Earned Value

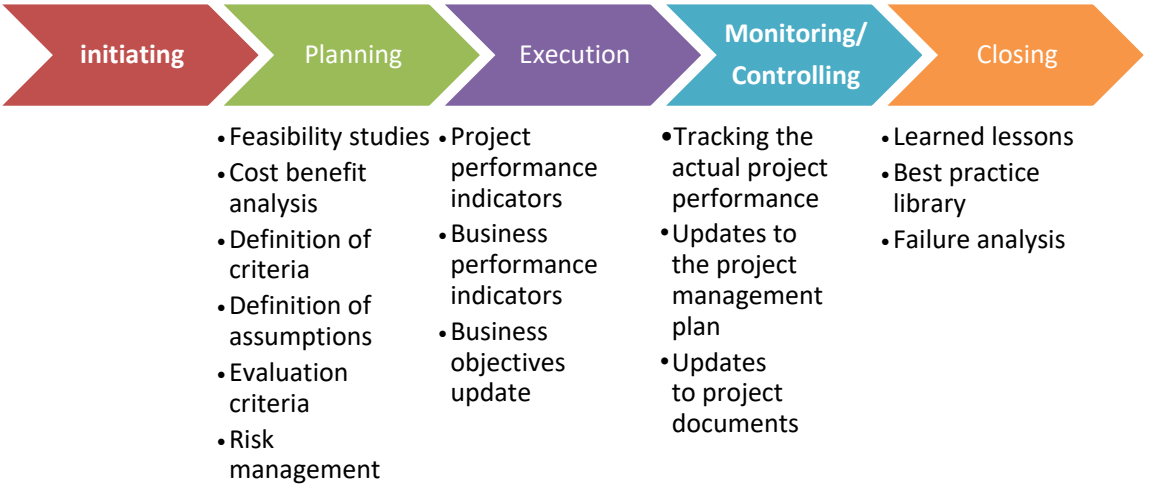


Fig 1. Where is used Earned Value Analysis

Introduction to Earned Value

Project Management had many tools and techniques for the management of the successful project. One of the most regarded of these tools would be Earned Value Analysis.

Maybe the less than full embrace can be attributed to following scenario. You as the project manager of a key project, have a client that contracted with your firm to produce 6 Strategic Deliverables for the company. You created a plan to produce the five Deliverables during this year. In fact, the plan calls for 100 hours to be spent for each assembled deliverable. The year ends and six deliverables were produced. At year end you check with the finance department to inquire about the total number of hours spent to produce the six deliverables. Finance informs you that 500 total hours were expended. At first blush, you, the project manager, are filled with a sense of accomplishment, in fact dazzling accomplishment as you finished the planned six-hundred-hour production of Gizmos in 500 hundred hours, saving the company 100 hours that may be applied to other projects in need. Then, a sense of less-than-great feeling is recognized from deep within, why? What's wrong with this picture? Bad estimations, bad planning? Under-allocation resources?

Perhaps it is the fear of the unknown that gives Earned Value a less than importance review by many in the field. Information, which is power, can help hold project fear controlled. Therefore, this paper sets out with the fundamental expectation of providing basic information about Earned Value that will allow us to embrace the positive of EVMS without the fear of unknow.

What is Earned Value Analysis?

Earned Value Analysis (EVA) is a method that allows the project manager to measure the amount of work actually performed on a project beyond the basic review of cost and schedule reports. EVA provides a method that permits the project to be measured by progress achieved. The project manager is then able, using the progress measured, to forecast a project's total cost and date of completion.

Oftentimes the term "earned value" is defined as the "budgeted cost of worked performed" or BCWP. This budgeted cost of work performed measure enables the project manager to compute performance indices or burn rates for cost and schedule performance, which provides information on how well the project is doing or performing relative to its original plans. These indices, when applied to future work, allow for to project manager to forecast how the project will do in the future, assuming the burn rates will not fluctuate, which oftentimes is a large assumption.

Earned Value Analysis Requirements

In order for the Earned Value Analysis to be accurate, a good solid project plan must be created. The project plan, especially the Scope Statement is the foundation to solid earned value practice.

In order to develop that common understanding of the project work, another key project deliverable should be created: The Work Breakdown Structure (WBS). The WBS breaks down all authorized work scope into appropriate elements for planning, budgeting, scheduling, cost accounting, work authorization, measuring progress, and management control

As one can plainly see, project planning is a necessity for project success and the incorporation of earned value analysis on your project. Now that basis for EVA has been established, let's focus on three primary areas of information needed to compute EVA.

EVM Foundational Concepts

As introduced above, Earned Value Management Systems allow the project manager to answer the following three questions, as they relate to the project:

1. Where have we been?
2. Where are we now?
3. Where are we going?

Introduction to Earned Value

- This Value is generally called "Earned Value", since it is literally the value obtained by the work done.
- It is an overall performance of the project in terms of both time and costs
- The purpose of this analysis is to measure the progress of the project and help predict its outcome.

In order for Microsoft Project to calculate the earned value of the Project Plan, you must first need:

- Save the Baseline to get the planned cost of the planned (planned) work
- Enter the work actually done from the tasks or assignments
- Set a status date for MS Project to calculate in actual performance

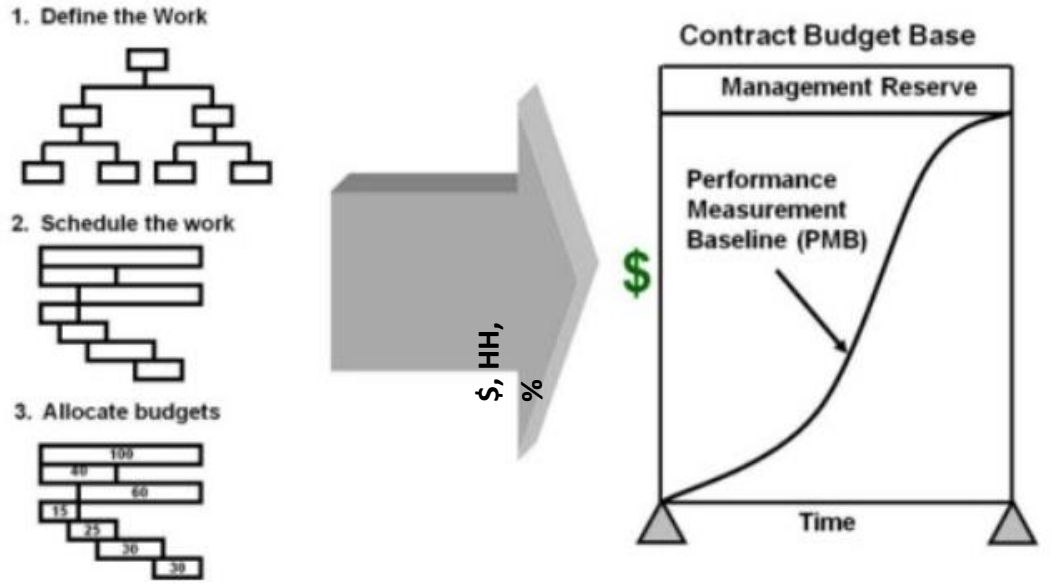


Fig 2. Establishing the baseline – an Iterative, three step process

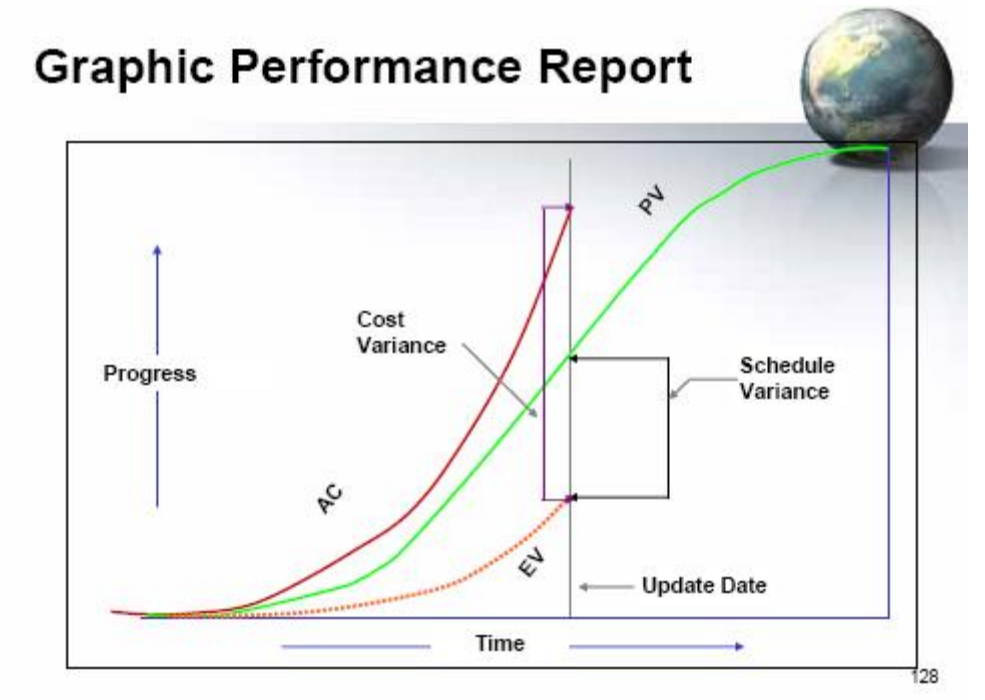


Fig 2. Earned Value Methodology

Definition of Basic Values

Planned value (CPTP, BCWS or PV): This is the cost of work budgeted for an activity or for the project over a period. Determines the total budgeted cost up to the date of the analysis.
Answers the question of "how much work should have been done by the analysis date?"

