Introduction to Earned Value Performance Management
(EVPM)
Then, Now and the Future

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Introduction to Earned Value Performance Management
(EVPM) Then, Now and the Future

Front matter

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Introduction – What is Earned Value – A quick overview

> *There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the imitator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new*
> Niccolò Machiavelli, The Prince

For many years the project management techniques that have been used extensively for the management of projects of all sorts, shapes and size: have tended to focus on achieving deadlines by controlling (initially) the use of time and then resources. The most common reports would be centred around "Milestones" showing time based progress reporting of the "Current Status" versus the "Original Planned Status" based on resources used. This of course only showed part of the picture, the use of time and resources whilst being valuable information, did not provide management with a full view of the project, what was missing, was the "Value" of the work done.

The concept of work having a value has been around for over thirty-five years and has been known by a series of popular acronyms, for example: EVA (Earned Value Analysis), CS^2 (Cost/Schedule Control Systems Criteria), EVPM (Earned Value Performance Management). In spite of software tools being available that would carry out Earned Value computations, it was considered too complicated by most project managers. However with the increasing number of projects failing to meet time or budget expectations, the project management market is examining ways to improve project delivery. Having noted that those projects, which have utilised the EVA method, have actually been successful in delivering the project that the stakeholders expected, the project management community is beginning to make moves towards the use of Earned Value techniques.

However many project managers within the wider project community see earned value as being a method that is mandated by the department of defence. There is now a current move the technique from the government arena and make it available to the wider project market. To this end, the existing definitions of how an Earned Value system should be established are being redefined by Standards Australia. However I have always used the term Earned Value Performance Management (EVPM) and will use it throughout this paper. What is EVPM? It is basically a way of understanding how a project is performing. It is a simple way of progress monitoring and forecasting completion.

Basic Cost Control

Obviously it is very important to know on a project how it is progressing in terms of time and cost. Usually there will be a "Target Plan", that is a document that shows the original plan. If each task is allocated a cost, then a cash flow curve can be prepared. The "Target Plan" shows how the project is intended to go and the cash flow curve how the money is expected to be spent.

Each progress period (weekly or monthly), the actual costs are plotted on the cash flow curve to compare what has been actually expended to what was intended. An example of such a cash flow is shown in Figure 1.

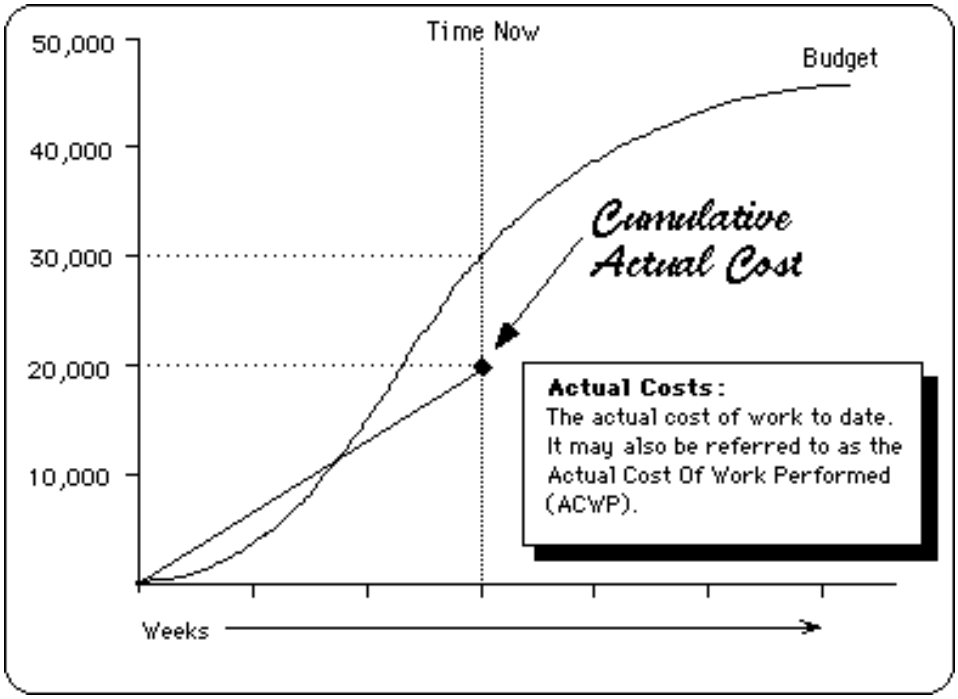

Figure 1: Original Cash Flow and Actual Cost Curves

Figure 1 indicates that the actual expenditure on the project is not keeping up with the original plan. The project manager is now faced with the dilemma of what the data means. One reason for the apparent decline in expenditure could be that amore efficient or less expensive way has been found to carry out the work. If this is the case then the project undoubtedly will be completed on time and under budget! Of course there are many other explanations equally likely, but this simple illustration shows how difficult the project manager's job can be in totally knowing what is going on.

