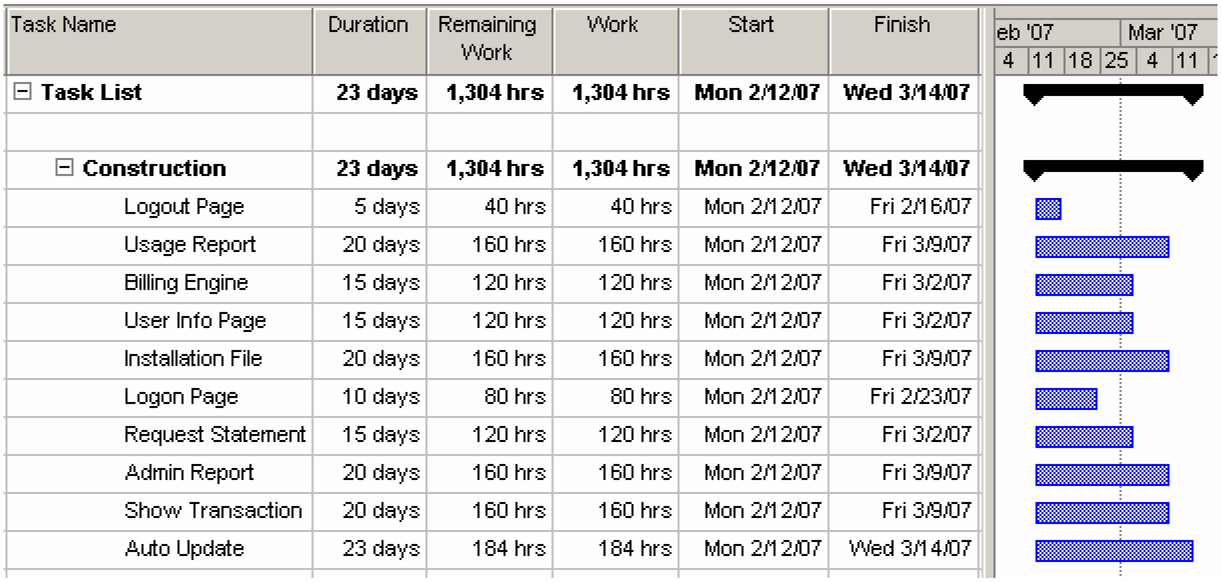
Project Management:
Tracking Progress and Earned Value with MS Project 2003

Project Planning

Suppose you have been assigned a project to construct a website in a certain time frame and given a certain number of resources. Open up MS Project and start a new project. Go to Project >> Project Information and enter 2/12/07 for the Start Date and then click **OK**. Now enter the values seen in Figure 1 into the project. Note that the Remaining Work and Work columns are built into Project. To add them, right click on the column header and choose Insert Column…. Find the corresponding column in the Field name drop down box and click **OK**. The Work field is the estimated time it will take to complete a task. The Remaining Work field is calculated dynamically as "Remaining Work = Work - Actual Work".

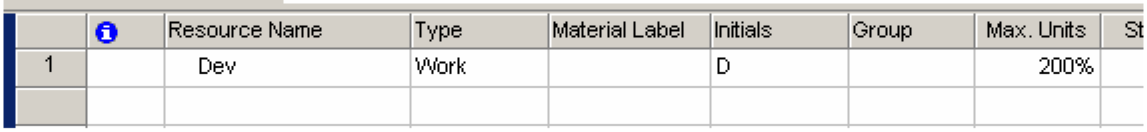


Task Name	Duration	Remaining Work	Work	Start	Finish
⊟ **Task List**	**23 days**	**1,304 hrs**	**1,304 hrs**	**Mon 2/12/07**	**Wed 3/14/07**
⊟ **Construction**	**23 days**	**1,304 hrs**	**1,304 hrs**	**Mon 2/12/07**	**Wed 3/14/07**
Logout Page	5 days	40 hrs	40 hrs	Mon 2/12/07	Fri 2/16/07
Usage Report	20 days	160 hrs	160 hrs	Mon 2/12/07	Fri 3/9/07
Billing Engine	15 days	120 hrs	120 hrs	Mon 2/12/07	Fri 3/2/07
User Info Page	15 days	120 hrs	120 hrs	Mon 2/12/07	Fri 3/2/07
Installation File	20 days	160 hrs	160 hrs	Mon 2/12/07	Fri 3/9/07
Logon Page	10 days	80 hrs	80 hrs	Mon 2/12/07	Fri 2/23/07
Request Statement	15 days	120 hrs	120 hrs	Mon 2/12/07	Fri 3/2/07
Admin Report	20 days	160 hrs	160 hrs	Mon 2/12/07	Fri 3/9/07
Show Transaction	20 days	160 hrs	160 hrs	Mon 2/12/07	Fri 3/9/07
Auto Update	23 days	184 hrs	184 hrs	Mon 2/12/07	Wed 3/14/07

Figure 1 - Gantt Chart

Goto View >> Resource Sheet.

Suppose we know that we will have *x* number of developers who are going to be completing the tasks listed on the Gantt Chart. We don't know the exact people who will be working on the tasks so just call this resource name "Dev" for now. The Max Units field is where you specify how many Dev resources you want working on this project. 100% implies one resource (i.e. one person). Change the field to read 200%.



	ℹ	Resource Name	Type	Material Label	Initials	Group	Max. Units	St
1		Dev	Work		D		200%	

Figure 2 - Adding Resources

This will tell MS Project that there will be two Dev resources working at full capacity at any one time. This Max Units value will be used by MS Project when level the project.