Current Cost (CRTR, ACWP or AC): It is the actual cost of the work to date (or for a period of time, for example: a phase). It includes direct and indirect costs. It answers the question: How much have we actually spent to date?

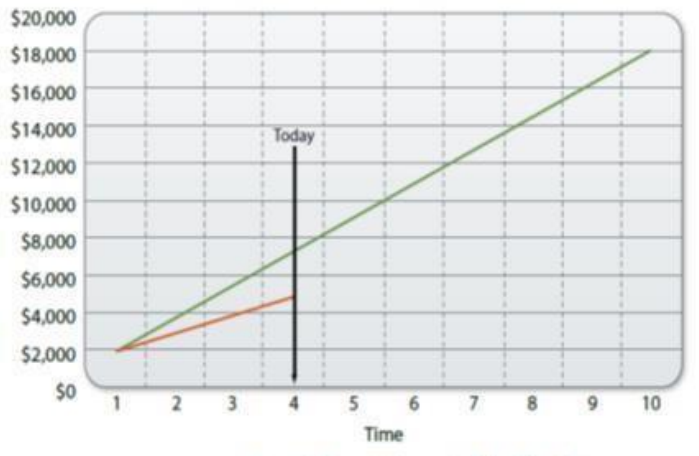
Earned Value (CPTR, BCWP or EV): It is a measure of the progress of the project to date or is the budgeted cost of the work done to date.
Answer the question "how much work has actually been completed from the initially budgeted?"

EV = PV * % actual progress) or BAC * % real progress

BAC= Is the sum of all budgets allocated to a project

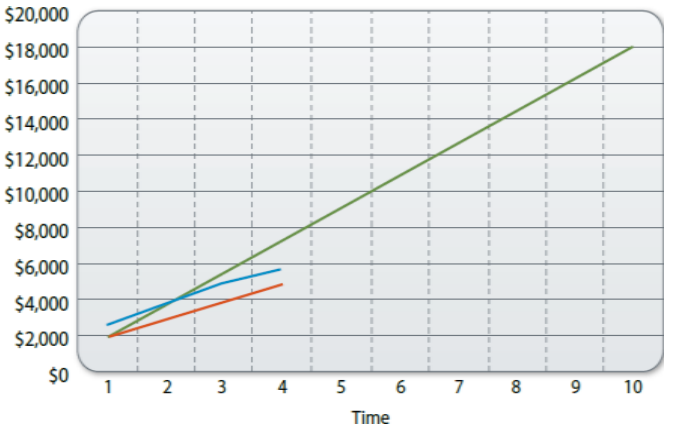
Example. If there an estimated project of $18,000 budget in a 10 month duration

At the end of the 4th month there is an progress of 26.7%.



EV= $4,806 (18,000*.267) (BAC * % actual advance) AC= $5,600 (Actual Cost

PV= $7,200 at cut (Planned Value)



Earned Value Example

In this example we will use a project with two tasks:

ID	Name
100	Solution Design
200	Build Application

We would like to produce a weekly project update to the Chief Technology Officer. The earned value method will give us metrics that include:

- Schedule status
- Budget status
- End-of-project projections for both

For this project, we will simply produce all of the earned value metrics in one table.

Project Planning

Earned value analysis requires four things to be set up during the project planning phase:

1. Breaking the project into tasks
2. Assigning each task, a start and end date
3. Assigning each task a budget
4. Choosing a project status period

Here is what our example project might look like after project planning:

ID	Name	Start	End	Budget
100	Solution Design	Mar. 1	Mar. 10	$10,000
200	Build Application	Mar. 7	Mar. 20	$15,000
			TOTAL	$25,000

At this point we also need to make a few assumptions. Let's assume it's March 3 today and we are doing the analysis up to the current point (today).

The Earned Value Calculation

The earned value calculation at each predefined status point is a 5-step process. Each step has several variables that are calculated during that step

1. Gather Work Performance Information (the **inputs**)
    - Budget at Completion (BAC)
    - Planned Value (PV)
    - Earned Value (EV)
    - Actual Cost (AC)
2. Determine Schedule Status
    - Schedule Variance (SV)
    - Schedule Performance Index (SPI)
3. Determine Cost Status
    - Cost Variance (CV)
    - Cost Performance Index (CPI)

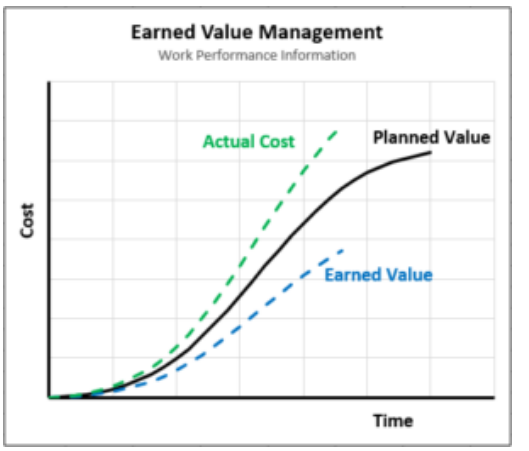
4. Forecasting
    - Estimate to Complete (ETC)
    - Estimate at Completion (EAC)
    - Variance at Completion (VAC)
    - To Complete Performance Index (TCPI)

5. Reporting

Gather Work Performance Information

To start, the project manager gathers the inputs to the earned value analysis.

1. Budget at Completion (BAC)
2. Planned Value (PV)
3. Earned Value (EV)
4. Actual Cost (AC)



Budget at Completion (BAC)

The Budget at Completion (BAC) simply refers to the budget of each task. Thus, we will rename the budget column 'BAC':

ID	Name	Start	End	BAC
100	Solution Design	Mar. 1	Mar. 10	$10,000
200	Build Application	Mar. 7	Mar. 20	$15,000
			TOTAL	$25,000

Planned Value (PV)

Also called the Budgeted Cost of Work Scheduled (BCWS), the PV is the authorized, time-phased budget assigned to accomplish the work. It is the amount that the project is supposed to be complete up to that status point.

Let's say it's March 3 today. The planned percent complete is 30% based on the start and end dates. Therefore,

Task 100: PV = 30% x $10,000 = $3,000.
Task 200: PV = $0. (On March 3, no work is planned yet)

ID	Name	Start	End	BAC	PV
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000
200	Build Application	Mar. 7	Mar. 20	$15,000	$0
			TOTAL	$25,000	$3,000

Earned Value (EV)

Also called the Budget Cost of Work Performed (BCWP), the EV is the measure of the work performed at a specific point in time, expressed in terms of the approved budget authorized for that work. It is the amount that the project is actually complete up to that status point.

Let's say that after discussions with the applicable project team members and inspection of the progress, we determine that the first task is 20% complete and the second task is 10% complete.

Task 100: EV = 20% x $10,000 = $2,000.
Task 200: EV = 10% x $15,000 = $1,500.

We will add another column to our table.

ID	Name	Start	End	BAC	PV	EV
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500
			TOTAL	$25,000	$3,000	$3,500

Actual Cost (AC)

Also called the Actual Cost of Work Performed (ACWP), the AC is the realized cost for the work performed during a specific time period. It is the actual cost of the work up to that status point.

After reviewing our time and expense software and compiling any miscellaneous expenses, we determine that the actual cost of the first task is $4,500 and the second task is $2,000.

ID	Name	Start	End	BAC	PV	EV	AC
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000
			TOTAL	$25,000	$3,000	$3,500	$6,500

This is the end of the information gathering phase. At this point the project manager transitions from gathering project information to calculating project status.

Determine Schedule Status

In order to determine the project's status as it relates to the schedule, we will calculate two variables from the initial four we gathered from the project data, above:

1. Schedule Variance (SV)
2. Schedule Performance Index (SPI)

Schedule Variance (SV)

The schedule variance tells you how far ahead or behind schedule the task is in terms of the task budget. The formula is:

SV = EV – PV

- If SV is negative, the task is behind schedule.
- If SV is zero, the task is on schedule
- If SV is positive, the task is ahead of schedule.

