Paper 139-30

Using SAS® to Automate Project Management Evaluation and Forecasting Techniques

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INTRODUCTION

This paper focuses on using SAS to facilitate two important project management techniques – evaluation and forecasting. The objective of these techniques is to explain and predict project duration and resource consumption at a specific point in time. The benefit of these techniques is that you can determine whether your initial work and spending schedule is on target well before the project ends.

SCENARIO

You are ten months into a project. On the first day of each month, a new task was scheduled to start. Each task was budgeted a specific amount of money and was had an estimate of how much should have been completed at the end of the month. The actual amount spent and the actual amount completed was also tracked; the information tracked was as follows:

Performance Period	Scheduled Task	Task Cost Estimates	Actual Costs	Planned % Complete	Actual % Complete
January	A	1000	1100	1.0	1.0
February	B	2000	1750	.9	.95
March	C	3000	2320	.8	.83
April	D	4000	2750	.7	.65
May	E	5000	3150	.6	.55
June	F	6000	2950	.5	.53
July	G	7000	2615	.4	.47
August	H	8000	2502	.3	.22
September	I	9000	1703	.2	.15
October	J	10000	730	.1	.05

Using these inputs, you calculate the Planned Value (PV) and the Earned Value (EV). PV represents the amount of value expected to have been realized at a specific period. EV represents the amount of actual value realized at a specific period. PV and EV are derived by multiplying the task cost estimate by the planned and actual completion percentages respectfully. When you calculate the PV and EV and sum them, the task cost estimates and the actual costs, you then have all of the inputs needed for evaluation and forecasting:

Performance Period	Scheduled Task	Task Cost Estimates	Actual Costs	Planned % Complete	Actual % Complete	Planned Value	Earned value
January	A	1000	1100	1.0	1.0	1000	1000
February	B	2000	1750	.9	.95	1800	1900
March	C	3000	2320	.8	.83	2400	2490
April	D	4000	2750	.7	.65	2800	2600
May	E	5000	3150	.6	.55	3000	2750
June	F	6000	2950	.5	.53	3000	3180
July	G	7000	2615	.4	.47	2800	3290
August	H	8000	2502	.3	.22	2400	1760
September	I	9000	1703	.2	.15	1800	1350
October	J	10000	730	.1	.05	1000	500
TOTAL		**55000**	**21570**			**22000**	**20820**

The code segment below mimics this scenario and provides the following evaluation and forecasting information in an email project status report:

EVALUATION – How Well Is the Project Performing Now?