Now go back to the Gantt Chart and assign the Dev resource to each task

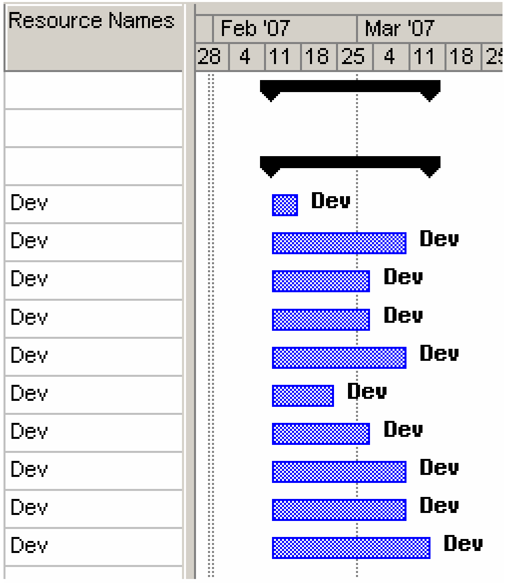
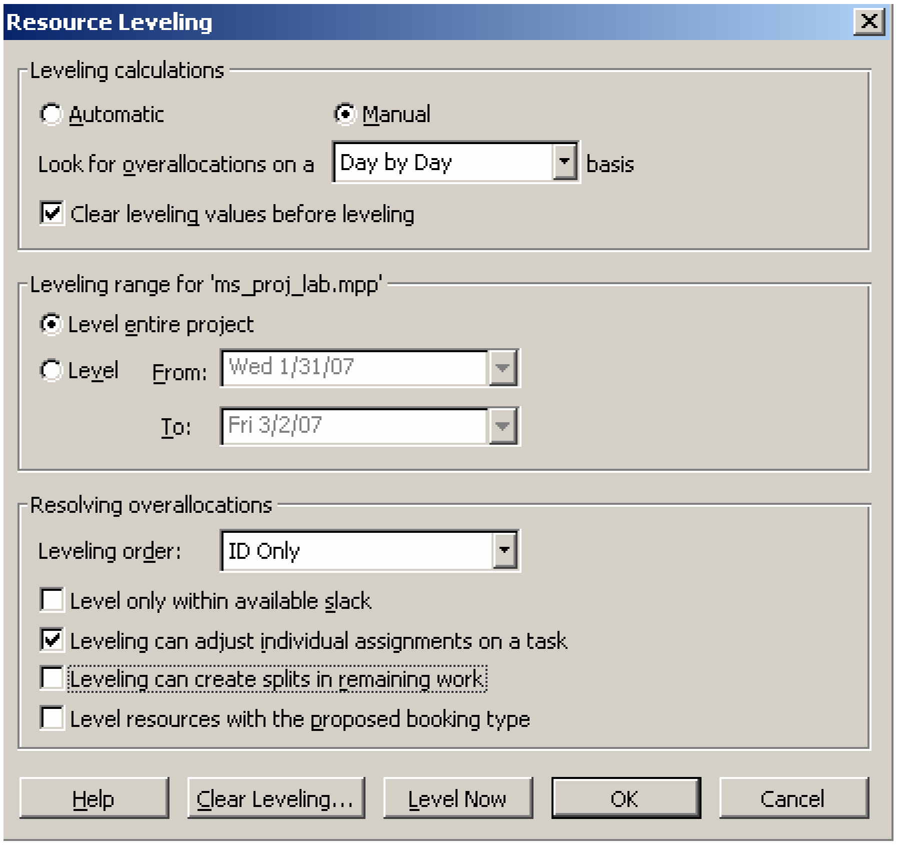


Figure 3 - Assigning Resources

Leveling

Clearly this Dev resource will be overloaded during the first week of the project so we need to stagger these tasks so that the resources are spread out across whatever max units they have. We can have MS Project do this for us by leveling the project. Leveling resolves resource conflicts or overallocations by delaying or splitting certain tasks. When Project levels a resource, its selected assignments are distributed and rescheduled. Leveling will also tell us what the projected end date for this project will be.

Goto Tools >> Level Resource.



Resource Leveling

Leveling calculations

○ Automatic ● Manual

Look for overallocations on a Day by Day basis

☑ Clear leveling values before leveling

Leveling range for 'ms_proj_lab.mpp'

● Level entire project

○ Level From: Wed 1/31/07

To: Fri 3/2/07

Resolving overallocations

Leveling order: ID Only

☐ Level only within available slack

☑ Leveling can adjust individual assignments on a task

☐ Leveling can create splits in remaining work

☐ Level resources with the proposed booking type

Figure 4 - Resource Leveling

Using this dialog box you can

- Specify whether you want Project to level automatically (as soon as it detects an overallocation) or manually (only when you click **Level Now**).
- Indicate how much a resource needs to be overallocated (for example, by an hour, day, or week) before they should be leveled.
- Set the criteria for the order that tasks should be reviewed for overallocations and leveling.

For now use the default choices (i.e. use manual leveling, level the entire project, and use ID Only as the leveling order) except uncheck the Leveling can create splits in remain work checkbox. The ID Only leveling order will level the tasks based on their id number from the Gantt Chart which works good for sequential processes. For more complex plans you would probably want to use one of the other options such as priority leveling which will level the resources based on the priority you assign them.

Click the **Level Now** button. You can now see how Project staggers the tasks based on the Dev resource capabilities. You will also noticed that it has assigned only two Dev resources to work on tasks at any given time. Furthermore Project indicates that the project will finish on June 13th.

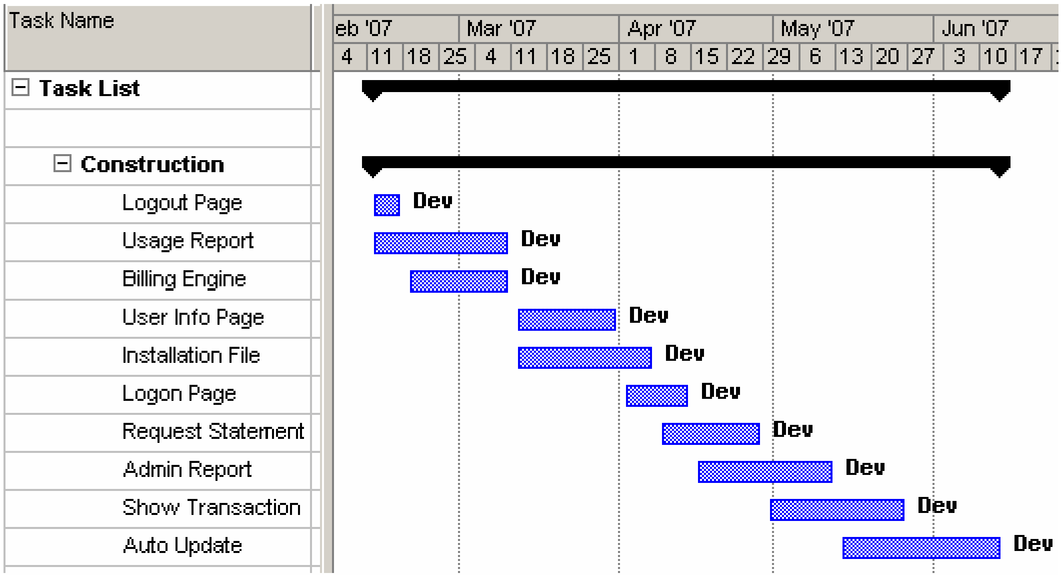


Figure 5 - Result of leveling

Now suppose you are assigned another developer to work on the project. We can have Project reschedule the project based on this new information. Go back to the Resource Sheet and set Dev's Max. Units field to 300%. Go back to the Gantt Chart and then re-level the project. Project should now have three Dev resources working on the project and a finish date of May 2nd.