For example,

- SV = -$500 means the project is behind schedule.
- SV = $0 means the project is right on schedule.
- SV = $500 means the project is ahead of schedule.

With the schedule variance, ***positive is good***.

As before, we will add a column to the table for Schedule Variance.

Task 100: SV = $2,000 – $3,000 = -$1,000.
Task 200: SV = $1,500 – $0 = $1,500.

ID	Name	Start	End	BAC	PV	EV	AC	SV
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500

As you can see, the project has a positive schedule variance because one task is ahead and the other is behind.

Schedule Performance Index (SPI)

The Schedule Performance Index (SPI) is similar to the Schedule Variance (SV). It also tells you how far ahead or behind schedule the task is in terms of the task budget, but it is a relative measure rather than an absolute one. It tells you the ***efficiency*** of the task. The formula is:

SPI = EV / PV

- If SPI is less than 1, the task is behind schedule.
- If SPI is zero, the task is on schedule
- If SPI is greater than 1, the task is ahead of schedule.

For example,

- SPI = 0 means the project work has not started.
- SPI = 0.5 means the project has performed half the work it was supposed to at this point.
- SPI = 1.0 means the project is on schedule.
- SPI = 2.0 means the project has performed twice the work it was supposed to at this point.

With the SPI, ***greater than 1.0 is good***.

We will add a column to the table for SPI.

Task 100: SPI = $2,000 / $3,000 = 0.67.
Task 200: SPI = $1,500 / $0 = N/A.

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67

It is easy to see that the first task has accomplished only 2/3 of what it should have at this point. Its ***efficiency*** is 2/3 of that which was planned. But task 200 did not have any

planned value at this point, therefore its SPI is effectively infinity. It can simply be ignored in the rest of the analysis.

Determine Cost Status

In order to calculate the project's status as it relates to the budget, we will calculated two more variables:

1. Cost Variance (CV)
2. Cost Performance Index (CPI)

Cost Variance (CV)

The Cost Variance (CV) is the amount that the task is over or under its budget. The formula is:

CV = EV – AC

- If CV is negative, the task is over budget.
- If CV is zero, the task is on budget.
- If CV is positive, the task is under budget.

For example,

- CV = -$1,000 means the project is over budget.
- CV = $0 means the project is right on budget.
- CV = $1,000 means the project is under budget.

In the case of both CV and SV, ***positive is good***.

We will add a column to the table for CV.

Task 100: CV = $2,000 – $4,500 = -$2,500.
Task 200: CV = $1,500 – $2.000 = -$500.

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67	-$2,500

200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$500
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000

The project is $3,000 over budget on a project value of $25,000. There is clearly a budget problem, but not a schedule problem.

Cost Performance Index (CPI)

The Cost Performance Index (CPI), like the Cost Variance, is a measure of the cost performance of the project, but it is a relative instead of an absolute measure. It tells you the cost efficiency of the project. The formula is:

CPI = EV / AC

- If CPI is less than 1, the task is over budget.
- If CPI is zero, the task is on budget.
- If CPI is greater than 1, the task is under budget.

For example,

- CPI = 0 means the project work has not started.
- CPI = 0.5 means the project has spent twice amount that it should have at this point.
- CPI = 1.0 means the project is on schedule.
- CPI = 2.0 means the project has spent half the amount that it should have at this point.

In the case of both CPI and SPI, ***greater than 1.0 is good***.

We will add a column to the table for CPI.

Task 100: CPI = $2,000 / $4,500 = 0.44.
Task 200: CPI = $1,500 / $2,000 = 0.75.
TOTAL: CPI = $3,500 / $6,500 = 0.54.

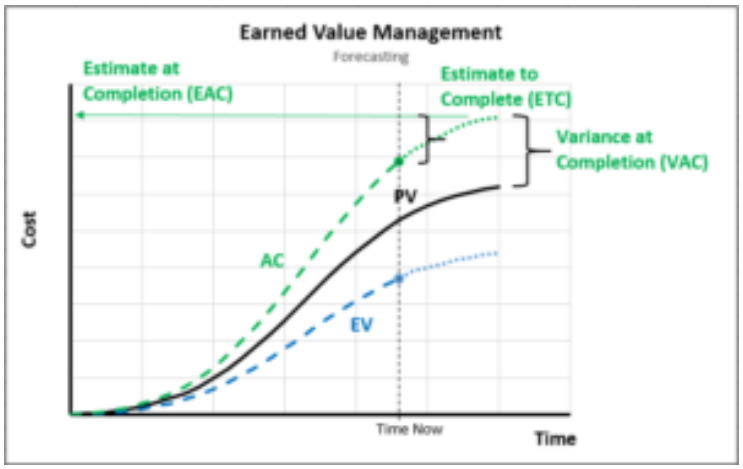
ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV	CPI
100	Solution	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-	0.67	-$2,500	0.44

	Design							$1,000			
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$,500	0.75
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000	0.54

The first task has spent more than twice what it should have at this point because CPI < 0.5. The second task is better but has spent one quarter too much. The project as a whole has spent just under twice what it was budgeted to at this point (CPI = 0.54). Note that in the case of SPI and CPI, the 'total' is an average, not a total.

This is the end of the metrics that tell you the current status. The last four variables give you projections (forecasts) to the end of the project.

Forecasting



There are four variables which allow the project manager to forecast the future performance of the project:

1. Estimate to Complete (ETC)
2. Estimate at Completion (EAC)
3. Variance at Completion (VAC)
4. To Complete Performance Index (TCPI)

Estimate to Complete (ETC)

ETC represents the expected cost required to complete the project. It measures only the ***future*** budget needed to complete the project, not the ***entire*** budget (that's the EAC, next). It allows the project manager to compare the funding needs to finish the project with funding available.

There are two ways to calculate ETC:

1. Based on past project performance:
   ETC = (BAC – EV) / CPI
2. Based on a new estimate
   This is called a ***Management ETC***. This means that a new estimate is created for the remaining tasks in the project.

In our example task we will calculate the ETC based on the past performance of the project. Again, we will add a column to the table for ETC.

Task 100: ETC = ($10,000 – $2,000) / 0.44 = $18,182.
Task 200: ETC = ($15,000 – $1,500) / 0.75 = $18,000.

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67	-$2,500	0.44	$18,182
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$500	0.75	$18,000
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000	0.54	$36,182

Many project managers wouldn't concern themselves too much about this project yet. It has spent $6,500 out of a project budget of $25,000. It's still early, so there's plenty of time to make up for it, right?

Wrong. The ETC of $36,182 is the expenditure to complete the project assuming the prior efficiency levels (a safe assumption). It also does not include the money already spent. If this project is not brought under control soon, it will go wildly over budget and schedule.

Often there are unique circumstances which don't allow for a simple extrapolation to the end of the project. That's where the Estimate at Completion (EAC) comes in.

Estimate at Completion (EAC)

The EAC is the full task or project cost expected at completion (the new project budget). There are multiple ways to calculate it based on how you expect the future of the performance of the project to be:

1. **Future performance will be based on the budgeted cost**
   If you think the existing variance was a unique event and the rest of the project should go according to plan, simply add the remaining project budget to the actual cost incurred to date (AC). This method does not assume the project finishes on budget. Rather it takes into account the one time event and adjusts the whole project plan upward or downward to determine the final result.
   EAC = AC + (BAC – EV)
2. **Future cost performance will be based on past cost performance**
   If you think the past performance is not unusual and there is no reason to expect the project to perform any differently than it already has, you would use this formula.
   EAC = AC + [(BAC – EV) / CPI]
3. **Future cost performance will be influenced by past schedule performance**
   Since schedule and cost performance are usually related, there could be a reason to adjust the cost performance by the schedule performance. In this case an average of the CPI and SPI are used to extrapolate the final project cost.
   EAC = AC + [(BAC -EV) / (CPI x SPI)]
   You could also use a combination of the past schedule or cost performance to extrapolate the final project cost. You could use only the schedule performance (SPI). Or you could figure in a small influence of the schedule performance. In the formula below, 20% of the SPI and 80% of the CPI has been used to determine the final project cost.

   EAC = AC + [(BAC -EV) / (0.8·CPI x 0.2·SPI)]

4. **A new estimate is produced**

   In this case a Management ETC can be added to the to-date cost (AC) to determine the final EAC.

   EAC = AC + ETC

In our example we will predict that the current problems were caused by a one time event that isn't likely to repeat itself. Thus, the EAC will use formula #1.

Task 100: EAC = AC + (BAC – EV) = $4,500 + ($10,000 – $2,000) = $12,500.
Task 200: EAC = AC + (BAC – EV) = $2,000 + ($15,000 – $1,500) = $15,500.

