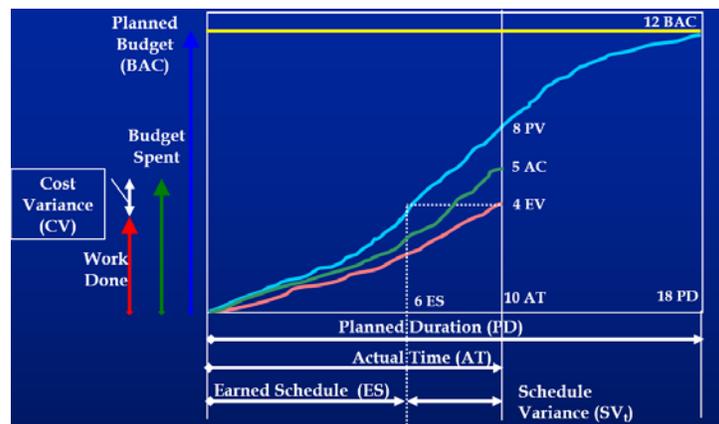
CPI, SPI, and SPI(t)
This section computes the SPI($) and CPI from the data found elsewhere on the worksheet. SPI(t) is repeated from the Earned Schedule section. Color coding is applied per the table of values found in rows 90-97.

TCPI and TSPI
The To-Complete-Performance-Index and the To-Complete-Schedule-Index are not computed until the fourth period in order that the performance data stabilize and trends are established.

TCPI is computed from
- $TCPI = (BAC-EV)/(BAC-AC)$
- $TCPI = (BAC-EV)/(LRE-AC)$
  - Where LRE is a user provided value in cell D33
TSPI is computed from
- $TSPI = (PD-ES/(PD-AT)$
- $TSPI = (PD-ES/(ED-AT)$
  - Where ED is a user provided value in cell D35

Both TCPI and TSPI are color coded red if they exceed 1.1, a value that represents an unrecoverable state.

To avoid accidental entry errors an informational diagonal box is displayed if the user enters values of LRE or ED that exceed 1.5 times the project BAC or PD.

Percent Spent, Complete, and Planned.

Percent spent, percent complete and percent planned are computed as:
- $PS = 100*AT/BAC$
- $PC = 100*EV/BAC$
- $PP = 100*PV/BAC$

Estimated Outcomes

Estimated outcomes are in rows 41-45. These estimates are not computed until the fourth period in order that the performance date stabilize and trends are established. There are four estimated at complete (EAC) cost estimates and one estimated completion date.

The four EACs are calculated from:
- $EAC = BAC/CPI$
- $EAC = AC + (BAC-EV)/CPI_3$; where CPI_3 is the cumulative (not average) CPI for the last three months
- $EAC = AC + (BAC-EV)/(CPI \ x \ SPI(t))$, this is often the worse case EAC for programs with CPI and SPI values below 1.0.
- An average of the above three EAC values

The estimated completion date (ECD) is calculated from $ECD = PD/SPI(t)$, where PD is found in cell E2.

Statistical Outcomes

The statistical outcomes use complex formulas involving past performance data, the number of periods behind and ahead of the current date, and a user provided desired confidence factor. The formula involves natural logarithms, the inverse Student-T distribution, sum-squared, and exponential functions.

Both the CPI and SPI(t) are handled the same. A forecast final lowest and highest value is computed based upon historic data and the user desired confidence factor (cell E48). This can be set from 50% to 90% in increments of 10%. Higher values will result in a narrower range of possible outcomes.

These values are applied to compute the final ETC and ECD using traditional formulas as used in the Estimated Outcomes section, above. A mid level value is simply the average between the highest and lowest values.

Data Validity Check

Data validity checks are performed on the values of incremental PV, EV, and AC.

Testing is performed on current values of PV, EV, and AC. Values which are shaded yellow may be incorrect based simply upon the mean and standard deviation of the all prior values entered. You may set the sensitivity in cell C4. Entry is limited to "1", "2", or "3". Three is least sensitive and values within three standard deviations is considered acceptable, otherwise they are colored yellow. Likewise 1 and 2 select the number of standard deviations to apply to the rule. Generally lower values may be used for projects that are familiar, well defined, have limited risks, and use experienced staff and known technologies.