Change the Dev resource's Max Units back to 200% and re-level the project. Now assign the tasks to the actual developers who will be working on the project, Pete and Dave. The easiest way to do this is to simply change the names in the Resource Names column in the Gantt Chart. When you type in a new resource name Project will automatically add the resource to the Resource Sheet at 100% Max Units. Assign Pete and Dave to every other task as seen in Figure 6.

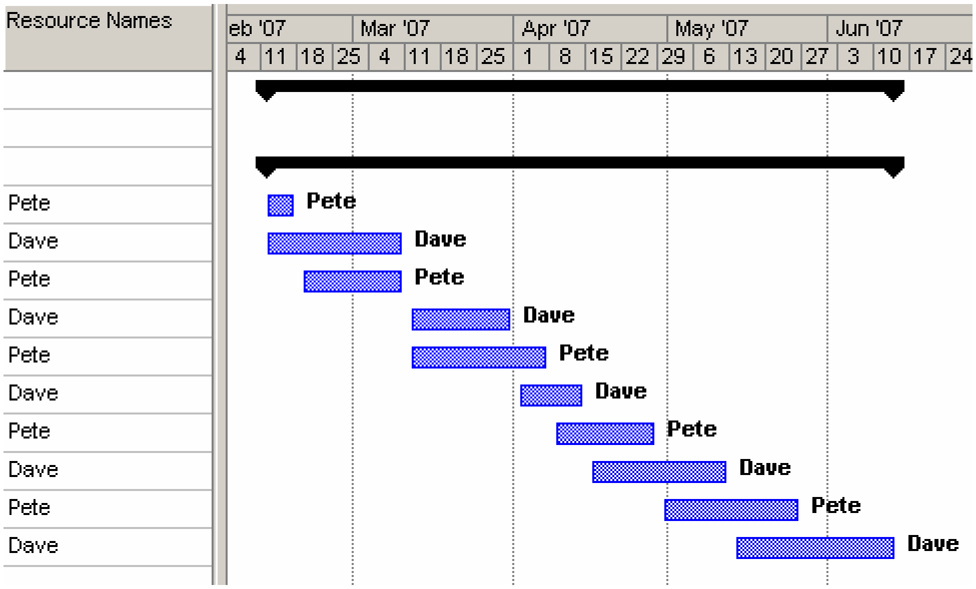


Figure 6 - Assigning actual employees

Pete and Dave are now 100% booked for the duration of the project. To see this, goto View >> Resource Graph. Navigate to Pete and switch the view by right clicking the bar chart and selecting Percent Allocated. This view shows the percent that a resource is allocated for a particular time period

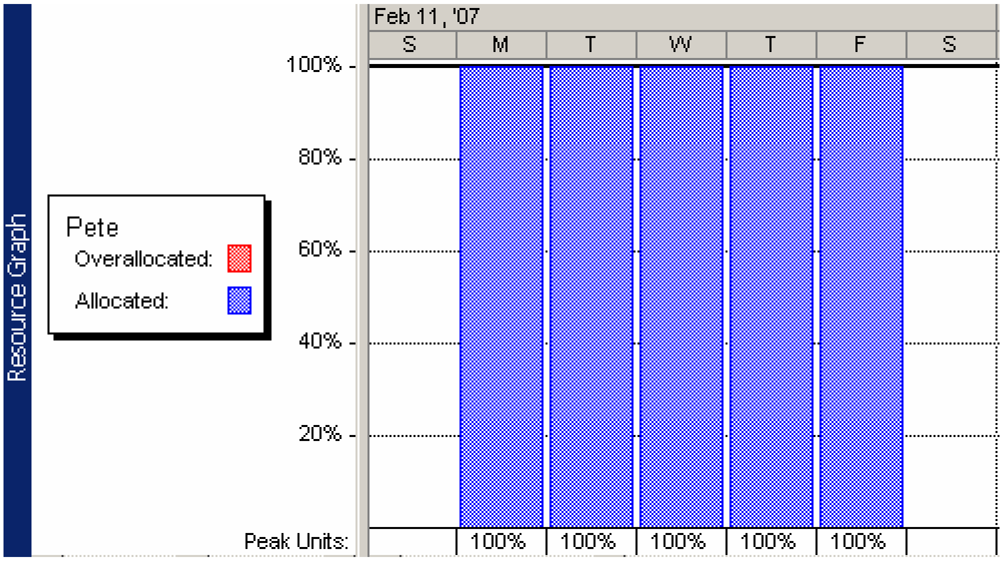
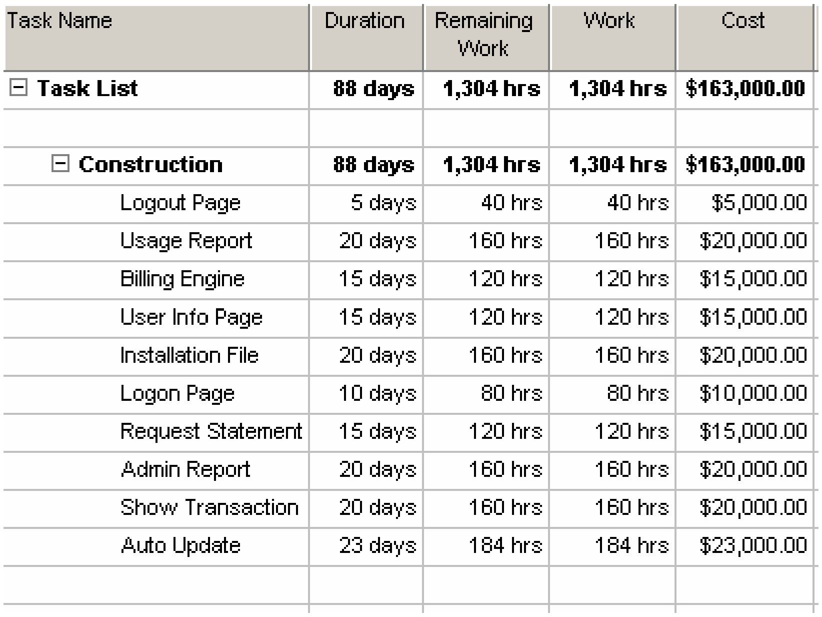


Figure 7 - Resource Graph

As can be seen in Figure 7, Project has allocated Pete at 100% (i.e. 8 hours a day) for the given work week (i.e. Monday – Friday).