The table now looks like this:

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67	-$2,500	0.44	$18,182	$12,500
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$500	0.75	$18,000	$15,500
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000	0.54	$36,182	$28,000

Now it looks a lot better. The assumption of a one time cost expenditure near the beginning of the project results in a final project budget of $28,000 versus the $25,000 original budget.

Variance at Completion (VAC)

The VAC is a forecast of what the variance, specifically the Cost Variance (CV), will be upon the completion of the project. It is the size of the expected cost overrun or underrun. In many situations the project manager must request additional funding as early as possible, or at least report the potential for an overrun. The VAC represents the size of this request.

The formula is:

VAC = BAC – EAC
= Old Budget – New Budget

This one is relatively simple. If you've calculated the EAC you've done the big math already, and the 'new budget' can simply be subtracted from the 'old budget' to determine the cost overrun or underrun.

The Variance at Completion is simply a future projected Cost Variance. It has the same units as CV. It is the same type of element.

We will once again add another column to the table:

Task 100: VAC = $10,000 – $12,500 = -$2,500.
Task 200: VAC = $15,000 – $15,500 = -$500.

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67	-$2,500	0.44	$18,182	$12,500	-$2,500
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$500	0.75	$18,000	$15,500	-$500
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000	0.54	$36,182	$28,000	-$3,000

Hence, the projected variance is -$3,000, and the project manager could obtain approval for the expected overrun as early as possible, if necessary.

To Complete Performance Index (TCPI)

The TCPI represents the efficiency level, specifically the CPI, that will make the project finish on time. It can be a powerful indicator because it is generally easy to ascertain if your people will be as productive as the indicator tells you. This indicator tends to be a bigger red flag than other indicators. If it says your people need to be twice as efficient as the schedule, it tends to make you take notice that action needs to be taken.

There are two ways to calculate the TCPI:

1. **To achieve the original budget**
   If the goal is to achieve the original project budget, that is, the overrun or underrun has not resulted in a change to the project schedule and/or budget, the following formula applies:

TCPI = (BAC – EV) / (BAC – AC)

2. **To achieve the revised budget**

   If the goal is to achieve the project's EAC, that is, the budget has been revised and an approved change to the project schedule/budget has occurred, use this formula. If additional funds covering the cost overrun have been requested and approved by the project sponsor, the EAC becomes the target of the project, and this scenario applies.

   TCPI = (BAC – EV) / (EAC – AC)

Obviously, the closer the project is to completion the higher the CPI that will be necessary to complete on budget. It can become extreme near the end.

Also, if the project has already spent more than its budget the TCPI will be negative.

TCPI is the last column in the table. We will assume the project budget has not been revised (EAC is simply a projection) and the goal is still the original project budget (formula #1, above).

Task 100: TCPI = ($10,000 – $2,000) / ($10,000 – $4,500) = 1.45.
Task 200: TCPI = ($15,000 – $1,500) / ($15,000 – $2,000) = 1.04.
TOTAL: TCPI = ($25,000 – $3,500) / ($25,000 – $6,500) = 1.16.

ID	Name	Start	End	BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC	TCPI
100	Solution Design	Mar. 1	Mar. 10	$10,000	$3,000	$2,000	$4,500	-$1,000	0.67	-$2,500	0.44	$18,182	$12,500	-$2,500	1.45
200	Build Application	Mar. 7	Mar. 20	$15,000	$0	$1,500	$2,000	$1,500	N/A	-$500	0.75	$18,000	$15,500	-$500	1.04
			TOTAL	$25,000	$3,000	$3,500	$6,500	$500	0.67	-$3,000	0.54	$36,182	$28,000	-$3,000	1.16

This project team must be 16% more efficient than they have been to finish on budget.

This table can be reported directly to management. They might need some training on what the numbers mean but this is not an onerous task.

Using MS Project to manage Earn Value on a project

Most Earned Value Management (EVM) environments use scheduling software like Microsoft Project as the input. You can use can Microsoft Project EVM to perform some basic earned value management.

EVM is a positive forecaster of project success. EVM values provide valuable insight into the true situation of the project. EVM combines measurements of the triple constraint: scope, time, and cost. The power of EVM is its ability to shift perspective from deliverables planned, deliverables completed, and funds spent to the value of work planned, the value of work done, and funds spent.

We have in Figure 1 our demonstration project schedule.

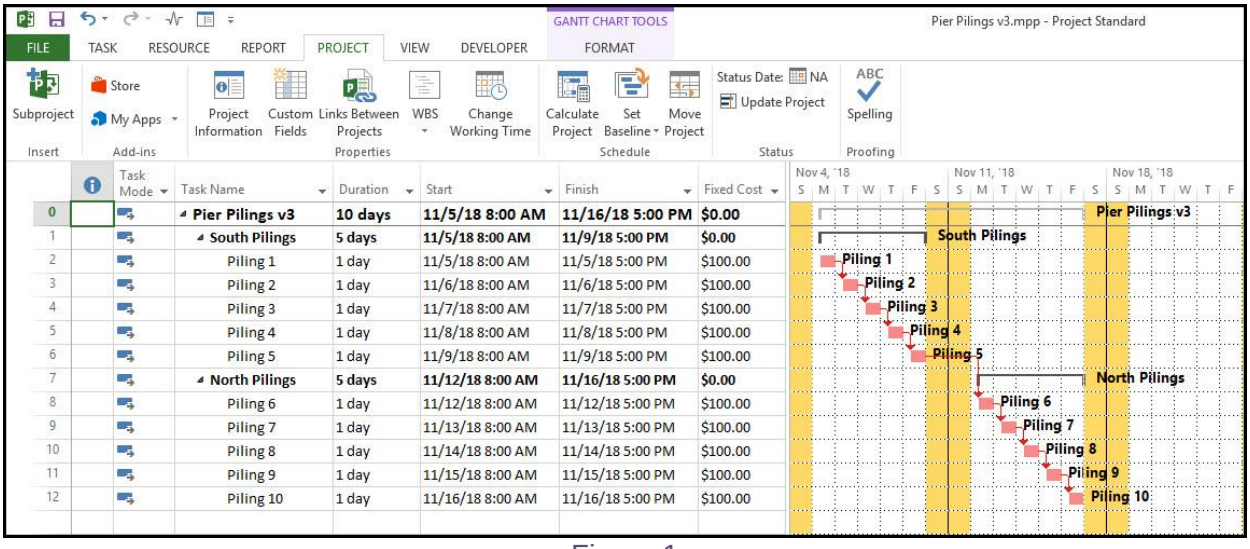


Figure 1

This schedule records the required effort to install pilings for construction of a pier. (Note the default task type for this project is fixed units.) This project consists of two deliverables: installation of five south pilings and installation of five north pilings. Each piling requires 1 day duration and a cost of $100. Note the fixed cost column in Figure 1 task table. Each piling costs $100 for material, equipment, and labor expenses. To use Microsoft Project EVM we need to set a baseline.

Let’s proceed and set a project baseline. Select the project tab, schedule ribbon group, and set baseline, Figure 2.

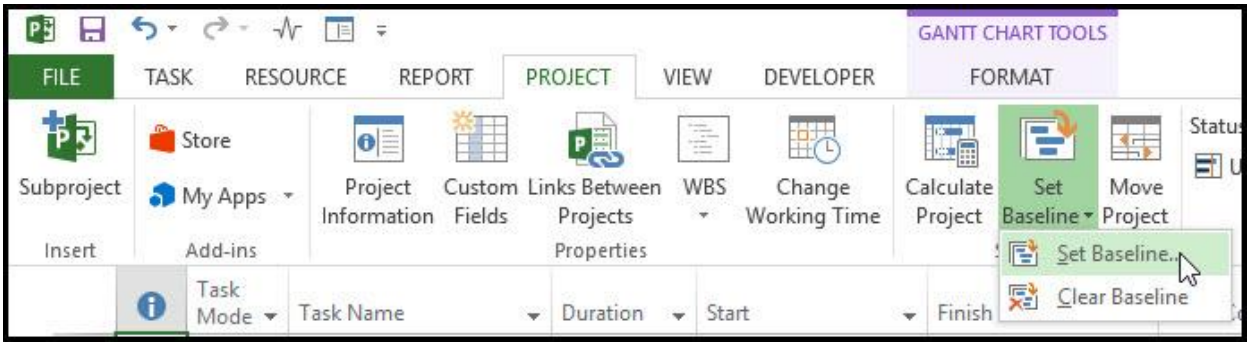


Figure 2

In the set baseline dialog toggle set baseline and choose baseline from the drop-down menu, Figure 3.