Earned Value Performance Management

Time reporting and the actual cash expended to date do not in themselves provide a measure of the "Value" of the work achieved. Earned Value Performance Management provides the solution. EVPM is a technique that permits the project manager to compare the 'value' of the work completed to date with the "value" of work originally scheduled. Basically EVPM suggests that the value of the physical work achieved (known as the Budgeted Cost for Work performed – BCWP) is compared with the value of the work that should have achieved (known as the Budgeted Cost of Work Scheduled – BCWS). The actual amount of work achieved at a given date is measured and multiplied by the cost rates used to produce the budget. It is not necessary to know how much has been spent, just the amount of work Achieved and the value of that work.

This process is carried out for each task, total groups of tasks and a total of all the tasks for a project overview. This approach has many advantages, only the physical amount of work achieved has to be measured, in most industries this is fairly easy. Because like is being measured with like it is very quick to produce the result on just how the project is going. In fact a single piece of A4 paper can show just how the project is performing. By adding in the actual costs to date for each task (the Actual Cost for Work Performed – ACWP), it is possible to produce a series of ratios each of which provides an indication as to the state of the project.

The BCWP is also known as the "Earned value", it is calculated by multiplying the original budget value for each task with the progress reported to date. The great benefit of this is, is that there is no waiting for the accounts department to catch up with the information. Meaningful reports can be produced quickly showing the status of the project on one page. Time is reported by Milestone reports and EVPM reports value.

The capacity to account for actual costs, that is, the "Actual Cost for Work Performed" – (ACWP) affords the project manager with a view of the full cost picture. From this information two major ratios may be calculated, these are "Scheduled Variance" (SV) which tells the project manager (based on original budget costs), the actual value (or quantity) of work performed against the original plan. The Scheduled Variance is computed as follows;-

SV = BCWP – BCWS

Schedule variance is illustrated below in Figure 2, along with Schedule Slippage, which indicates how far behind in terms of time, when the value of work to be performed should have taken place and when it actually took place.

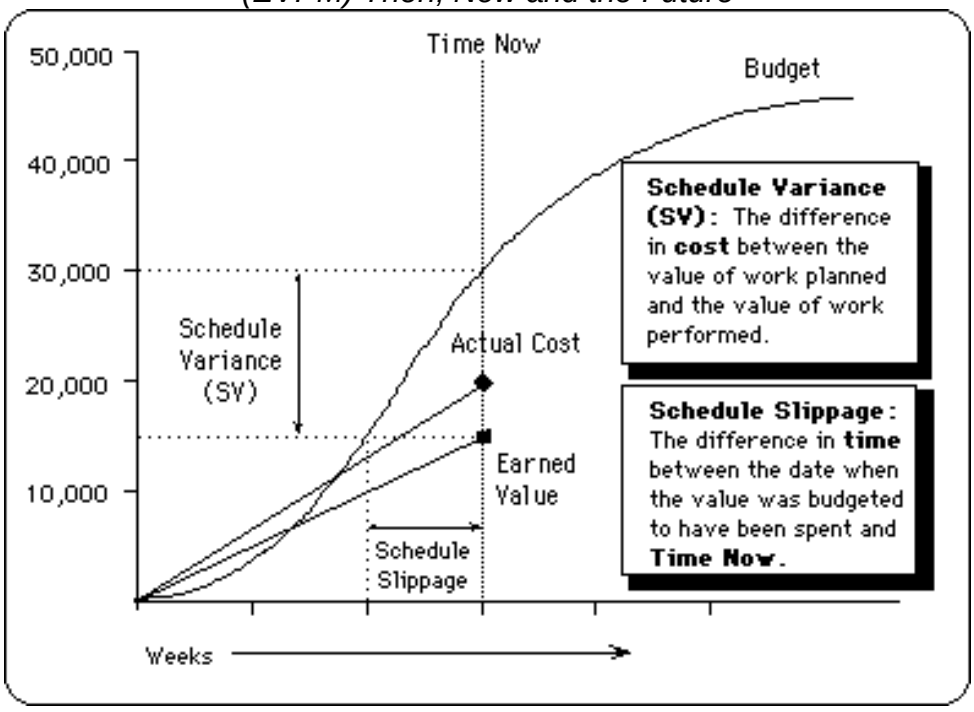

Figure 2 Schedule Variance and Scheduled Slippage

Schedule slippage indicates to the project manager that unless corrective action is implemented as quickly as possible then the final project completion date will be delayed by that amount.