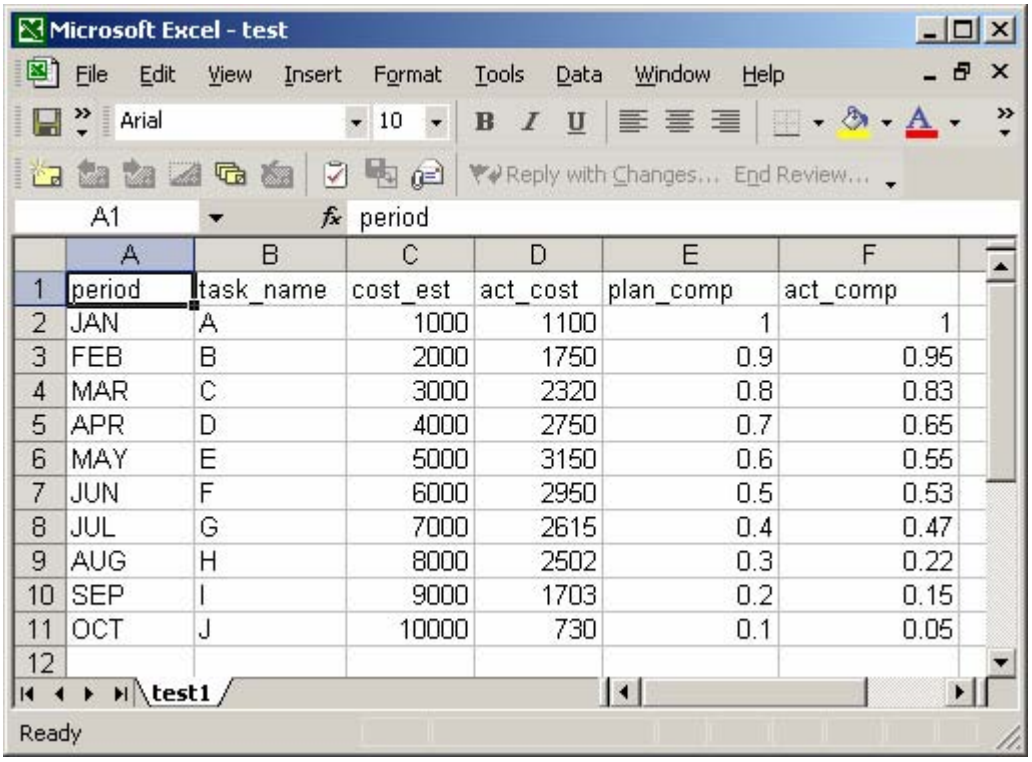
- BAC (Budget At Completion) – The original cumulative cost for the project; the same as the summed task cost estimates.
- CV (Cost Variance) – The difference between the estimated values of the work completed (EV) and what is actually paid out for the work (AC).
- SV (Schedule Variance) – The difference between the estimated value of the work actually completed (EV) and the planned value completed (PV). The SV is expressed in dollars. Using earned value analysis, you can measure schedule progress in terms of dollars because the completed work is defined by a dollar amount. Hence, this is the spending schedule or amount of time that a project is ahead or behind.
- PC (Percent Complete) – The percentage of work completed to date compared with the planned work for the entire project.
- PS (Percent Spent) – The percentage of money spent to date compared with the budget for the entire project.
- CPI (Cost Performance Index) – The value of work completed for each dollar actually spent.

- SPI (Schedule Performance Index) – The value of work completed for each dollar planned to be spent.

FORECASTING – How Well Will the Project Perform?

- EAC (Estimate At Completion) – The new/adjusted cumulative estimate of how much the project will cost.
- VAC (Variance At Completion) – The difference between the original estimate and the new/adjusted estimate of the cumulative completion cost.
- ETC (Estimate To Complete) – The estimate of how much money will be needed to operate the project from today until the end of the project.
- TCPI_B (To Complete Performance Index – BAC) – An index of how much effort will be needed to get the project back on track based on the original budget (BAC). It represents the relationship between the remaining work and the remaining money to complete the work.
- TCPI_E (To Complete Performance Index – EAC) – An index of how much effort will be needed to get the project back on track based on the new/adjusted budget (BAC). It represents the relationship between the remaining work and the remaining money to complete the work, assuming that the original budget has been re-baselined to the current budget.

For this example, the project status information is stored in an Excel® worksheet. SAS will read this file to capture the inputs:



	A	B	C	D	E	F
1	period	task_name	cost_est	act_cost	plan_comp	act_comp
2	JAN	A	1000	1100	1	1
3	FEB	B	2000	1750	0.9	0.95
4	MAR	C	3000	2320	0.8	0.83
5	APR	D	4000	2750	0.7	0.65
6	MAY	E	5000	3150	0.6	0.55
7	JUN	F	6000	2950	0.5	0.53
8	JUL	G	7000	2615	0.4	0.47
9	AUG	H	8000	2502	0.3	0.22
10	SEP	I	9000	1703	0.2	0.15
11	OCT	J	10000	730	0.1	0.05
12						