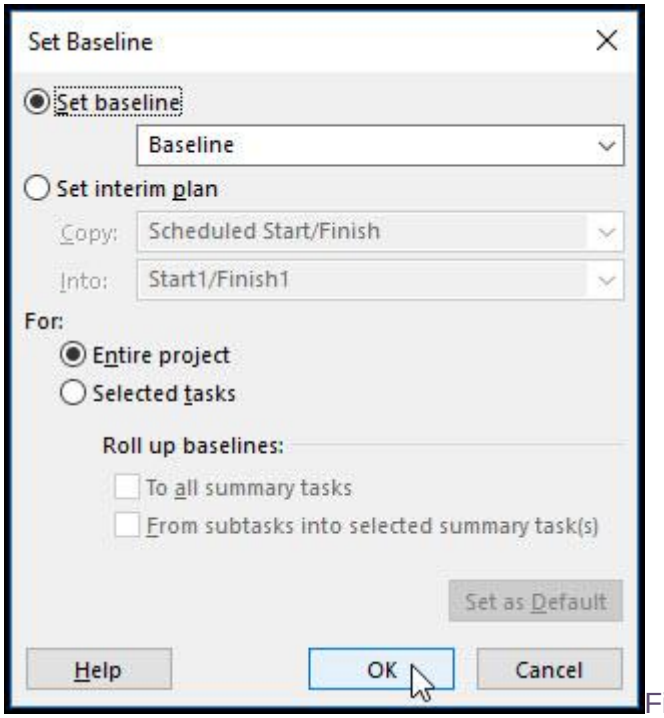


Figure 3

Select OK. This process takes a snapshot of the project at a moment in time and stores this data in baseline. Now to see the baseline on the Gantt chart select the format tab, bar styles ribbon group, baseline drop down menu, and the baseline stored in the field baseline, Figure 4.

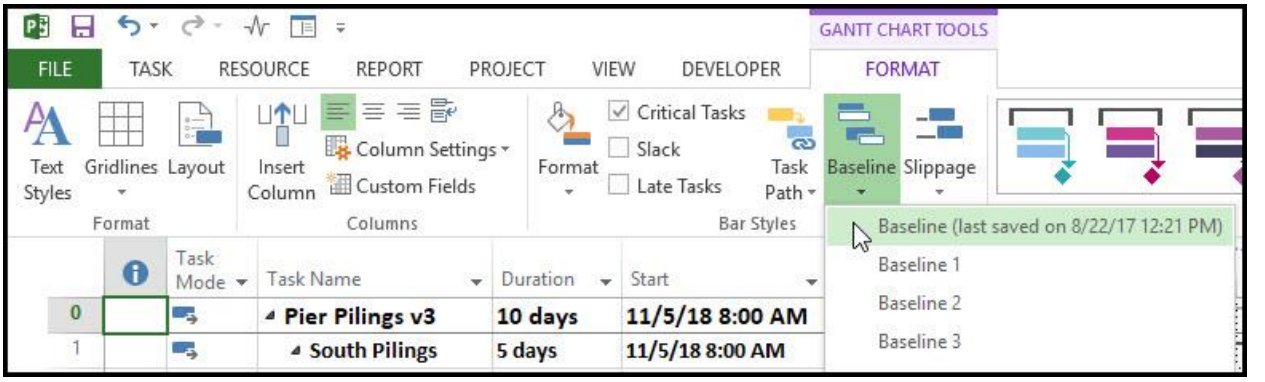


Figure 4

The resulting schedule is displayed in Figure 5.

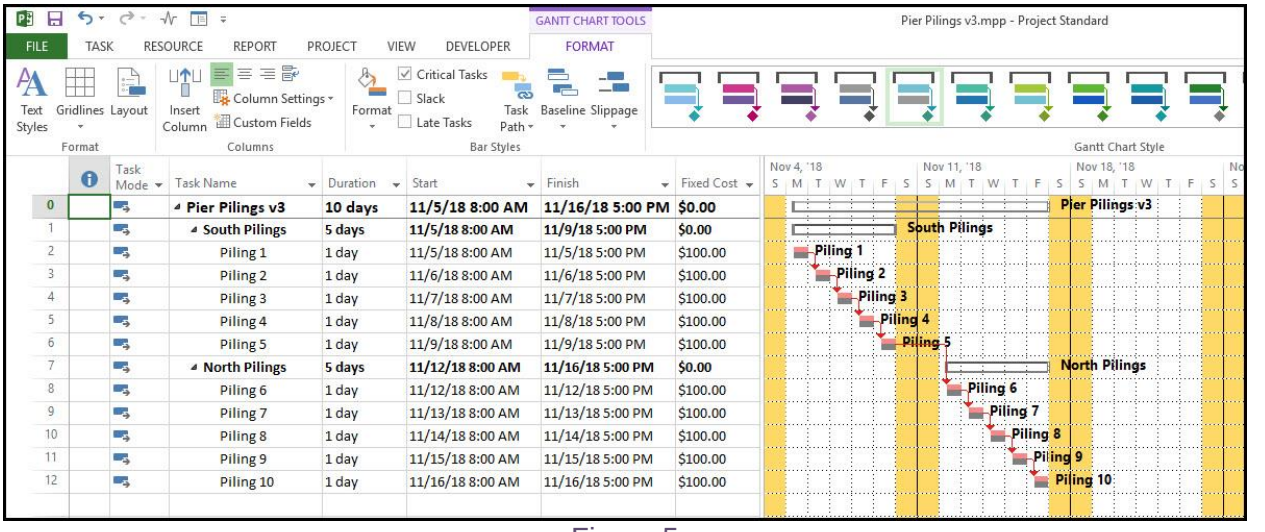


Figure 5

Microsoft Project has EVM variables in an earned value table. To access this table select the view tab, data ribbon group, tables drop down menu, and more tables, Figure 6.

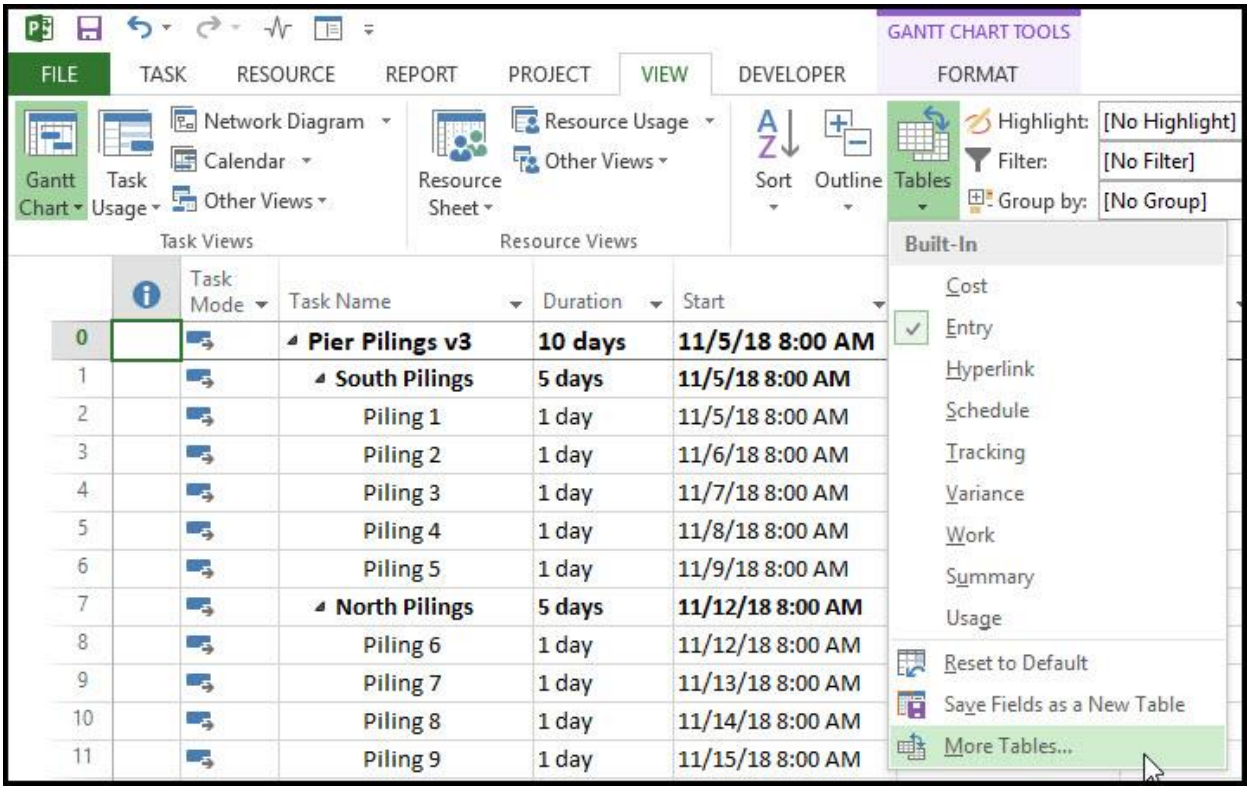


Figure 6

In the more tables dialog, Figure 7, we choose the earned value table and click apply.