The second ratio is the "Cost Variance" (CV), which is also known as the "Cost Performance Index" (CPI). This ratio compares the actual cost for performing the work completed to date against the original budget value (plus or minus variations) for that work. Thus answering the question is the work that is actually being achieved, being performed in a cost effective manner. The Cost variance is computed as follows:-

CV = BCWP – ACWP

Figure 3 below illustrates the cost variance and clearly shows that the project is currently running behind in both schedule and costs. Without the BCWP and ACWP, management, if it were just

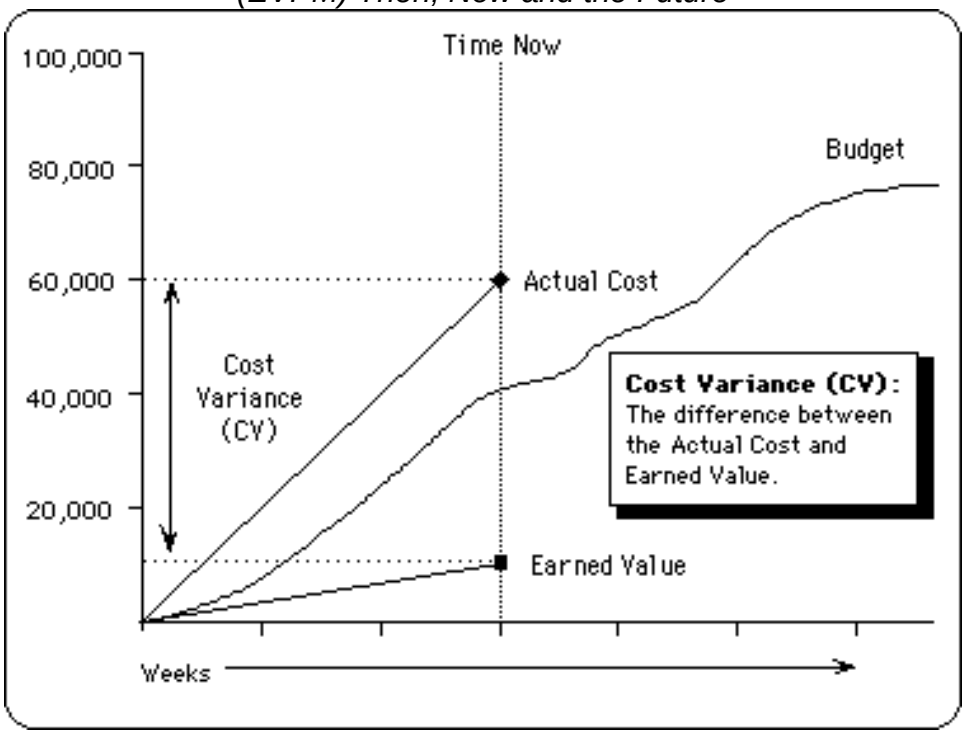

Figure 3: Cost Variance

looking at the budget curve would have no indication as to how far behind the project is at Time Now.

In addition to understanding the situation at Time Now, the project manager needs to understand what the implications of progress to date have on the projected completion date and the value to completion of the project. This gives rise to another set of ratios and values, which are calculated, from Time Now; these are "Budget at Completion" (BAC), "Estimate to Complete" (ETC), "Estimate at Completion" (EAC), "Variance at Completion" (VAC). Figure 4 below shows each of the ratios as defined in the Earned Value Performance Management technique.

Figure 4: EVPM Curves and Ratios

The EVPM Terms Explained

The following is a simple and concise explanation of the various acronyms (factors) and ratios used in EVPM. Usually a computer program is used to calculate these factors.

BCWS – Budgeted Cost of Work Scheduled
BCWS is the VALUE of the work that SHOULD have been accomplished at a given point in time. This takes the work PLANNED to have been done and the budget for each task indicating to you what part of the budget you planned to have used.

BCWP – Budgeted Cost for Work Performed
BCWP is the VALUE of the work you HAVE accomplished at a given point in time. This takes the work that HAS been done and the budget for each task indicating to you what part of the budget you ought to have used to achieve that.

ACWP – Actual Cost for Work Performed
ACWP is the ACTUAL cost of the work done.

SV – Schedule Variance
SV is the value of the work you HAVE accomplished minus the value of the work you SHOULD have accomplished (BCWP – BCWS). A negative value indicates that you are behind schedule in monetary terms.

CV – Cost Variance
CV is the budgeted cost of work accomplished to date minus the actual cost of work accomplished to date (BCWP – ACWP). A negative cost variance indicates the current budget overrun.

BAC – Budget at Completion
BAC is the original budget for the whole project from start to finish.

EAC – Estimate Cost at Completion
EAC is the revised prediction of how much the project will cost (taking into account what has actually been spent so far and the current estimate to complete the remaining work).

ETC – Estimate to Complete
ETC is the estimated value required to complete the remaining work.

VAC – Variance at Completion
VAC is the difference between the original budget and the latest revised budget (BAC-EAC). If the value is negative, it indicates an anticipated cost overrun.

