

Tracking Project Progress with OPEN PLAN

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Introduction

OPEN PLAN (a product of WST Corporation) has been selected as the management software for the SSC construction project, and the SSC Management Division has been engaged in implementing this program to provide the appropriate Cost and Schedule Control functions. This note reports the results of our recent efforts to understand OPEN PLAN and to work out a scheme to use it to track project progress. That is, when the progress on ongoing activities is entered into OPEN PLAN, the program must deal with the information in a coherent and consistent manner, calculate cost and schedule variances, and make revised schedules. This note briefly describes how OPEN PLAN is used, discusses how it deals with project progress, assesses its strengths and weaknesses, defines requirements for a revised scheme to calculate and report project progress, and proposes a new scheme appropriate for the SSC project. It appears that the core programs in OPEN PLAN may be used with minor modifications, but some completely new reports will need to be written for the SSC.

Running OPEN PLAN

OPEN PLAN is a menu-driven shell program written primarily in dBASE III PLUS, a relational data base management system from Ashton-Tate. The following is a brief description of how OPEN PLAN is operated.

1. A *new project* is created and entered into the project directory
2. *Supporting files* are linked to the new project
 - Calendar file
 - Resource availability file (which contains labor rates)
 - Two code files (which describe the CWBS and the OBS)
3. *Activities* are entered into the activity file. "Budgeted Cost" is a field in the activity file which can be used for the "materials" cost or fixed cost of an activity. At the same time, *resource requirements* (labor costs) for each activity are entered into the resource file. Different resource requirements for different periods during the activity duration may be specified.
4. A *time analysis* is performed, and *reports* on the original plan (cost, schedule, and resources) can be printed at this time.
5. The *baseline dates* are set (usually to the "early dates")
6. The *progress* on scheduled activities is entered
7. The *cost and schedule variances* (in dollars) can be calculated and printed out using the standard report ACTCOST
8. A *new time analysis* can be performed at this time to revise the schedule, and standard reports can be used to print out a new Gantt chart and revised resource requirements.

OPEN PLAN Decoded
How Does It Calculate and Report Progress?

The current version of OPEN PLAN, as it is provided by WST Corporation, has a specific way of handling project progress. This section describes the input data requested by the program, the calculations performed by the core programs, the definitions of the calculated quantities, and the content of the standard reports. Figure 1 shows OPEN PLAN screen for project progress.

Project TEST06	ACTIVITY PROGRESS		Time Now 04/01/88
Activity	Original Duration	Start Date	Finish Date
100	90	Early: 04/01/88	04/30/88
		Late: 04/01/88	04/30/88
		Scheduled: / /	/ /
		Baseline: 01/01/88	03/30/88
Description			
magnet ED			
		Actual: 02/01/88	/ /
Activity Status: R	(C, P, R, or E: see below)		
Progress Value: 60	(Enter % complete or Remaining/Elapsed duration)		
(Complete, Percent Complete, Remaining Duration, Elapsed Duration)			
Physical % Complete 33	Actual Cost to Date	60000	(Base 90000)

Figure 1. OPEN PLAN Data Entry Screen for Activity Progress.
The input fields are circled.

Calculations of Variances, in Dollars. To begin with, OPEN PLAN has the following information about each activity: original duration, baseline dates for the start and finish, and baseline cost (which was entered in the "Budgeted Cost" field during activities details data entry). When the "Physical % Complete" and "Actual Cost to Date" are input, the standard report ACTCOST can be used to calculate and to display the Cost Variance and the Schedule Variance, both calculated in dollars according to the formulae given in Figure 2.

ACWP = actual cost
 BCWP = % Physical Complete x Budgeted Cost
 BCWS = if Baseline start > Timenow = 0
 if Baseline Finish < Timenow = Budgeted Cost
 otherwise $\frac{\text{Timenow} - \text{Baseline Start}}{\text{Baseline Finish} - \text{Baseline Start}} \times \text{Budgeted Cost}$
 VARIANCE COST = BCWP-ACWP
 VARIANCE SCHEDULE = BCWP-BCWS
 AT COMPLETION BUDGET = Budgeted Cost
 AT COMPLETION FORECAST = AT COMPLETION BUDGET+VARIANCE COST

Figure 2. Definitions of Variances, in Dollars

Note that only the "Budgeted Cost" is used in the variance calculations, and that the resource requirements for an activity (stored in the resource file) are completely ignored. Also note that the "Budgeted Cost" (which can be used for the materials cost) is assumed to be expended uniformly over the duration of the activity.