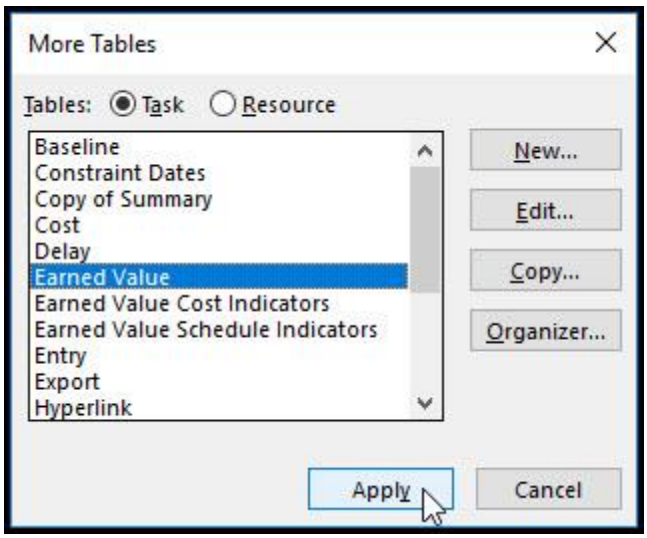


Figure 7

Now our project and tabulated earned value data is displayed in Figure 8.

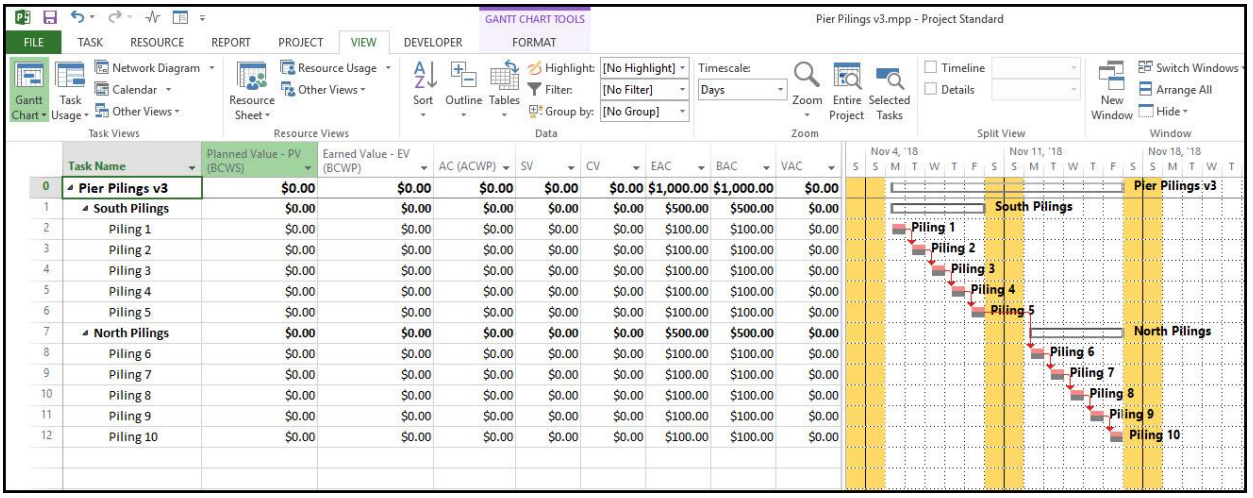


Figure 8

Because we have not yet progressed the schedule most of the variable cells are not populated. In addition to this earned value generic table we want to include the schedule performance index (SPI) and cost performance index (CPI) in our tabulated earned value data, Figure 9.

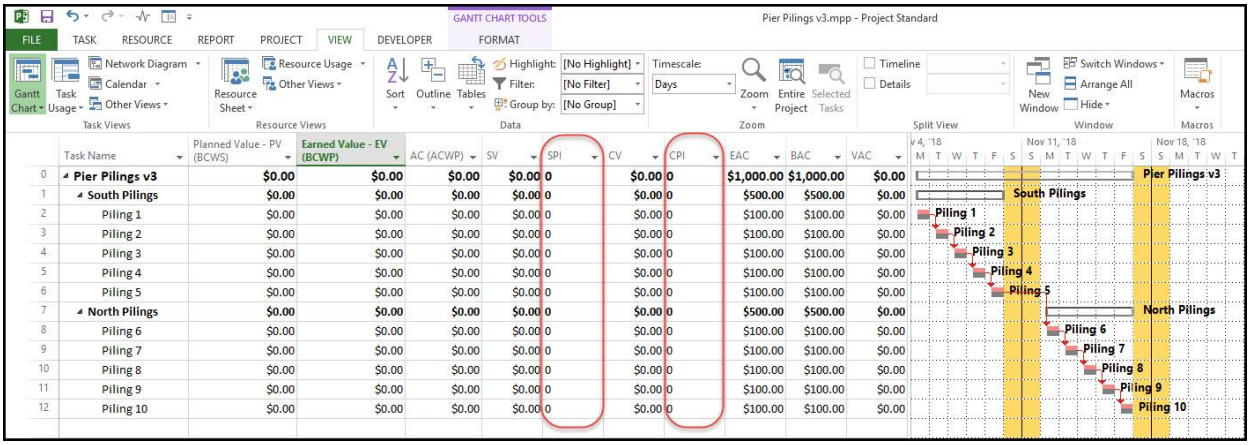


Figure 9

We now continue and progress the project, Figure 10.

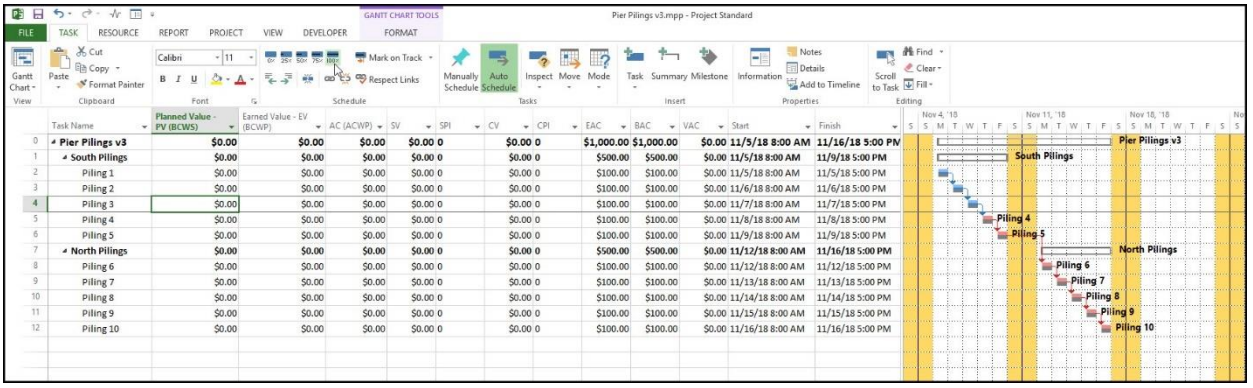


Figure 10

The first three pilings are updated as 100% complete. No progress was achieved on pilings 4 and 5. Next we update the status date. Select the project tab, status ribbon group, and status date icon, Figure 11.

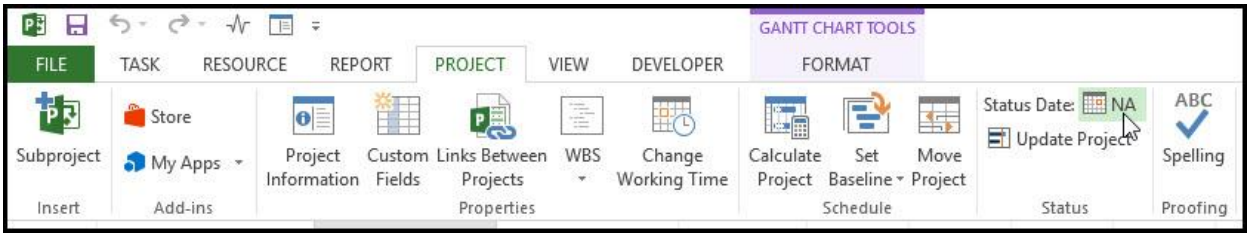


Figure 11

In the status date dialog, Figure 12, move the status date one week forward to November 11th, 2018.

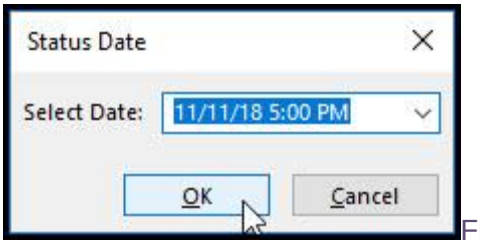


Figure 12

We can see in Figure 13 that some earned value cells are now populated, but we are not done yet.