Earned Value Then (or Cost/Schedule Control Systems Criteria as it was known)

The Earned Value process (Cost/Schedule Control Systems Criteria or as we said above more commonly known as CS²) was a set of 35 criteria (for a full description of these see Appendix 1) for measuring the adequacy of management control systems through, among other things, the application of earned value performance management concepts. These criteria were adopted by the U.S Department of Defence for large value projects as a means of keeping, the then, ever escalating cost overruns on major projects under some sort of control. It was originated as Department of Defence Instruction 7000.2 on April 25th 1968 (which at the time of writing this paper October 2000 makes it over 32 years old!). The objectives of this DoDI were stated as follows:

1) To provide an adequate basis for responsible decision making by both contractor management and DoD Components, contractor's internal management control systems must provide data which

- indicates work progress,
- properly relates cost, schedule and technical accomplishment,
- are valid, timely and auditable, and
- supply DoD managers with information at a practicable level of summarization.

2) To bring to the attention of, and encourage, DoD contractors to accept and install management control systems and procedures, which are most effective in meeting their requirements and controlling contract performance. DoD contractors also should be continuously alert to advances in management control systems, which will improve their internal operations.

In recognition of the benefits apparent from the application of C/SCSC back in 1986/1987 the Australian DoD on the then the advent of ANZAC Frigate Project, the Collins Class Submarine Project, JORN (Jindalee Over the Horizon Radar) and the Jindivick refurbishment program, caused the issue of a policy statement for the application of C/SCSC to selected Defence Capital Equipment acquisition projects.

EVPM Now

In 1991 US DODI 5000.2 superseded US DODI 7000.2, then in 1996 DoD Regulation 5000.2–R, superseded DODI 5000.2 and it was during this time that the name of the methodology gradually changed from Cost/Schedule Control Systems Criteria to Earned Value Performance Management. However after twenty-three or so years the criteria had remained essentially the same. The 1991 change dropped three of the original criteria. It is interesting to note that in 1996 the British

Standards Institute in its BS 6079:1996 Guide to Project Management has adopted the criteria laid out in DODI 5000.2.

The 1991 US DODI 5000.2, formed the basis for the Def (AUST) 5655 issued in October 1992 when the initial major Australian thrust into CS was established, the then Department of Project Management System within DoD developed an Australian version of CS². These were generated from the US DoDI and were numbered and titled as follows:-

- Def (AUST) 5655 – Australian Cost Schedule Control Systems Criteria
- Def (AUST) 5657 – Australian Cost Schedule Control Systems Criteria; Implementation Guide (ACSIG)
- Def (AUST) 5658 – Cost Schedule Status Reporting (CSSR) Specification and Implementation Guide
- Def (AUST) 5664 – Work Breakdown Structures for Defence Materiel projects – Policy and Guidance

The Australian DoD policy, stated that all projects (including subcontracts to eligible prime contracts) that are over $100m in value (including multiple subcontracts to one prime contractor) or projects / subcontracts over $40m that include a significant development component will use C/SCSC techniques. Thus during the early 1990's there was an upsurge in defence contractors attempting to bring their internal control systems into line with the Australian standards.

As a consequence, the then traditional hierarchical structures gave way to flat management organisations with much of the responsibility for completing the project resting with the various Cost Account Managers (CAM). However, before we can discuss the role of the CAM, we need to understand how developing the project Work Breakdown Structure derives Cost Accounts.

Work Breakdown Structure & Organisation Breakdown Structure

EVPM sets out to monitor and control many variables; however, the two major breakdowns for any project are the Organizational Breakdown Structure (OBS) and the Work Breakdown Structure (WBS). The WBS techniques were originally defined in the U.S. Military Standard 881A, which in Australia is known as Def (AUST) 5664. Establishing the WBS provides the structure for the basic planning, scheduling and budgeting process. The OBS establishes the 'line of authority' structure within the project. The contractor on winning a bid has to provide, among many other items, the following:-

1) A schedule of authorised work, which describes the sequence of work and identifies the significant activity interdependencies required to meet the development, production and delivery requirements of the contract.

2) Identification of physical deliverables, milestones, technical performance goals, or other indicators that will be used to measure output.

3) A time-phased budget baseline at the cost account level against which contract performance can be measured.

4) Budgets for all authorised work with separate identification of cost elements (e.g. labour, materials, equipment, etc.)

5) An OBS Chart.

Once the baseline schedule (cost and budget) has been agreed, EVPM imposes rigorous requirements on the Contractor to furnish information accounting for direct and indirect costs and a summarisation of costs rolling up through the WBS. In addition the contractor has to provide detailed analysis of time, resources used, costs, materials, overruns and scope change; all in all not an easy task.