CODING APPROACH

```
%macro eval_fore;
  proc datasets kill;            /*delete pre-existing temporary data sets*/
  run;
  quit;

  %macro calculate(period=,      /*performance period*/
                   task_name=,   /*task id*/
                   cost_est=,    /*original budget*/
                   act_cost=,    /*actual cost*/
                   plan_comp=,   /*planned completion percentage*/
                   act_comp=);   /*actual completion percentage*/

    data one;
      period="&period";
      task="&task_name";
      cost_est=&cost_est;
      act_cost=&act_cost;
      plan_comp=&plan_comp;
      act_comp=&act_comp;
      pv=round(cost_est*plan_comp); /*planned value*/
      ev=round(cost_est*act_comp);  /*earned value*/
    run;

    proc append base=all_tasks data=one force;
    run;

  %mend calculate;

  %macro importit;  /*Import the input values from an EXCEL file */

    %macro obsnvars(ds);  /*metadata macro that captures data set information*/
      %global dset nvars nobs;
      %let dset  = &ds;
      %let dsid  = %sysfunc(open(&dset));
      %let nobs  = %sysfunc(attrn(&dsid,NOBS));
      %let nvars = %sysfunc(attrn(&dsid,NVARS));
      %let rc    = %sysfunc(close(&dsid));
    %mend obsnvars;

    proc import datafile="c:\bkb\test\test.xls"
      out=test dbms=excel replace;
    run;
    quit;

    %obsnvars(test);

    %do n = 1 %to &nobs;  /*for each observation, calculate the evaluation and forecasting inputs */
      data _null_;
        set test;
        if _N_ = &n;
        call symput('perd',period);
        call symput('task',task_name);
        call symput('estm',cost_est);
        call symput('act1',act_cost);
        call symput('plan',plan_comp);
        call symput('act2',act_comp);
      run;


%calculate(period=&perd.,task_name=&task.,cost_est=&estm.,act_cost=&act1.,plan_comp=&plan.,act_comp=&act2.);

    %end;
  %mend importit;
  %importit;

  proc means data=all_tasks sum noprint;
    output out=two(keep=cost_est act_cost pv ev rename=(cost_est=bac)) sum=;
  run;

  data three;
    set two;
    cv=ev-act_cost;                    /*cost variance*/
    sv=ev-pv;                          /*schedule variance*/
    cpi=round((ev/act_cost),.01);      /*cost performance index*/
    spi=round((ev/pv),.01);            /*schedule performance index*/
    pc=round((ev/bac),.01);            /*percent complete*/
```