Rows 63-69 show the limiting values applied. If either of these values are exceeded the corresponding data cell is colored yellow.

Rebaseline Trigger Analysis

Rebaseline trigger analysis is done considering recent trends and directions in current period CPI, SPI(t), and SPI($).

The approach used in this workbook deviates from the approach cited in the Sources of Concepts section. The original concept reviewed ALL control accounts and tallied only those showing a rebaseline might be in order. The total number of control accounts that satisfied the rules for a rebaseline is divided by the total number of control accounts. Since this workbook only looks at one control account, WBS, OBS, or program such a tally is not possible.

The indication of a rebaseline in the workbook is based only upon the data in the workbook.

The following rules are applied:

An acceptable range of CPI and SPI values is set by the user (typ. 0.8 – 1.2) in cells C26-C29. The CPI, SPI($), SPI(t) are each individual reviewed and the number of periods are counted where the following condition occur.
- Threshold is consecutively breached three or more periods, per index
- The trend is in the same direction over this period
- The trend is in the wrong direction

The following graphic illustrates examples of when the excursions DO NOT COUNT:
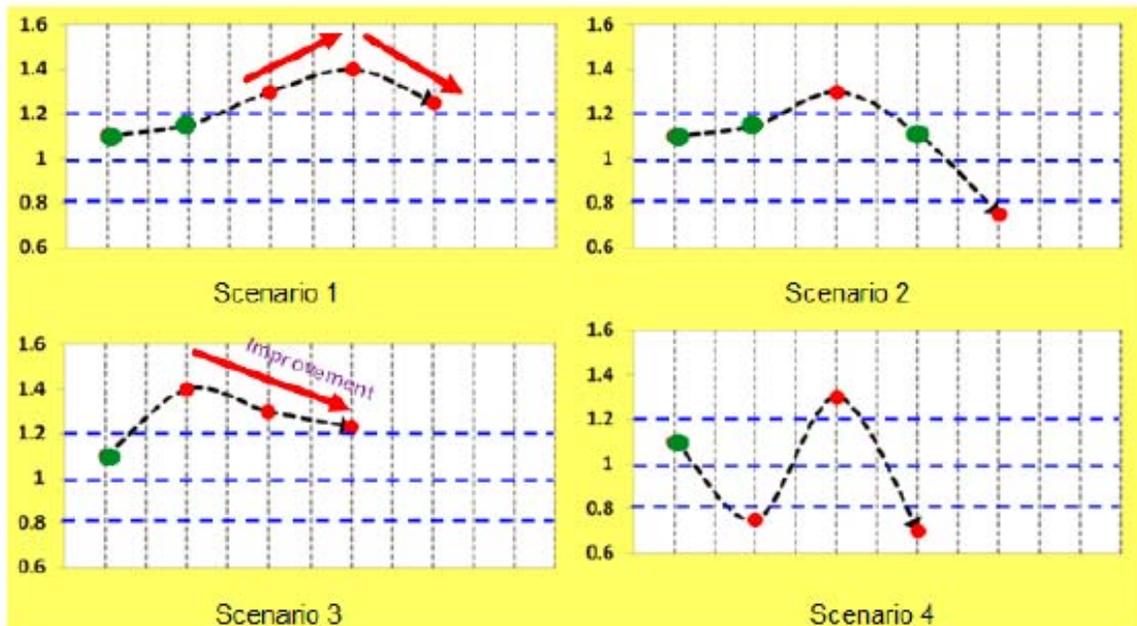
If any of the examined values (CPI, SPI($), SPI(t)) meet all three conditions above then row 87 is set TRUE. This indicates that a rebaseline may be a good idea for the program element (CA, WBS, OBS, whole program) EVM data in the workbook.

In practice a rebaseline should be considered only if the indication is TRUE over several recent periods.

Exporting data analysis

A worksheet titled "Exportable Data" appears as one of the last worksheets in the workbook. This sheet contains all the analysis performed on the "Analysis" sheet in a form available to copy and paste into other workbooks. All data cells are available to be selected, copied, and pasted into another workbook or other document.