The Def (AUST) 5664, provides for a standard Work Breakdown Structure of the upper three (summary) levels of a WBS and has a uniform element terminology, definition, and placement structure in the family tree. The upper three levels of a summary WBS have been organised to cover seven categories of defence projects, these are:-

1) Aircraft Systems
2) Electronic Systems
3) Missile Systems
4) Ordnance Systems
5) Ship Systems
6) Space Systems
7) Surface Vehicle Systems

The top three levels of the WBS are defined as follows:-

- Level 1 is the entire defence item, for example the LHA Ship System, or the Anzac Frigate Project.

- Level 2 are the major elements of the defence item, for example, a frigate or a submarine.

- Level 3 elements are sub ordinate to level 2 major elements, for example, an electric power plant or an airframe.

Figure 5 below, illustrates the standard WBS for a typical ship construction

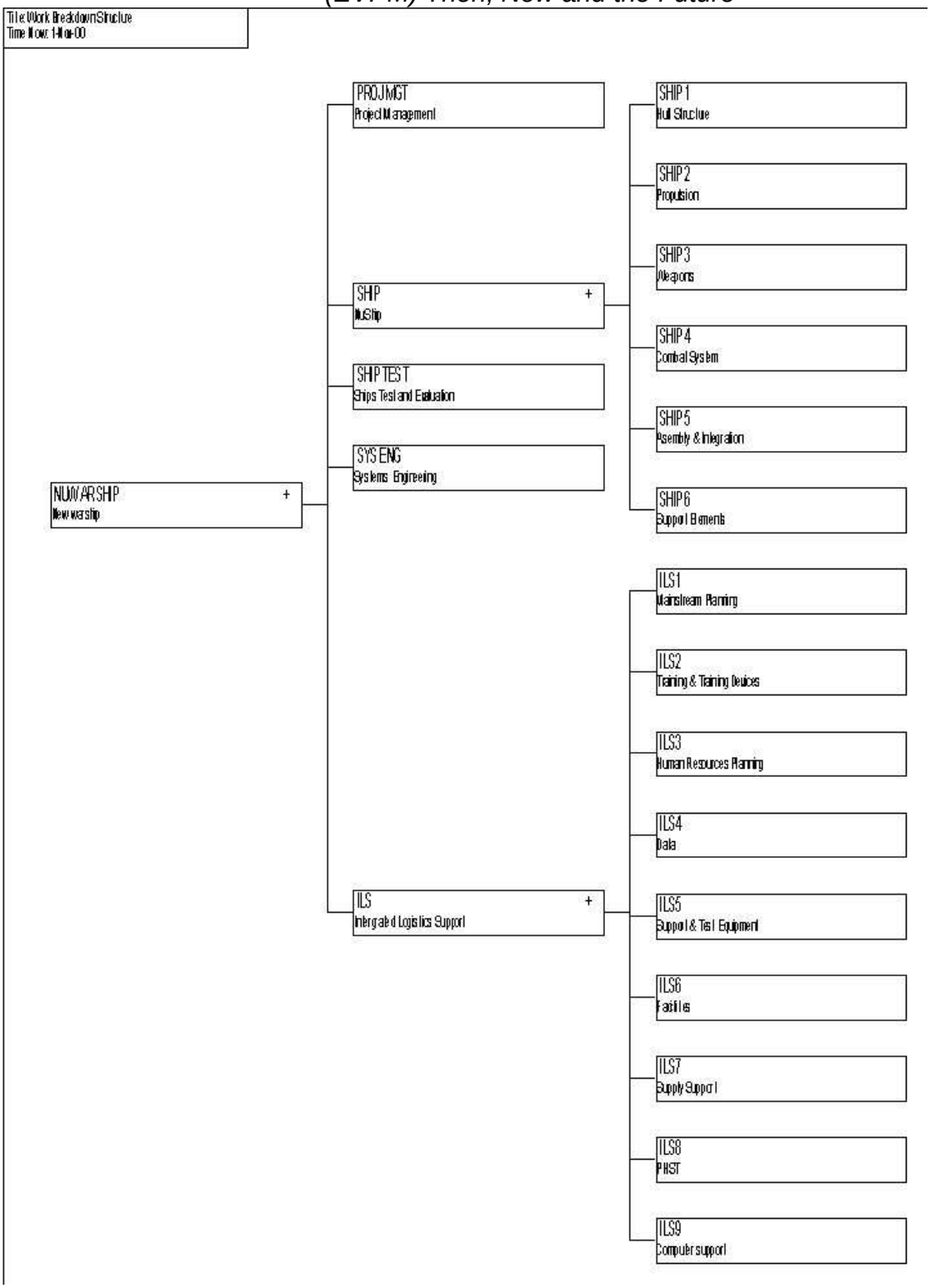

Figure 5: WBS for Typical NuShip Construction

In addition the contractor must furnish information on configuration items, systems engineering, logistics engineering, integrated logistics support, acquisition and finally how the elements will be integrated and assembled. The OBS follows a similar pattern to the WBS but is less standardised due to the wide range of different management structures within various companies. Whilst developing this massive amount of systems information it must not be forgotten that all the elements are subject to the most stringent quality control.