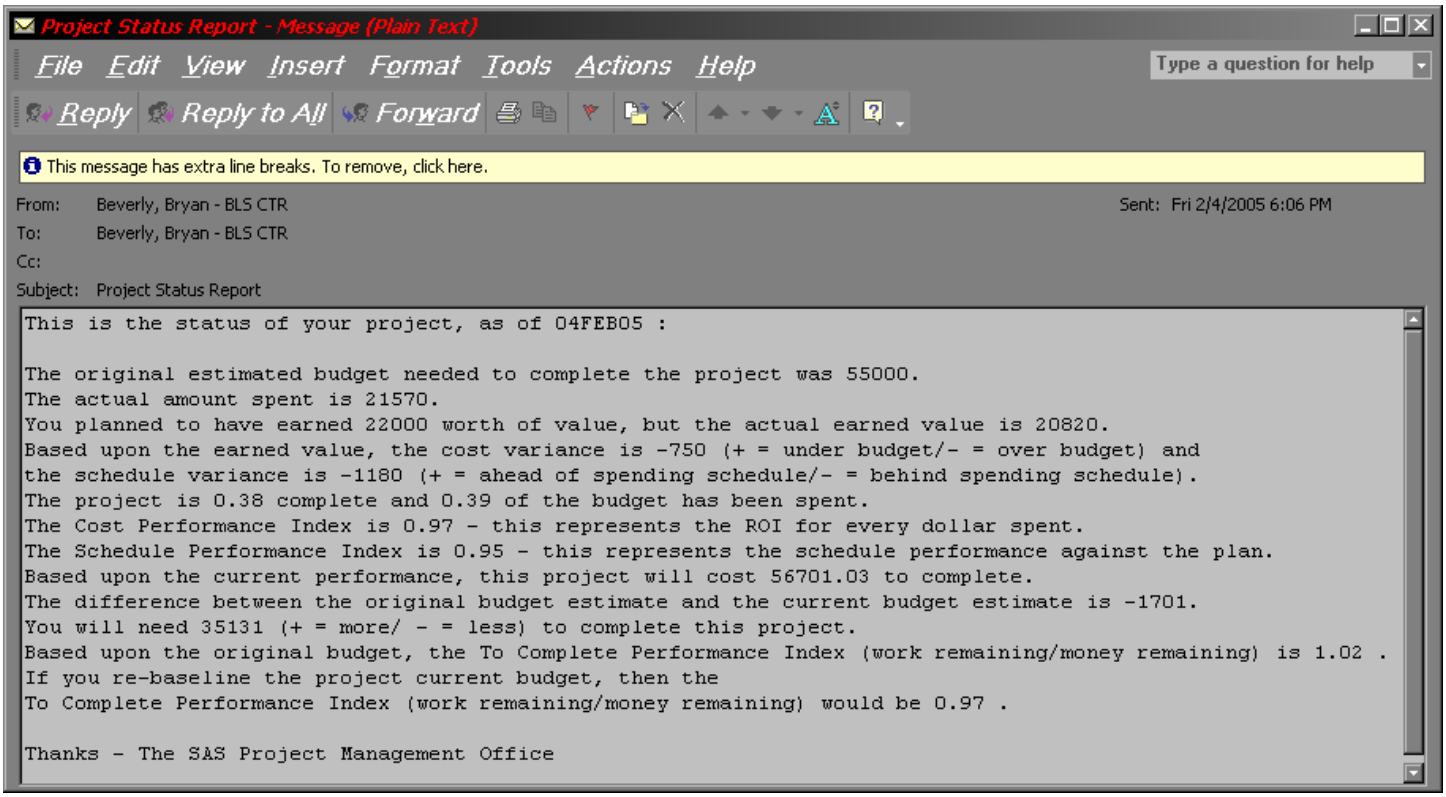
```
    ps=round((act_cost/bac),.01);        /*percent spent*/
    eac=round((bac/cpi),.01);            /*estimate at completion*/
    vac=round(bac-eac);                  /*variance at completion*/
    etc=round(eac-act_cost);             /*estimate to complete*/
    tcpi_b=round(((bac-ev)/(bac-act_cost)),.01); /*to complete performance index - bac*/
    tcpi_e=round(((bac-ev)/(eac-act_cost)),.01); /*to complete performance index - eac*/
  run;

  data _null_;                           /*macrotize the outputs*/
    set three;
    call symput('bac',bac);
    call symput('act_cost',act_cost);
    call symput('ev',ev);
    call symput('pv',pv);
    call symput('cv',cv);
    call symput('sv',sv);
    call symput ('cpi',cpi);
    call symput ('spi',spi);
    call symput ('pc',pc);
    call symput ('ps',ps);
    call symput ('eac',eac);
    call symput ('vac',vac);
    call symput ('etc',etc);
    call symput ('tcpi_b',tcpi_b);
    call symput ('tcpi_e',tcpi_e);
  run;

  data _null_;                         /*send results in email */
    filename outbox email "beverly_b@bls.gov";
    file outbox
    subject="Project Status Report";
    put "This is the status of your project, as of &sysdate :";
    put "                                                    ";
    put "The original estimated budget needed to complete the project was %cmpres(&bac).";
    put "The actual amount spent is %cmpres(&act_cost).";
    put "You planned to have earned %cmpres(&pv) worth of value, but the actual earned value is %cmpres(&ev).";
    put "Based upon the earned value, the cost variance is %cmpres(&cv) (+ = under budget/- = over budget) and";
    put "the schedule variance is %cmpres(&sv) (+ = ahead of spending schedule/- = behind spending schedule).";
    put "The project is %cmpres(&pc) complete and %cmpres(&ps) of the budget has been spent.";
    put "The Cost Performance Index is %cmpres(&cpi) - this represents the ROI for every dollar spent.";
    put "The Schedule Performance Index is %cmpres(&spi) - this represents the schedule performance against the
plan.";
    put "Based upon the current performance, this project will cost %cmpres(&eac) to complete.";
    put "The difference between the original budget estimate and the current budget estimate is %cmpres(&vac).";
    put "You will need %cmpres(&etc) (+ = more/ - = less) to complete this project.";
    put "Based upon the original budget, the To Complete Performance Index (work remaining/money remaining) is
%cmpres(&tcpi_b) .";
    put "If you re-baseline the project current budget, then the ";
    put "To Complete Performance Index (work remaining/money remaining) would be %cmpres(&tcpi_e) .";
    put "                                                    ";
    put "Thanks - The SAS Project Management Office";
  run;

%mend eval_fore;
%eval_fore;
```

The email report is as follows:



Project Status Report - Message (Plain Text)

File Edit View Insert Format Tools Actions Help

Type a question for help

Reply Reply to All Forward

This message has extra line breaks. To remove, click here.