The final task for the project planning stage is to assign a cost to the resources. This will support the calculation of the earned value metrics once we've updated the plan with the actual hours worked versus the estimate. Go back to the Resource Sheet and set Dave and Pete's Std. Rate to $125/hr. Project will automatically apply this rate to the tasks and roll them up so you can get a feel for the total cost of the project. To see this, go back to the Gnatt Chart and insert the Cost column.



Task Name	Duration	Remaining Work	Work	Cost
⊟ **Task List**	**88 days**	**1,304 hrs**	**1,304 hrs**	**$163,000.00**
⊟ **Construction**	**88 days**	**1,304 hrs**	**1,304 hrs**	**$163,000.00**
Logout Page	5 days	40 hrs	40 hrs	$5,000.00
Usage Report	20 days	160 hrs	160 hrs	$20,000.00
Billing Engine	15 days	120 hrs	120 hrs	$15,000.00
User Info Page	15 days	120 hrs	120 hrs	$15,000.00
Installation File	20 days	160 hrs	160 hrs	$20,000.00
Logon Page	10 days	80 hrs	80 hrs	$10,000.00
Request Statement	15 days	120 hrs	120 hrs	$15,000.00
Admin Report	20 days	160 hrs	160 hrs	$20,000.00
Show Transaction	20 days	160 hrs	160 hrs	$20,000.00
Auto Update	23 days	184 hrs	184 hrs	$23,000.00

Figure 8 - Project Cost

Basline

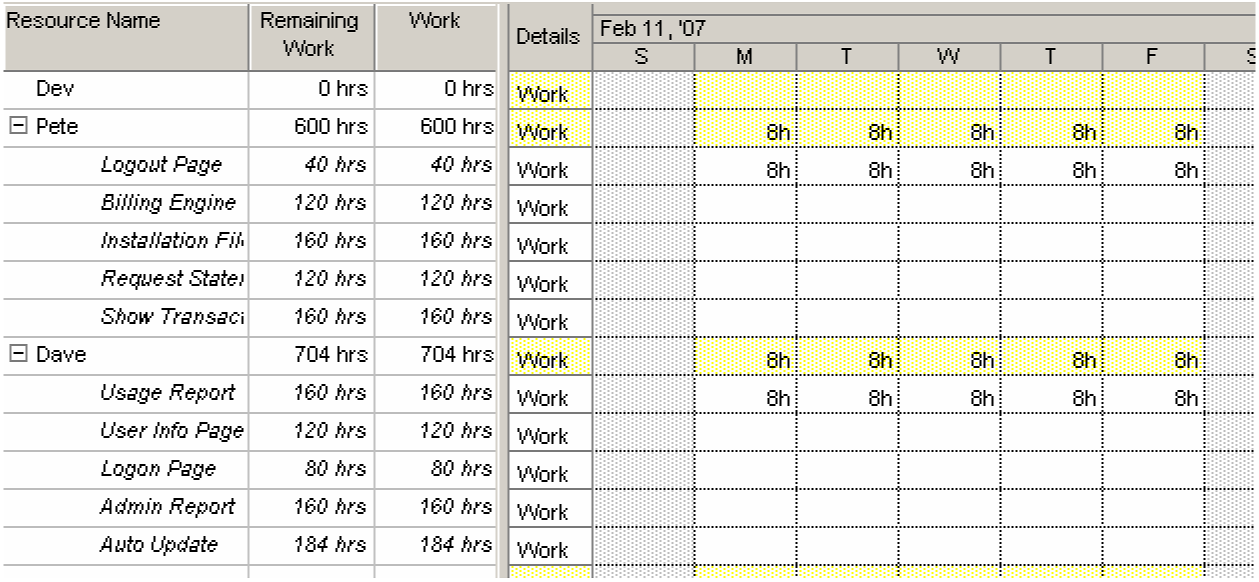
The project planning phase of our project is now complete. Now we want to baseline the plan. We need the baseline to compare the actual work that has been performed on the project. The baseline for our project is 1,304 hours at $163,000. Project will allow you to save up to 10 baselines for a project. You could then compare the current plan with any one of those baselines.

Go to Tools >> Tracking >> Save Basline…. In the dialog box that opens simply click **OK**.

Project Tracking

Now suppose a week has gone by and we want to update our project plan based on the work that has been performed. Go to Project >> Project Information. Set the Current Date and the Status Date to 2/17/07 to let Project know that a week has gone by. The Status Date is used to drive the earned value calculations. Click **OK**.

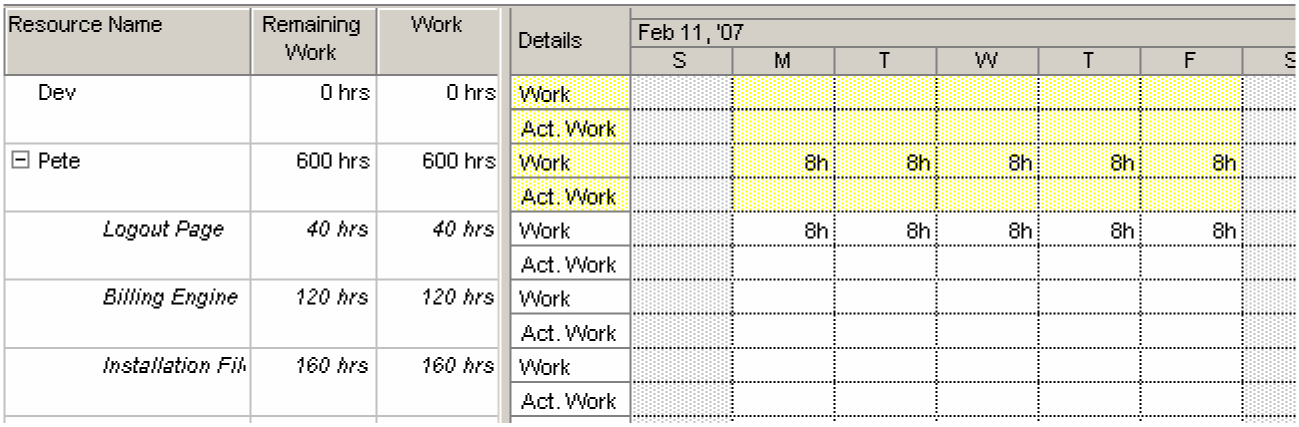
To update the plan we will enter the actual work performed per resource. Go to View >> Resource Usage which presents a time-sheet view of the work performed by the resources. To this view add the Remaining Work column.