Cost Accounts

From the WBS and OBS, the individual "Cost Accounts" (CA) are derived. Each CA is managed by a "Cost Account Manager" (CAM) and in my view of EVPM the role of the CAM is central to the whole management process. Each Cost Account Manager is responsible for the completion of a major component (or process) of the project within specified quality, cost and time constraints. Naturally as each CAM is responsible for meeting the completion deadlines for his/her section of the project, they are all entitled to control the project planning processes within their CA.

Figure 6 below shows a typical Cost Account Chart. Each Cost Account is at the intersection of a WBS element and an OBS element (person), although it is obvious that each intersection does not of itself constitute a CA. Each CAM may be responsible for one or more CAs and one or more CAs may require completing to make up a full WBS element, the final structure being dictated by the realities of the project.

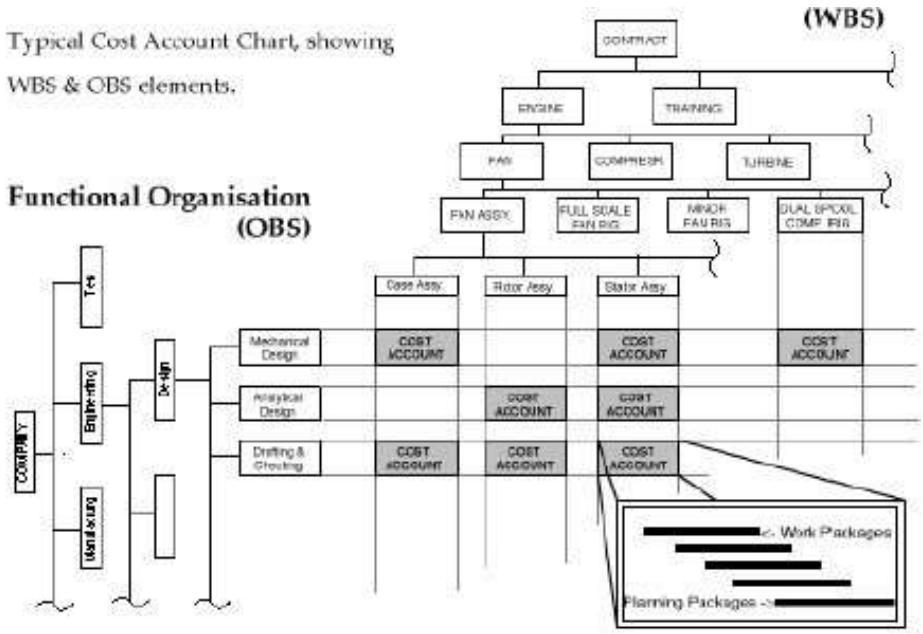

Figure 6 Cost Account Chart

The individual CAs are further divided into a series of "Planning Packages" and "Work Packages". Planning Packages are turned into Work Packages as time progresses and sufficient information is available for a detailed schedule and budget to be established. Ideally Work Packages only extend

6 - 9 months into the future, everything beyond that remaining as a Planning Package. Each Planning Package has a predefined budget, schedule, milestone(s) and scope of works. On development projects, the details of CAs and Planning Packages later in the contract may not be known until after the completion of design work (i.e. other Work Packages or Planning Packages) earlier in the project and may simply be "blocked in" as a general allowance with details being added as they become known.

A significant number of the 35 C/SCSC criteria relate to the management and control of the financial reporting process, change orders, budget variations, contingencies and quality standards, however, these items, remain the responsibility of the CAM. My intention is to examine how the project scheduling systems need to be managed to serve the requirements of the project, the individual CAM and still remain current in a steadily changing environment.

Project Planning Under EVPM

The Planning Challenge

EVPM presents the project manager with a series of interesting and complex problems:-

1) The essence of EVPM is to push management control down to the CAM but the contractor is required to report to the Client, in an effective way, summary information relating to the whole project.

2) Well ahead of the appointment of many of the CAM, there is a requirement to develop the baseline schedule for the whole contract, yet each CAM, if (s)he is to work efficiently must have schedule control over the work involved in completing each work package within their CA.

3) In parallel with these requirements there is an additional need to provide departmental management capabilities so that the competing demands of several CAM from within the same department can be adjudicated. To further complicate this aspect of the planning, each department may have CAM working on several different projects, fighting for resources from the same pool.

4) To be effective, the overall planning process must maintain data integrity up and down the system and needs to minimise the double entry of information. At the same time, simply consolidating data from lower levels in the planning system is not acceptable as any errors at the CA level will be passed straight through to corporate reports and more senior management may wish to demand changes in the current CA plan before accepting the information.