Schedule Changes. There are several essentially equivalent ways to enter schedule changes for an activity.

1. If the Actual Start Date is entered, and no Activity Status is entered, the Actual Start Date is used to calculate the remaining duration of the activity.
2. If the Activity Status is entered, it overrides the Actual Start Date in the calculation of the remaining duration. As can be seen in Figure 1, there are four mutually exclusive methods of entering the Activity Status:
 - Activity Complete
 - Percent Complete (not to be confused with Physical % Complete)
 - Remaining Duration
 - Elapsed Duration

If the remaining duration of the activity is entered in one of the above ways, performing a *time analysis* will cause the schedule to be revised accordingly. The revised schedule can be printed out using the standard report GANTT. A resource aggregation performed with report AGGLIST will show that the schedule for the (labor) resource requirements has also been appropriately modified.

Comments. The striking aspect of the above analysis is that there are two completely separate and inconsistent calculations. The Physical % Complete and the Actual Cost to Date are combined with the

Baseline Dates and the Budgeted Cost to yield variances in dollars. On the other hand, entering the remaining duration of the activity causes an adjustment of the project schedule. These two calculations are entirely independent in OPEN PLAN.

An Assessment of OPEN PLAN

1. The design of the core programs in OPEN PLAN appear to be quite satisfactory. For example, entering project progress by specifying the remaining duration of an activity causes the resource requirements to be delayed according to the algorithm described in the following excerpt from page 4-8 of the OPEN PLAN Reference Manual:

For example, consider an activity with an original duration of ten days, using two units of a resource A for the first five days and one unit for the last five days. When the remaining duration is six days, the resource requirement is two units for one day, followed by one unit for five days. This applies even if the start date indicates that the elapsed duration is not four days. In cases where progress has not been as planned, it may therefore be necessary to revise the resource requirement profiles and/or the original duration for the activity.

2. The calculations of the two variances, in dollars, are far too simple. The costs associated with the (labor) resource requirements are ignored, and a uniform spending profile is assumed for the Budgeted Cost. In any case, the Schedule Variance in dollars does not appear to be particularly meaningful or useful.
3. The independent treatment of cost and schedule is unsatisfactory. We would surely want an integrated approach in which the estimated cost of an activity is consistent with the resources which must be allocated to the remainder of that activity.

SSC Requirements for Reporting Project Progress

Defining requirements for a new scheme to report project progress is not an entirely straightforward process, because we are looking for a method to treat intrinsically inconsistent data. Of course, if the progress on an activity follows exactly the predetermined plan, then the reporting of progress is a trivial matter. In the general case, however, the progress will deviate from the plan and therefore will require analysis and reporting. In some cases where we notice a deviation, we may choose to modify the entire schedule to reflect the changes in an important activity. Here again, we end up with a consistent set of data which can be dealt with very simply. For most activities, however, we will wish to enter whatever we know of the activity progress without revising all the details of the activity, its estimated costs, and its resource requirements. In that case, it is necessary to reconcile in some reasonable fashion the outdated plan and the new data on remaining duration. There cannot be an exactly correct method to treat these inconsistent data. All that we can ask for is a clear, unambiguous, and reasonable method to calculate cost and schedule variances. With this general goal in mind, I propose the following list of requirements for a new scheme to report project progress for the SSC construction project:

1. A simple and unambiguous scheme is needed to provide readily understandable and useful information for the management team.
2. In the absence of contradictory information, OPEN PLAN should assume as much as possible that the original plan has been followed, especially in the case of small deviations from the original plan.

3. We wish to calculate a cost variance in dollars and a schedule variance in days. The (labor) resource requirements for the remainder of the activity should be reconciled with both variances.
4. The calculation of remaining resource requirements should be conservative, so that enough resources are allocated for the near future.
5. The fixed cost or materials cost must be scheduled in detail: it is not sufficient to assume that the fixed cost is expended uniformly over the duration of the activity. For one thing, we plan to model obligations and costs by using different time profiles for the fixed costs.
6. The selected scheme should be readily implemented using OPEN PLAN.