Resource Name	Remaining Work	Work	Details	Feb 11, '07 S	M	T	W	T	F	S
Dev	0 hrs	0 hrs	Work							
⊟ Pete	600 hrs	600 hrs	Work		8h	8h	8h	8h	8h	
Logout Page	*40 hrs*	*40 hrs*	Work		8h	8h	8h	8h	8h	
Billing Engine	*120 hrs*	*120 hrs*	Work							
Installation Fil	*160 hrs*	*160 hrs*	Work							
Request State	*120 hrs*	*120 hrs*	Work							
Show Transac	*160 hrs*	*160 hrs*	Work							
⊟ Dave	704 hrs	704 hrs	Work		8h	8h	8h	8h	8h	
Usage Report	*160 hrs*	*160 hrs*	Work		8h	8h	8h	8h	8h	
User Info Page	*120 hrs*	*120 hrs*	Work							
Logon Page	*80 hrs*	*80 hrs*	Work							
Admin Report	*160 hrs*	*160 hrs*	Work							
Auto Update	*184 hrs*	*184 hrs*	Work							

Figure 9 - Resource Usage

To update the project plan you need to know what task each resource worked on, how many hours did they spend on those tasks during the time period, and the amount of work that remains for the tasks they have been assigned. By default Project only shows the work that the resource should be performing in order for the task to be completed on time. To enter the actual work performed, right click on the calendar view and choose Actual Work.

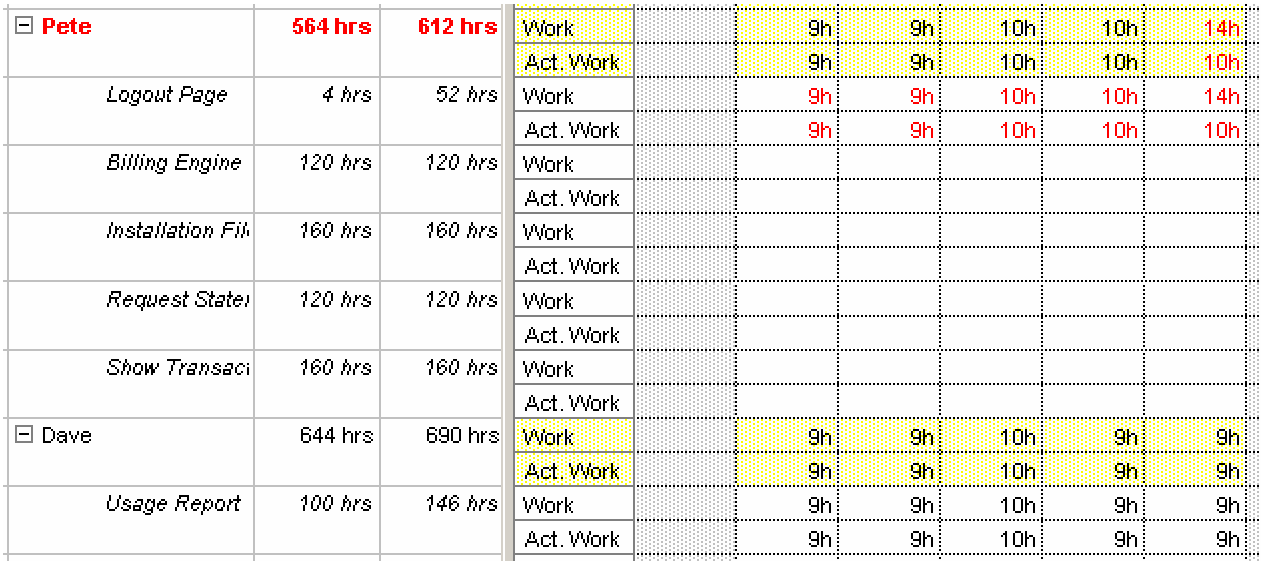


Resource Name	Remaining Work	Work	Details	Feb 11, '07 S	M	T	W	T	F	S
Dev	0 hrs	0 hrs	Work							
			Act. Work							
⊟ Pete	600 hrs	600 hrs	Work		8h	8h	8h	8h	8h	
			Act. Work							
Logout Page	*40 hrs*	*40 hrs*	Work		8h	8h	8h	8h	8h	
			Act. Work							
Billing Engine	*120 hrs*	*120 hrs*	Work							
			Act. Work							
Installation Fil	*160 hrs*	*160 hrs*	Work							
			Act. Work							

Figure 10 - Adding actual work data

Suppose Dave indicates that he worked 9 hours on Monday, Tuesday, Thursday, and Friday and that he work 10 hours on Wednesday. Enter those values into the Act. Work row for the *Usage Report*. Project will update the Remaining Work column to indicate that there are 114 hours of work left for the *Usage Report*. Dave believes that it will only require two and a half more weeks (or 100 hours) to finish the task so replace the 114 with this value in the Remaining Work column.

Suppose Pete indicates that he worked 9 hours on Monday and Tuesday and then 10 hours on Wednesday, Thursday, and Friday. Enter these values into Act. Work row for the *Logout Page*. Notice that Project indicates that there are 0 hours remaining for the *Logout Page* since the original work estimate was 40 hours. Project assumes the task is complete but Pete indicated that there is still 4 hours of work left. Enter that value in the Remaining Work field for the *Logout Page*.



⊟ **Pete**	**564 hrs**	**612 hrs**	Work		9h	9h	10h	10h	14h
			Act. Work		9h	9h	10h	10h	10h
Logout Page	*4 hrs*	*52 hrs*	Work		9h	9h	10h	10h	14h
			Act. Work		9h	9h	10h	10h	10h
Billing Engine	*120 hrs*	*120 hrs*	Work						
			Act. Work						
Installation Fil	*160 hrs*	*160 hrs*	Work						
			Act. Work						
Request State	*120 hrs*	*120 hrs*	Work						
			Act. Work						
Show Transaci	*160 hrs*	*160 hrs*	Work						
			Act. Work						
⊟ Dave	644 hrs	690 hrs	Work		9h	9h	10h	9h	9h
			Act. Work		9h	9h	10h	9h	9h
Usage Report	*100 hrs*	*146 hrs*	Work		9h	9h	10h	9h	9h
			Act. Work		9h	9h	10h	9h	9h

Figure 11 - Project with 1 weeks worth of data

Notice that Project added the extra 4 hours required to finish the *Logout Page* to the end of the current week. To get another view of this, open the Resource Graph and view the results.