Using charts

The workbook contains charts of the various analysis products over time. These can be exported to other documents. Use COPY – COPY AS PICTURE.

SOURCES OF CONCEPTS

- Lipke, *Schedule is Different*, The Measurable News, March 2003
- Lipke, *The To Complete Performance Index … An Expanded View*, The Measurable News, 2009, Issue 2
- Lipke, *Applying Statistical Forecasting of Project Duration to Earned Schedule - Longest Path*, The Measureable News, 2015.02
- Kasunic, McCurley, Goldenson, Zubrow. *An Investigation of Techniques for Detecting Data Anomalies in Earned Value Management Data*, SEI Technical Report CMU/SEI-2011-TR-027
- Kesheh, Stratton, *Taking The Guessing Out Of When To Rebaseline*, The Measurable News, 2013, Issue 4

KEY CELLS AND USER ENTRIES

Cell	Data item	Remarks
C1	Project End Date	Project End Date is <u>computed</u> using BAC and the date when the cum PV is the same value, or closest value not exceeding the BAC.
E1	Authorized Budget	Authorized Budget (BAC): The budget for all the work planned in this workbook. May be hours, dollars, or other resource units. Same units must be used throughout.
F1	Project Start Date	Month the project begins, use the first or last day of the month. No work should be planned to be completed on this date.
G1 – BG1	Period ending dates	Usually the beginning or end of the month. You can enter or possibly copy the dates from your scheduling or accounting system. If you are copying these dates from another source use "Paste Values". You may also use Excel's FILL/SERIES. Note that FILL/SERIES may not produce dates identical to your scheduling or financial system dates. You may insert dates past the end of the project to allow for slipped schedules. DO NOT INSERT DATES WELL PAST THE PLANNED COMPLETION DATE TO AVOID CHARTS WITH EXCESSIVE TIMELINES.
D2	Planned Duration (Days)	Computed from Project End date minus Project start date
G2 – BG2	Current period planned PV (BCWS)	Enter the current period Planned Value. <u>Must have a value in G3</u>. All values entered must be positive values. If the cell is yellow the value may be incorrect.
C4	Data Error Sensitivity	Select a value of 1, 2, or 3 for sensitivity to questionable data
G3 – BG3	Current period planned EV (BCWP)	Enter the current period Earned Value. All values entered must be positive values. If the cell is yellow the value may be incorrect.
G4 – BG4	Current period planned AC (ACWP)	Enter the current period Actual Cost. All values entered must be positive values. If the cell is yellow the value may be incorrect.
C26	Rebaseline CPI Upper Trigger	If the CPI is greater than this value it is of concern to the project.
C27	Rebaseline CPI Lower Trigger	If the CPI is less than this value it is of concern to the project.
C28	Rebaseline SPI Upper Trigger	If the SPI is greater than this value it is of concern to the project.
C29	Rebaseline SPI Lower Trigger	If the CPI is less than this value it is of concern to the project.
D33	Latest Revised Estimate (LRE)	Enter a value here to compute the TCPI using a target budget other than the BAC.

D35	Estimated Durations (ED)	Enter a value here to compute the TSPI using a target project duration other than the Planned Duration.
E48	Confidence Factor	Enter 0.5 to 0.9 as a confidence factor. Larger values will reduce the range of possible outcomes.
C92, D92, E92	Green Cumulative Color Coding	Range, about 1.0, that cumulative CPI, SPI($), and SPI(t) should be colored Green above.
C93, D93, E93	Yellow Cumulative Color Coding	Range, about 1.0, that cumulative CPI, SPI($), and SPI(t) should be colored Yellow above. Outside this range the cells will be colored Red.
C96, D96, E96	Green monthly Color Coding	Range, about 1.0, that monthly CPI, SPI($), and SPI(t) should be colored Green above.
C97, D97, E97	Yellow monthly Color Coding	Range, about 1.0, that monthly CPI, SPI($), and SPI(t) should be colored Yellow above. Outside this range the cells will be colored Red.