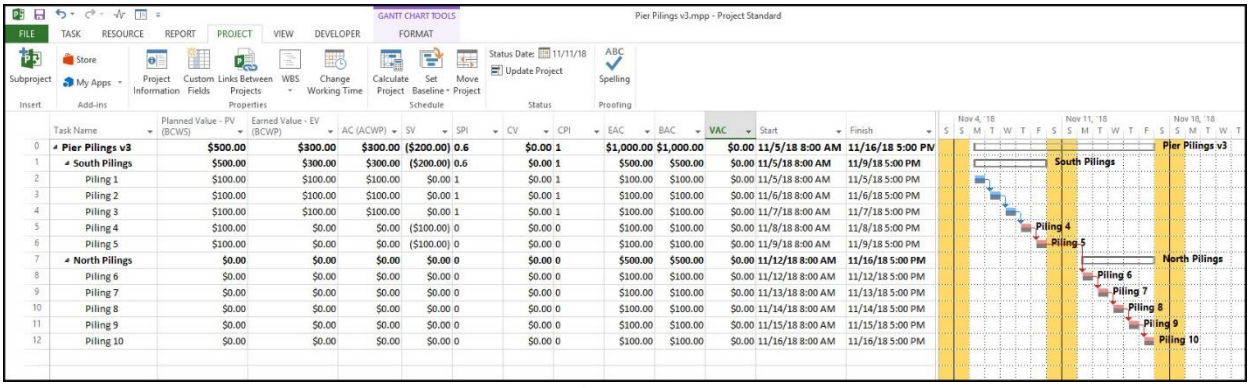


Figure 13

We need to move uncompleted work to continue after the status date. Select the project tab, status ribbon group, and update project, Figure 14.

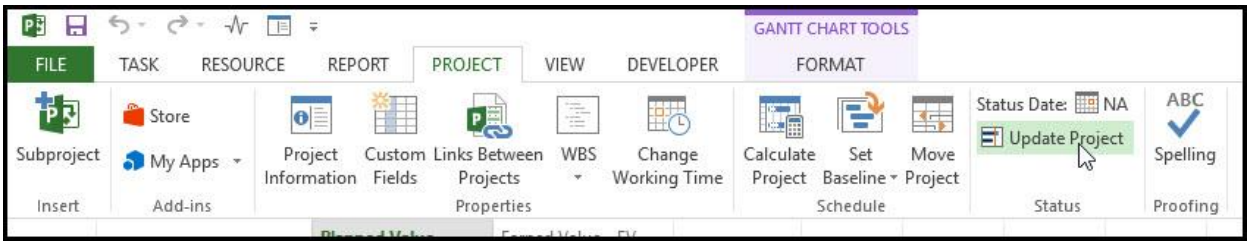


Figure 14

In the update project dialog, Figure 15, toggle ‘reschedule uncompleted work to start after’ the status date and click OK.

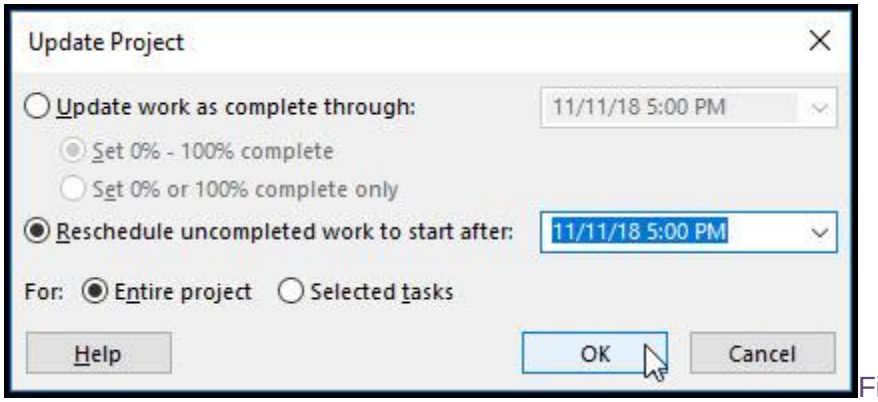
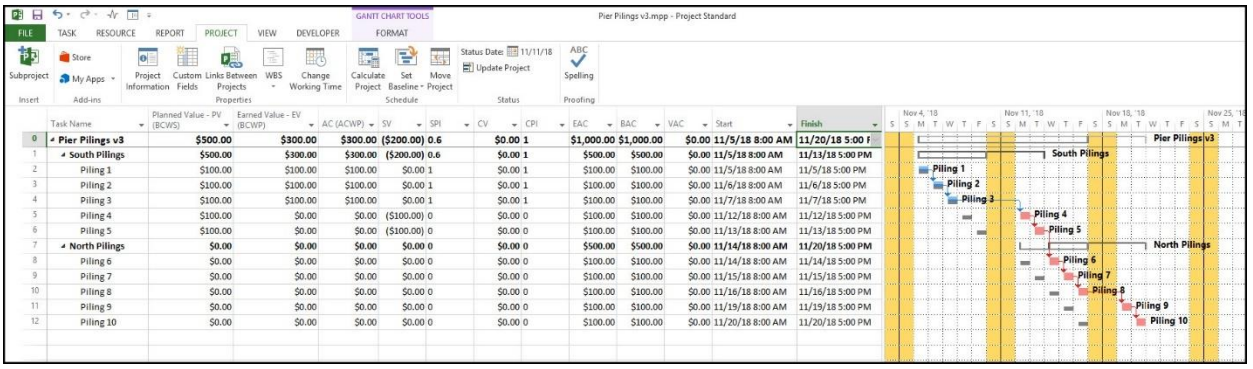


Figure 15

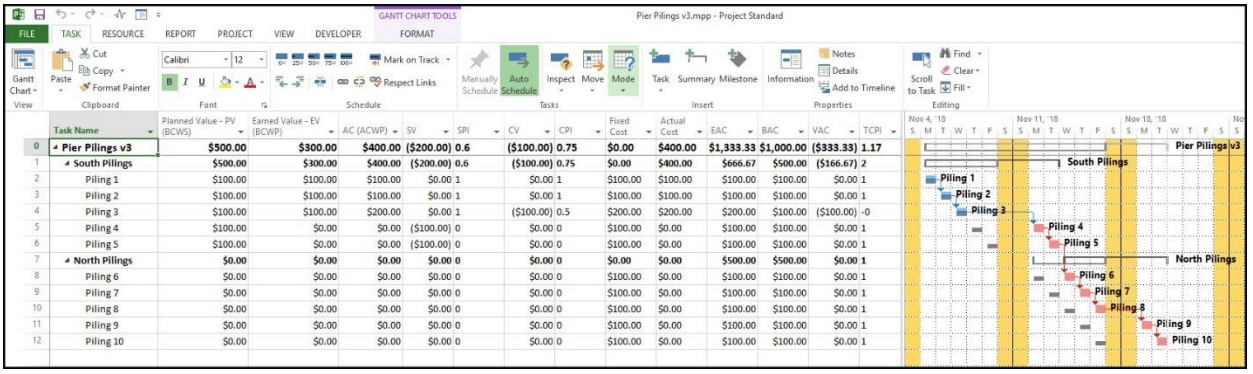
Observe on the Gantt chart, Figure 16, pilings 1 through 3 are complete and pilings 4 through 10 are delayed.



	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	SPI	CV	CPI	EAC	BAC	VAC	Start	Finish
0	Pier Pilings v3	$500.00	$300.00	$300.00	($200.00)	0.6	$0.00	1	$1,000.00	$1,000.00	$0.00	11/5/18 8:00 AM	11/20/18 5:00 P
1	South Pilings	$500.00	$300.00	$300.00	($200.00)	0.6	$0.00	1	$500.00	$500.00	$0.00	11/5/18 8:00 AM	11/13/18 5:00 PM
2	Piling 1	$100.00	$100.00	$100.00	$0.00	1	$0.00	1	$100.00	$100.00	$0.00	11/5/18 8:00 AM	11/5/18 5:00 PM
3	Piling 2	$100.00	$100.00	$100.00	$0.00	1	$0.00	1	$100.00	$100.00	$0.00	11/6/18 8:00 AM	11/6/18 5:00 PM
4	Piling 3	$100.00	$100.00	$100.00	$0.00	1	$0.00	1	$100.00	$100.00	$0.00	11/7/18 8:00 AM	11/7/18 5:00 PM
5	Piling 4	$100.00	$0.00	$0.00	($100.00)	0	$0.00	0	$100.00	$100.00	$0.00	11/12/18 8:00 AM	11/12/18 5:00 PM
6	Piling 5	$100.00	$0.00	$0.00	($100.00)	0	$0.00	0	$100.00	$100.00	$0.00	11/13/18 8:00 AM	11/13/18 5:00 PM
7	North Pilings	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$500.00	$500.00	$0.00	11/14/18 8:00 AM	11/20/18 5:00 PM
8	Piling 6	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$100.00	$0.00	11/14/18 8:00 AM	11/14/18 5:00 PM
9	Piling 7	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$100.00	$0.00	11/15/18 8:00 AM	11/15/18 5:00 PM
10	Piling 8	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$100.00	$0.00	11/16/18 8:00 AM	11/16/18 5:00 PM
11	Piling 9	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$100.00	$0.00	11/19/18 8:00 AM	11/19/18 5:00 PM
12	Piling 10	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$100.00	$0.00	11/20/18 8:00 AM	11/20/18 5:00 PM

Figure 16

We make a few more updates to the schedule, Figure 17, including insertion of fixed cost and actual cost columns, and to specify the actual cost of piling 3 as $200.