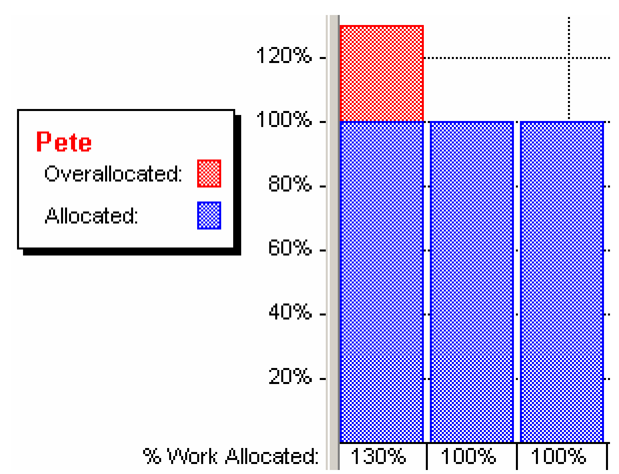


Figure 12 - Pete's updated resource usage

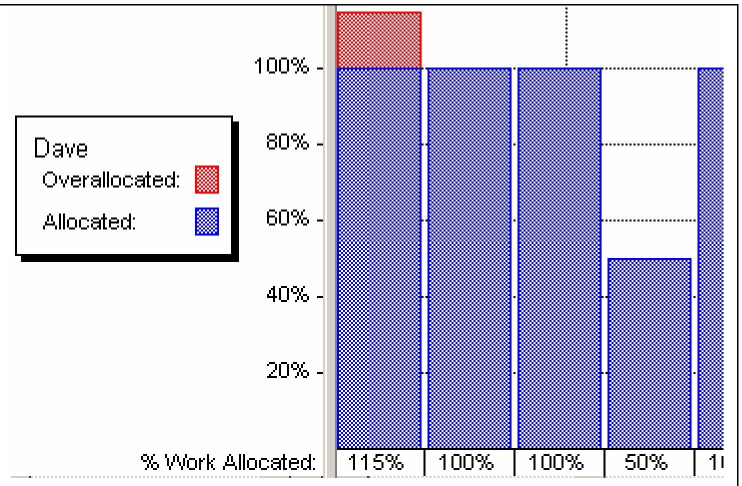


Figure 13 - Dave's updated resource usage

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We can see that Pete was overallocated by 30% for the past week. Part of this is due to the overtime he worked on the task but it is also the result of the additional 4 hours that were added to Friday. Dave's resource graph shows that he too was overallocated for the past week but it also indicates that he will have some slack time during the fourth week as a result of the task being finished ahead of schedule. We need Project to reschedule Pete's work so that the extra 4 hours are assigned to the upcoming weeks. We would also like Dave's schedule altered so that the slack time is removed. Essentially this will cause Pete to finish later than expected and Dave to finish earlier than expected.

To accomplish this, first go back to the Gantt Chart. Go to Tools >> Tracking >> Update Project. Check the radio button for Update uncompleted work to start after and enter 2/18/07. Apply this to the entire project and click **OK**. If you go back to the Resource Graph you can see that Project shifted the extra 4 hours for Pete into week 2 causing him to be overallocated by 10% for that week. If we don't expect Pete to work overtime next week then we need to re-level the project.

Go back to the Gantt Chart and before you level the project notice that Pete's resource assignment usage is 500% and Dave's is 125%.

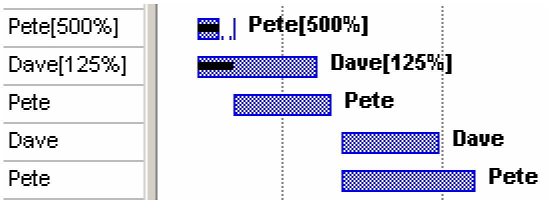


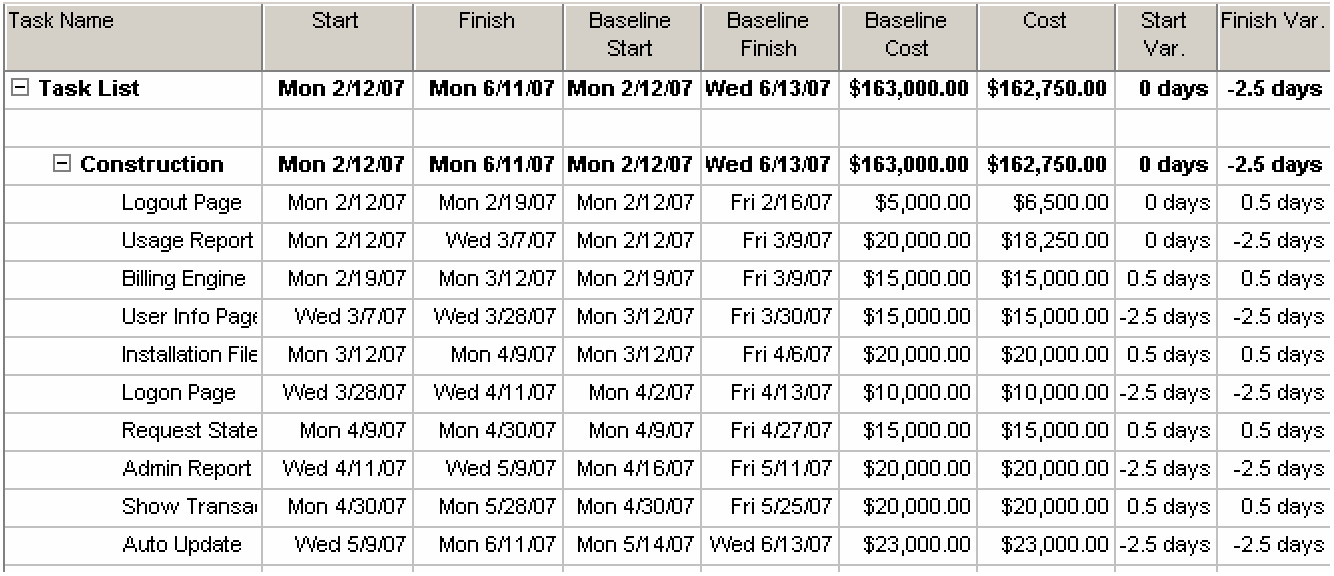
Figure 14 – Gantt Chart showing overallocation

If we were to level the project now, Project would assume that we want Pete to work at 500% capacity on the extra 4 hours meaning that he would have to complete them in 1/5 of the time (i.e. he would finish them in less than an hour). Clearly this isn't what we want so you need to manually change the 500% for Pete and the 125% for Dave to 100% in the Resource Names column.

Re-level the project and go back to the Resource Graph and choose the Work view by right clicking on the bar chart. Observe that Project has shifted the extra work required of Pete to the upcoming weeks so that he is now scheduled to work 4 hours during the final week of the project. Also notice that Dave's slack time during the fourth week has been filled and as a result he will now finish his assigned tasks a couple of days early.