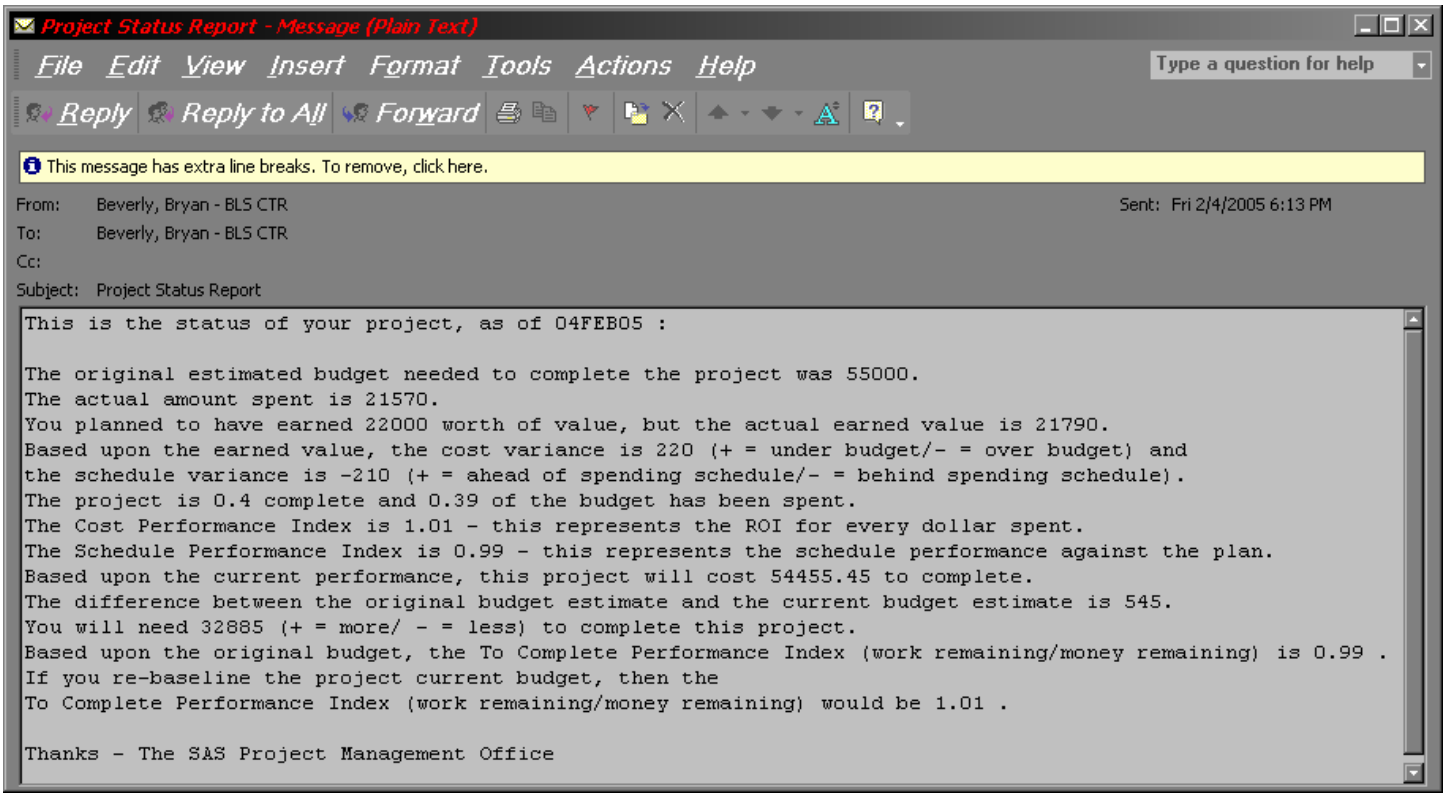
From: Beverly, Bryan - BLS CTR
Sent: Fri 2/4/2005 6:06 PM
To: Beverly, Bryan - BLS CTR
Cc:
Subject: Project Status Report

```
This is the status of your project, as of 04FEB05 :

The original estimated budget needed to complete the project was 55000.
The actual amount spent is 21570.
You planned to have earned 22000 worth of value, but the actual earned value is 20820.
Based upon the earned value, the cost variance is -750 (+ = under budget/- = over budget) and
the schedule variance is -1180 (+ = ahead of spending schedule/- = behind spending schedule).
The project is 0.38 complete and 0.39 of the budget has been spent.
The Cost Performance Index is 0.97 - this represents the ROI for every dollar spent.
The Schedule Performance Index is 0.95 - this represents the schedule performance against the plan.
Based upon the current performance, this project will cost 56701.03 to complete.
The difference between the original budget estimate and the current budget estimate is -1701.
You will need 35131 (+ = more/ - = less) to complete this project.
Based upon the original budget, the To Complete Performance Index (work remaining/money remaining) is 1.02 .
If you re-baseline the project current budget, then the
To Complete Performance Index (work remaining/money remaining) would be 0.97 .

Thanks - The SAS Project Management Office
```