5) The project planning team, as a whole needs to be capable of working for many different masters who will often have different objectives whilst maintaining common standards and methods.

The challenge of the planning system is to meet all of the above requirements without becoming overly complex.

One way to resolving these problems has been to set up a tiered planning structure, as shown in Figure 7.

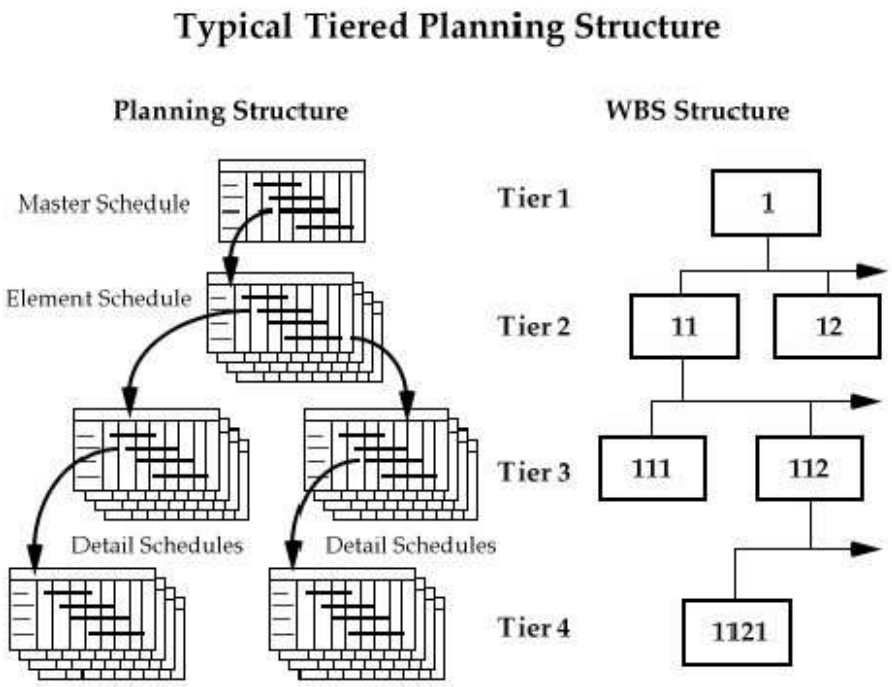

Figure 7. Tiered Planning Structure

However, I advocate a slightly different approach to exploit the facilities offered by the current range Project Management software.

At the top level, the Master Schedule can become a summary produced from within the Programme Element schedule utilising Hammocks, rather than a separate programme. The Programme Element Schedule, however, maintains its traditional role with each activity on the Element Schedule relating to a single Cost Account (or identifiable section of a CA) and is used to map the interaction of schedule changes between different CAs, including external subcontractors. The role up requirements of the WBS system is then largely controlled within the Master Programme as discussed below.

At the CA level a series of small to medium sized project programmes exist, at least one per Cost Account. However, to be effective all of the individual CA programmes need to be dynamically

linked at key points so if the deliverable elements from one CA change, e.g. If documentation is late from one CA, the corresponding training course (requiring the Documents for its students) is delayed within the other (Training) CA. The third element in the matrix is to be able to merge all of the detailed requirements for resources from several different CA programmes into one Departmental Control Programme to ensure the Department has all of the necessary resources to meet all of its obligations. If insufficient resources are available, revised schedule data needs to be passed back from the Departmental schedule to the CA programme and then up to the Programme Element schedule.

Many years ago to achieve all of these requirements was almost impossible and required extensive manual effort. However, the advances in Project Management Software have now made an integrated system not only possible but also a very practical proposition.

The Master Programme

The Master Programme is the start of the process, along with defining the project WBS and OBS. Once the Master Programme, with its Elemental Schedule, Milestones and WBS are complete the Contractor can establish his baseline schedule for the project in terms of both time and cost. This should be based on Adjusted Budget Values (ABV), i.e. the nett value for each element, stripped of management reserves. The programme should contain one task per Cost Account, Work Package or Planning Package, depending on the level of detail available. The Elements are summarised into a series of Hammocks to produce the overall Master Schedule and are connected to a series of Milestones designed to pick up progress information from all of the CA programmes. Figure 8 shows a suggested project structure