Earned Value Analysis

Go back to the Gantt Chart and view the variance table by going to View >> Table: Entry >> Variance. This adds some additional columns to the Gantt Chart which show various variance numbers of the actual work to date versus the baseline work. To this view add the Baseline Cost and Cost columns.



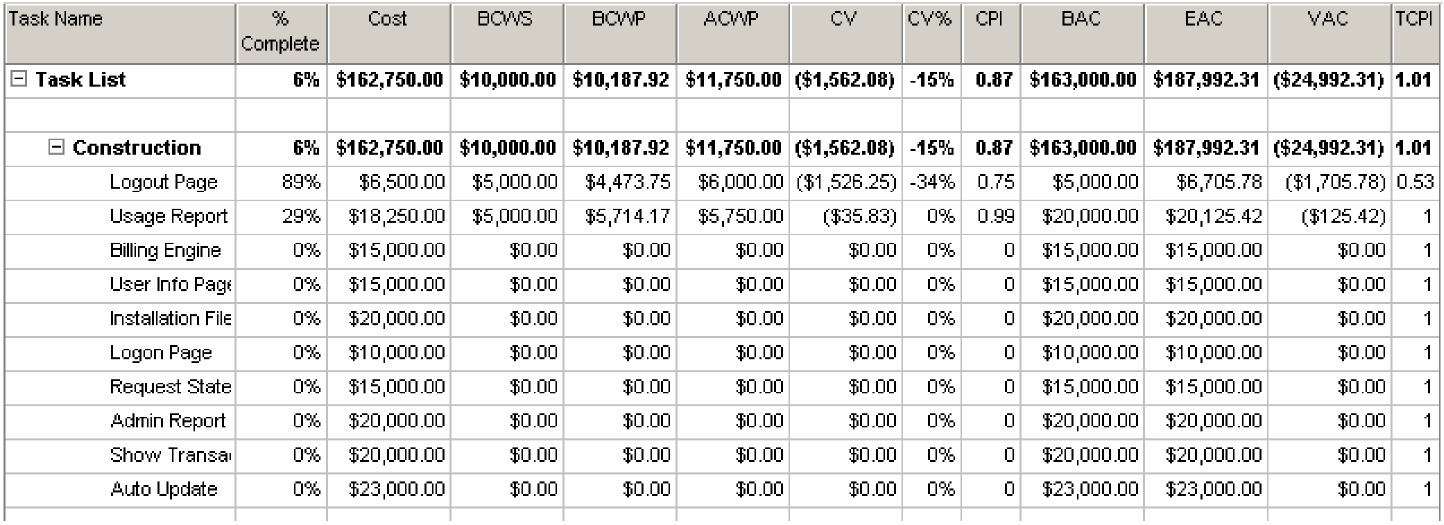
Task Name	Start	Finish	Baseline Start	Baseline Finish	Baseline Cost	Cost	Start Var.	Finish Var.
⊟ **Task List**	**Mon 2/12/07**	**Mon 6/11/07**	**Mon 2/12/07**	**Wed 6/13/07**	**$163,000.00**	**$162,750.00**	**0 days**	**-2.5 days**
⊟ **Construction**	**Mon 2/12/07**	**Mon 6/11/07**	**Mon 2/12/07**	**Wed 6/13/07**	**$163,000.00**	**$162,750.00**	**0 days**	**-2.5 days**
Logout Page	Mon 2/12/07	Mon 2/19/07	Mon 2/12/07	Fri 2/16/07	$5,000.00	$6,500.00	0 days	0.5 days
Usage Report	Mon 2/12/07	Wed 3/7/07	Mon 2/12/07	Fri 3/9/07	$20,000.00	$18,250.00	0 days	-2.5 days
Billing Engine	Mon 2/19/07	Mon 3/12/07	Mon 2/19/07	Fri 3/9/07	$15,000.00	$15,000.00	0.5 days	0.5 days
User Info Page	Wed 3/7/07	Wed 3/28/07	Mon 3/12/07	Fri 3/30/07	$15,000.00	$15,000.00	-2.5 days	-2.5 days
Installation File	Mon 3/12/07	Mon 4/9/07	Mon 3/12/07	Fri 4/6/07	$20,000.00	$20,000.00	0.5 days	0.5 days
Logon Page	Wed 3/28/07	Wed 4/11/07	Mon 4/2/07	Fri 4/13/07	$10,000.00	$10,000.00	-2.5 days	-2.5 days
Request State	Mon 4/9/07	Mon 4/30/07	Mon 4/9/07	Fri 4/27/07	$15,000.00	$15,000.00	0.5 days	0.5 days
Admin Report	Wed 4/11/07	Wed 5/9/07	Mon 4/16/07	Fri 5/11/07	$20,000.00	$20,000.00	-2.5 days	-2.5 days
Show Transa	Mon 4/30/07	Mon 5/28/07	Mon 4/30/07	Fri 5/25/07	$20,000.00	$20,000.00	0.5 days	0.5 days
Auto Update	Wed 5/9/07	Mon 6/11/07	Mon 5/14/07	Wed 6/13/07	$23,000.00	$23,000.00	-2.5 days	-2.5 days

Figure 15 - Variance Table

With this information we may get the impression we that we are exceeding expectations since our project is under budget by $250 and ahead of schedule. This is where earned value can help us get an accurate view of where our project actually is.

Cost Indicators

Switch the table view by going to View >> Table: Variance >> More Tables … and selecting Earned Value Cost Indicators. Add the columns seen in Figure 16 to this view.



Task Name	% Complete	Cost	BCWS	BCWP	ACWP	CV	CV%	CPI	BAC	EAC	VAC	TCPI
⊟ **Task List**	**6%**	**$162,750.00**	**$10,000.00**	**$10,187.92**	**$11,750.00**	**($1,562.08)**	**-15%**	**0.87**	**$163,000.00**	**$187,992.31**	**($24,992.31)**	**1.01**
⊟ **Construction**	**6%**	**$162,750.00**	**$10,000.00**	**$10,187.92**	**$11,750.00**	**($1,562.08)**	**-15%**	**0.87**	**$163,000.00**	**$187,992.31**	**($24,992.31)**	**1.01**
Logout Page	89%	$6,500.00	$5,000.00	$4,473.75	$6,000.00	($1,526.25)	-34%	0.75	$5,000.00	$6,705.78	($1,705.78)	0.53
Usage Report	29%	$18,250.00	$5,000.00	$5,714.17	$5,750.00	($35.83)	0%	0.99	$20,000.00	$20,125.42	($125.42)	1
Billing Engine	0%	$15,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$15,000.00	$15,000.00	$0.00	1
User Info Page	0%	$15,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$15,000.00	$15,000.00	$0.00	1
Installation File	0%	$20,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$20,000.00	$20,000.00	$0.00	1
Logon Page	0%	$10,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$10,000.00	$10,000.00	$0.00	1
Request State	0%	$15,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$15,000.00	$15,000.00	$0.00	1
Admin Report	0%	$20,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$20,000.00	$20,000.00	$0.00	1
Show Transa	0%	$20,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$20,000.00	$20,000.00	$0.00	1
Auto Update	0%	$23,000.00	$0.00	$0.00	$0.00	$0.00	0%	0	$23,000.00	$23,000.00	$0.00	1