Proposed Procedure for Tracking Project Progress

Based on the preceding list of requirements, I suggest a new procedure to calculate and report progress on the SSC project. Some modest revisions of the OPEN PLAN core programs are required, and several new reports need to be written.

Activities Data. The *labor resource* requirements for each labor category are entered into the resource file, exactly in the same manner as for the current version of OPEN PLAN. It is best to input labor resources using the "total amount of resources" option rather than the "level of resource" option, so that schedule changes will not cause unintended changes in total resource requirements. The *materials* costs, however, are no longer entered into the "Budgeted Cost" field, but are now stored in the resource file, under a resource category named "MAT". This procedure permits a time profile to be defined for the materials cost.

Project Progress Data Entry.

1. The "Physical % Complete" and "Actual Cost to Date" are entered for the purpose of calculating the cost variance in dollars. Because the cost variance is the primary indication of overspending and underachieving, an accurate and unbiased estimate for Physical % Complete is central to the assessment of an activity in progress. In many cases, it would be best to estimate this quantity by comparing actual progress with previously defined milestones. Defining activities so that they have short durations will also help to minimize the effects of errors in estimating current progress.
2. A simplified procedure allows the remaining duration for an activity to be specified in three mutually exclusive ways.
 - Actual Start Date
 - Activity Complete
 - Remaining Duration

Calculations.

1. The *cost variance* in dollars is calculated from the "Physical % Complete" and the "Actual Cost to Date", much like before. However, the "Originally Budgeted Cost" for the activity is now calculated from the resource requirements (including "MAT") contained in the resource file.
2. The *schedule variance* in dollars can be calculated, as before.
3. The *schedule variance* in days is calculated by subtracting the new finish date (NFD) from the Baseline Finish Date, where the new finish date is calculated from the remaining

duration (NFD = Time Now + "R" days). The labor and materials requirements for the remaining R days are assumed to be the same as those which were originally planned for the last R days of the activity. This algorithm assumes that the remainder of an activity will proceed according to plan, regardless of problems encountered during the first portion of that activity. Past delays and overruns are not projected automatically into the future. This method for estimating the remaining resources is already implemented in OPEN PLAN, and it represents a conservative method to estimate resource requirements for the near future.

4. A consistent and integrated treatment of cost and schedule requires that we reconcile two independent methods to calculate the new cost estimate for an activity.

$$\text{New cost estimate} = \text{budgeted cost} + \text{cost variance}$$

$$\text{New cost estimate} = \text{cost to date} + \text{remaining labor} + \text{remaining materials}$$

In the second equation, the remaining required resources are assumed to be those which were originally planned for the last R days of the activity. One way to reconcile these two equations is to define a new quantity, the *change in resource requirements*, so that the following equations are true:

New cost estimate

$$= \text{budgeted cost} + \text{cost variance}$$

$$= \text{cost to date} + \text{remaining labor} + \text{remaining mat.} - \text{change in res. requirements}$$

A substantial value of this new quantity would be an indication that a deviation from the resource plan may occur.

5. If it is desirable for OPEN PLAN to treat labor cost differently from materials cost, the materials cost can be distinguished by keying on the resource type name "MAT".

New Reports. At least two new reports must be written for OPEN PLAN.

1. A new report modeled on RESCOST is needed to provide a resource cost summary for each activity. The materials cost is stored as the resource type "MAT" in the resource file.
2. A new report modeled on ACTCOST is needed to report on the cost and schedule variances as defined previously. Here, the schedule variances in days are calculated *individually* for each activity. The overall schedule impact can be studied by performing a time analysis and using the standard report GANTT.

Conclusions

The operation of OPEN PLAN is now rather well understood, and some limitations of the standard version of OPEN PLAN have been explored. A proposed list of requirements for the project progress reporting system has been developed, and these requirements have in turn led to specific suggestions for modifying and upgrading OPEN PLAN to track progress on the SSC construction project.