	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	SPI	CV	CPI	Fixed Cost	Actual Cost	EAC	BAC	VAC	TCPI
0	Pier Pilings v3	$500.00	$300.00	$400.00	($200.00)	0.6	($100.00)	0.75	$0.00	$400.00	$1,333.33	$1,000.00	($333.33)	1.17
1	South Pilings	$500.00	$300.00	$400.00	($200.00)	0.6	($100.00)	0.75	$0.00	$400.00	$666.67	$500.00	($166.67)	2
2	Piling 1	$100.00	$100.00	$100.00	$0.00	1	$0.00	1	$100.00	$100.00	$100.00	$100.00	$0.00	1
3	Piling 2	$100.00	$100.00	$100.00	$0.00	1	$0.00	1	$100.00	$100.00	$100.00	$100.00	$0.00	1
4	Piling 3	$100.00	$100.00	$200.00	$0.00	1	($100.00)	0.5	$200.00	$200.00	$200.00	$100.00	($100.00)	-0
5	Piling 4	$100.00	$0.00	$0.00	($100.00)	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
6	Piling 5	$100.00	$0.00	$0.00	($100.00)	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
7	North Pilings	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$0.00	$0.00	$500.00	$500.00	$0.00	1
8	Piling 6	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
9	Piling 7	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
10	Piling 8	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
11	Piling 9	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1
12	Piling 10	$0.00	$0.00	$0.00	$0.00	0	$0.00	0	$100.00	$0.00	$100.00	$100.00	$0.00	1

Figure 17

Additionally, we had a column for to complete performance index (TCPI). Our tabulated earned value data, Figure 17, now has all the elements necessary for rudimentary EVM project analysis.

EVM Fundamental Parameters

Let's review some of the basic EVM parameters observed in our pier piling construction project earned value table, again, Figure 17. These include planned value, earned value, actual cost, and budget at completion. These four parameters enable computation of variety of earned value metrics to examine the health of a project.

Planned Value

The first column lists the schedule Planned Value (PV). The planned value has to do with the schedule budget. Normally when we consider budget we think of the cost for completion of the entire project. But the planned value is the budget separated into periods of time. It essentially is the project spending plan or the value of work planned to be completed over time. The planned value is computed up to the status date, so planned value cells will not be populated until the schedule is progressed.

Earned Value

The Earned Value (EV) is the value of work completed, as measured in dollars. The earned value simply is a dollarized percent complete value; it measures deliverable progress in monetary terms (value of work done). Considering earned value requires a shift in perspective from deliverables percent completed to value of work done or earned. The earned value is also specified over time.

Actual Cost

The Actual Cost (AC) is the project funds spent to date. It is the cost of completing each activity. It is often reported in project financial reports using the Work Breakdown Structure (WBS). One of the benefits of earned value management is the capability to compare the *cost* of work completed with the *value* of work completed. The actual schedule cost is depicted over time.

Budget at Completion

Budget At Completion (BAC) is the project budget. This is the amount of money estimated to be spent performing the scheduled work. It is also the planned value of all work displayed on the project schedule and performance management baseline.

EVM Metrics

With our four fundamental EVM parameters we are ready for the races. Let's review earned value metrics included in our pier piling project earned value table.

Cost Variance

The Cost Variance (CV) compares the economic value of completed work to the value of the actual cost. It is computed as follows:

CV=EV-AC

In our pier piling project the PV is $500 and the AC is $400. Without our earned value variable it appears that the project is underspent by $100. Including EV provides insight to the true health of our project.

CV=$300-$400

CV=-$100

The reality of our project situation, as per earned value, is an overspent project. This demonstrates the power of EVM: you compare what you spent to what you accomplished, not what you spent compared to what you planned to spend.

Schedule Variance

You may determine Schedule Variance (SV) using both a dollarized approach and a time units approach. SV in economic terms uses the vertical performance management baseline axis. SV determined in time units uses the horizontal axis. The vertical axis is the traditional SV approach. SV in monetary vertical axis terms is identified with the ($) symbol subscript and SV in time units is labeled with the (t) subscript. The dollarized SV equation is below:

SV$ = EV-PV

The $SV_{\$}$ for our piling project is

SV$ = $300-$500

SV$ = -$200

Negative $SV_{\$}$ values result if the project is behind schedule. Positive $SV_{\$}$ values are good news; more project work was completed than planned. So the $SV_{\$}$ formula allows project ahead or behind schedule assessment in terms of dollars.

Cost Performance Index

Both the Cost Performance Index (CPI) and schedule performance index (SPI) represent unit-less measures of the projects performance efficiency. CPI shows the efficiency with which the project is spending funds. It computes as follows:

CPI = EV/AC

The CPI for our pier piling project is as follows:

CPI = $300/$400

CPI = 0.75

You interpret CPI results as below:

- CPI less than 1.0 indicates the project is overspending funds.
- CPI equals 1.0 than the project is on target.
- CPI greater than 1.0 says the project is under budget.

CPI is a particularly important EVM metric, because past performance can be used to accurately determine final performance requirements to meet financial goals.

Schedule Performance Index

Again, SPI can be computed from time units or the more traditional monetary units. The dollarized SPI equation is as follows:

SPI$ = EV/PV

Our project's SPI is below:

SPI$ = $300/$500

SPI$ =0.6

The $SPI_{\$}$ is less than one indicating the project is behind schedule. However, our $SPI_{\$}$ value does not indicate whether the project is behind a week, month, or year. $SPI_{\$}$ is not an exact value, it does, however, indicate the scheduling trend.

Estimate at Completion

Compute Estimate At Completion (EAC) as follows:

EAC = AC + (BAC-EV)／CPI

The numerator (BAC – EV) is the remaining work. The EAC equation estimates that the remaining work is accomplished at a cost based on the efficiency to date or CPI. This CPI reflected EAC provides the most optimistic estimate of the final project cost. This equation algebraically simplifies to the below:

EAC = BAC／CPI

The EAC for the pier pilling project is below:

EAC = $1000／0.75

EAC = $1,333.33

Again, this is the most optimistic estimate of final project cost when you consider that past overruns are not recoverable and future problems and realized risk may still occur. Our EAC, assuming current fund spending efficiency, is greater than the BAC, so this project at conclusion will be overspent.

To Complete Performance Index

The TCPI is the last Microsoft Project supported EVM metric discussed in this article. Some consider CPI and TCPI the two most important EVM metrics. TCPI focuses on future performance, whereas, the CPI indicates past performance. The TCPI equation is as follows:

TCPI = Work Remaining / Funds Remaining

TCPI = BAC-EV / BAC-AC

As per status to date, the TCPI of the pier piling project is as follows:

TCPI = $1000-$300 / $1000-$400

TCPI = 1.17

You interpret TCPI results as below:

- TCPI less than one the target cost is easy to achieve or better.
- TCPI equals one the target cost is achievable at the current level of performance.
- TCPI greater than one means an improvement in performance is required.

Our pier piling project TCPI is 1.17, this means all remaining work has to be completed with a cost performance that is 17% better than the original plan. The current CPI is 0.75. The increase in performance required to achieve our target is 1.17 – 0.75 = 0.42. The required percent increase in performance is 0.42/0.75 = 56%. Not good! This would be very difficult to achieve.

Summary

Using Microsoft Project EVM for basic analysis is possible. Numerous EVM metrics are within reach in Microsoft Project when the four horsemen of EVM are derived. These four horsemen or parameters, as discussed, are: PV, EV, AC, and BAC. Achievement of these parameters requires assigning tasks costs and setting a baseline.

Note, in particular, that the PV requires progressing the schedule; PV values populate up to the status date. The CV and CPI metrics require actual costs. Adjust the actual costs, accordingly, if the spending does not go precisely as planned. After progressing the schedule and updating the actual costs EVM analysis is possible. This analysis includes computation of the EAC, which provides to the most optimistic estimate of final project cost.

The CPI and TCPI metrics are considered two of the most important EVM metrics. CPI highlights past performance and TCPI focuses on future performance. All these mentioned tabulated earned value metrics are available in Microsoft Project.