Figure 16 - Earned Value Cost Indicators

The Budgeted Cost of Work Scheduled (BCWS) column indicates how much work should be done by this point in the project. The Budgeted Cost of Work Performed (BCWP) column tells us how much it cost to complete the work that has been performed to date. Fore example, the original cost estimate of the *Logout Page* was $5,000. In order to get 89% complete for a task that was baselined at $5,000, the baseline cost of the work performed should be $4,473.75. This tells us where we should be at in terms of cost for this task.

Now look at the actual cost that has been incurred to date. The Actual Cost of Work Performed field (ACWP) shows $6,000 for the *Logout Page* since Pete worked more than the 8 hours per day that he was budged at. So he has used $6,000 to get to 89% completion for the *Logout Page* whereas we had baselined him to use only $4,473.75. This tells us this task is not tracking too well since we are using more money to get the task completed. This is summarized in the Cost Variance (CV) and Cost Variance Percent (CV%) columns. This shows what the difference is between the actual cost and the cost that we should have incurred (CV = BCWP – ACWP, a value greater than 0 indicates we're under budget). For the *Logout Page* our values indicate that we are running 34% overbudget for this task alone.

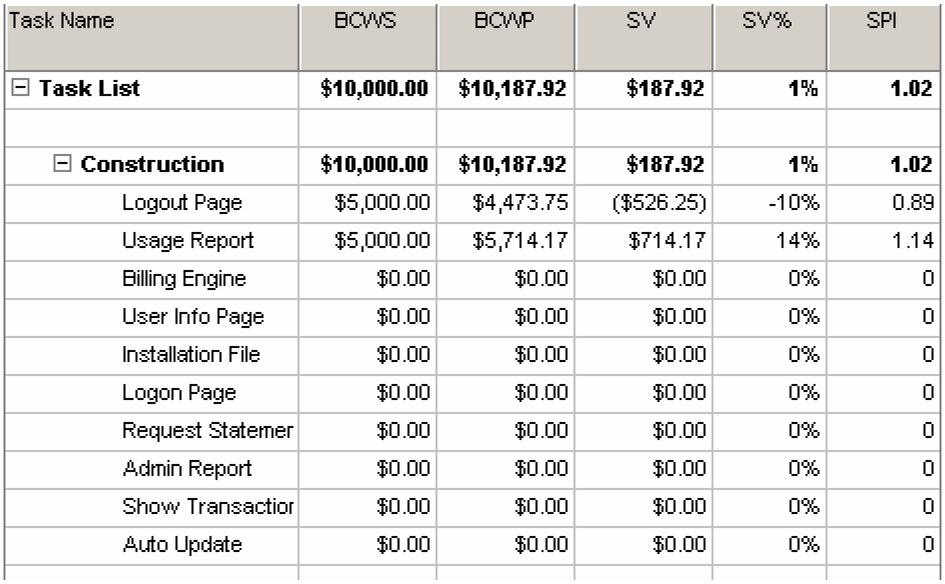
The Budgeted Actual Cost (BAC) field shows the total planned cost for a task. The Estimate at Completion (EAC = ACWP + (BAC - BCWP) / CPI where CPI = BCWP/ACWP) field shows the expected cost of a task based on performance up to the status date. From our data we can see that the *Logout Page* will cost $6,705.78 if the current trends continue which is $1,705.78 overbudget as seen in the Variance at Completion (VAC = BAC - EAC) field.

If we look at the top line in the Gantt Chart we will see the EV metrics for the entire project. The BCWP tells us that if we have a $163,000 baseline cost and are 6% complete then we should have used $10,187.92 to date. The ACWP tells us that we actually used $11,750 and so we are 15% overbudget on the project. The EAC tells us that based on the performance to date the final cost of the project will be $187,992.31 which is $24,992.31 over budget. This might seem a little unreasonable since we only had a small variance in the amount of work required yet that had a significant impact on the estimated values. This is the result of EV being performed on a very small set of data points. The extrapolation that is done behind the scenes becomes more powerful as more actual data gets entered into the project plan. However, even at this early stage EV can indicate that there might be problems up ahead. This is something that we would not be able to uncover if we were to just look at Cost field in Figure 16.

To summarize, EV for cost provides an early warning of performance problems while there is still time to correct them. These metrics are based not only on the raw costs but also on the trends that are occurring within the project. You can also use EV for each resource to see which resource is giving you the best value or which resource may need additional help.

Scheduling Indicators

Go to View >> Table: Earned Value Cost Indicators >> More Tables … and choose Earned Value Schedule Indicators.



Task Name	BCWS	BCWP	SV	SV%	SPI
⊟ **Task List**	**$10,000.00**	**$10,187.92**	**$187.92**	**1%**	**1.02**
⊟ **Construction**	**$10,000.00**	**$10,187.92**	**$187.92**	**1%**	**1.02**
Logout Page	$5,000.00	$4,473.75	($526.25)	-10%	0.89
Usage Report	$5,000.00	$5,714.17	$714.17	14%	1.14
Billing Engine	$0.00	$0.00	$0.00	0%	0
User Info Page	$0.00	$0.00	$0.00	0%	0
Installation File	$0.00	$0.00	$0.00	0%	0
Logon Page	$0.00	$0.00	$0.00	0%	0
Request Statemer	$0.00	$0.00	$0.00	0%	0
Admin Report	$0.00	$0.00	$0.00	0%	0
Show Transactior	$0.00	$0.00	$0.00	0%	0
Auto Update	$0.00	$0.00	$0.00	0%	0

Figure 17 - Earned Value Schedule Indicators

The Schedule Variance (SV = BCWP - BCWS) and Schedule Variance % (SV%) are for schedule management and do not require the accumulation of actual cost. This can be helpful since the true cost for a project may not be known. If the SV% is a positive percentage, the task is ahead of schedule. If it's 0 percent, the task is right on target. If it's a negative percentage, the task is behind schedule. According to our data, the SPI is greater than 0 so we are slightly ahead of schedule which matches our expectations since Dave is scheduled to finish a few days early.