These results suggest that the project is slightly over budget and slightly behind schedule at the time of this report. However, by adding $1,701 to the total budget, there will be enough money to cover the remaining work. Another option would be to maintain the original budget, and improve the performance of the under-performing tasks. For example, if you can redesign work processes, motivate project staff and reduce waste for Tasks H, I and J, such that the actual completion percentages are 27%, 18% and 8% respectively, then outcomes are dramatically different:



Project Status Report - Message (Plain Text)

File Edit View Insert Format Tools Actions Help

Type a question for help

Reply Reply to All Forward

This message has extra line breaks. To remove, click here.

From: Beverly, Bryan - BLS CTR
Sent: Fri 2/4/2005 6:13 PM
To: Beverly, Bryan - BLS CTR
Cc:
Subject: Project Status Report

```
This is the status of your project, as of 04FEB05 :

The original estimated budget needed to complete the project was 55000.
The actual amount spent is 21570.
You planned to have earned 22000 worth of value, but the actual earned value is 21790.
Based upon the earned value, the cost variance is 220 (+ = under budget/- = over budget) and
the schedule variance is -210 (+ = ahead of spending schedule/- = behind spending schedule).
The project is 0.4 complete and 0.39 of the budget has been spent.
The Cost Performance Index is 1.01 - this represents the ROI for every dollar spent.
The Schedule Performance Index is 0.99 - this represents the schedule performance against the plan.
Based upon the current performance, this project will cost 54455.45 to complete.
The difference between the original budget estimate and the current budget estimate is 545.
You will need 32885 (+ = more/ - = less) to complete this project.
Based upon the original budget, the To Complete Performance Index (work remaining/money remaining) is 0.99 .
If you re-baseline the project current budget, then the
To Complete Performance Index (work remaining/money remaining) would be 1.01 .

Thanks - The SAS Project Management Office
```

Hence, by slightly improving the performance of three tasks, the whole project moved within $545 (1%) of being on target of the baseline estimate ($55,000). As a follow up, it would be worthwhile to target Tasks D, E, H, I and J for additional analysis. Determining

why these tasks under-performed (as per their respective Earned Value schedules) would serve as the agenda for a risk/scheduling meeting.

CONCLUSION

The main take-away from this paper is that you can combine SAS with project management tools to proactively improve project and task performance. Specifically, by codifying industry-standard project management techniques, managers and technologists can work together in monitoring the schedule and cost of producing SAS-based deliverables. The benefit of using these duration and resource surveillance tools is that challenges to success can be addressed while they are still risks and before they become problems.

ACKNOWLEDGEMENTS

The author acknowledges the support of BAE Information Technology and the Bureau of Labor Statistics in the development and presentation of this paper.

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