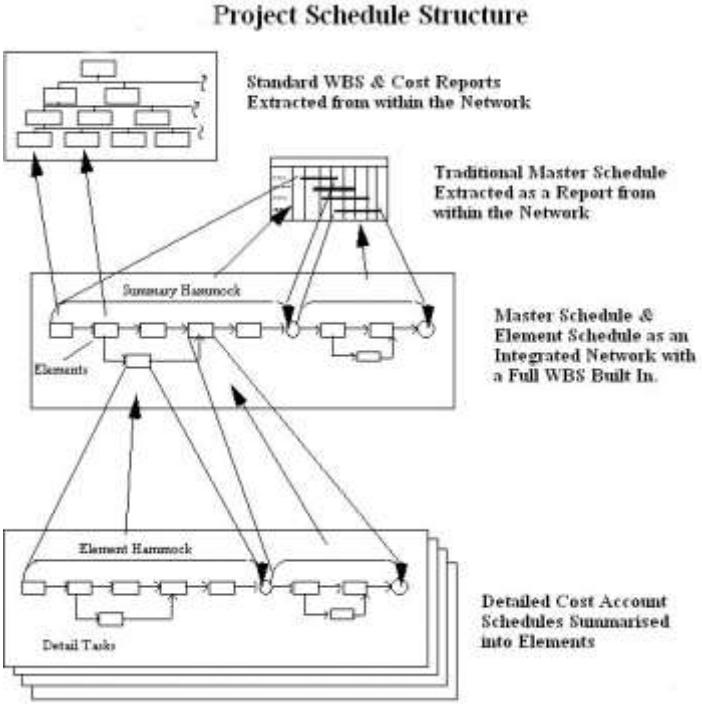

Figure 8. Suggested Project Structure

This programme is the source of most of the Cost and Schedule reporting required from the Contractor. Progress and actual cost data is obtained from the individual CA programmes and should be uploaded electronically, but not automatically. I feel each CAM should be required to certify the accuracy of the data from his or her CA and senior Functional or Departmental management must have the option to require changes and amendments before the data is accepted into the Master Programme. The decision to build the Master Programme (Element Schedule) at the CA or Package level will depend on the available information and the interaction with other CAs. One of the prime functions of the Element Schedule is to map the interactions between the different CAs.

The Cost Account Schedule

These detailed programmes are the driving force of the whole structure. Initially they are developed to meet the requirements of the master programme and once agreed, have their own baseline stored to allow the CAM to manage his section of the works. The programmes should be designed to allow all cost and schedule data to be summarised into blocks identical to the activities in the Elemental Schedule, for transfer to Elements in the Master Programme (Refer Figure 4) for full project update and reporting purposes. Milestones in the CA programme should match Milestones in the Master Programme to allow the two-way transfer of progress information.

The decision between building one detailed schedule per work package or one schedule for the full CA with each Work Package occupying a separate Subproject will largely depend on resource constraints and the size of the CA. If several Work Packages are drawing resources from the same pool, at the same time, or the CA is relatively small, a single schedule is recommended. If the Work Packages are large and relatively independent, separate schedules may be preferable. The decision is largely the responsibility of the CAM provided reporting standards are maintained and the programmes are capable of accurately reporting progress and its effect on Milestones linking to other CAs.

Within the Contractors own organisation, data relating to the expected delivery dates for the various Milestones can be automatically transferred between the various CA programmes, however, the movements in milestones from external subcontractors can probably only be garnered from information provided to the Planning Engineers looking after the Master Programme and downloaded from Master Programme Milestones to the relevant CA Milestones prior to updating the programme.

Departmental Resource Programmes

One noticeable omission from traditional EVPM planning is the Department Level Resource planning. In my experience, this is one of the key constraints on the completion of CA works. A typical Department may have several CAM running their own CAs and they may well be working on completely different projects. The Department Managers role is to allocate his or her scarce resources to the CAs with most important / urgent work to complete. Provided the Department and Company have established overall planning standards, this process is relatively simple but often requires significant data management capabilities. To resource analyse the departments overall requirements and commitments, all of the relevant CA programmes are merged into a single Department Programme and analysed against the available resources. The resource levelled scheduled is then passed back to the various CAMs with information regarding the number of resources allocated to the CAM for the next period. The CAM is then free to rearrange his schedule within the overall resource limits imposed by the Department but cannot exceed these limits. The consequences of the Departmental scheduling are of course passed back up to the Master Programme from the CA Programme. At the same time, consolidating the full resource demands against the Department into a single schedule allows detailed resource planning for the department to be undertaken and decisions on staffing levels, recruitment, etc. to be made based on complete information.

A variation on the process described above is to pass the Elemental data directly to the Master Programme from the Departmental analysis. The method chosen will depend on the relative importance of the Project Team and the Department. In a single project organisation, the path would most probably be: CAM -> Department -> Master Programme. In a multi-project organisation the path would probably be: Department -> CAM -> Master Programme.

The planning strategy outlined above requires the ready transfer of data between various levels of a project and to be successful requires the establishment of a series of Planning Data Standards within an organisation. These standards will be very similar to those required by a Total Quality Management system and should not, therefore, add any particular workload to the project planning staff. Figure 9 outlines Programme levels and the data movements discussed to date.

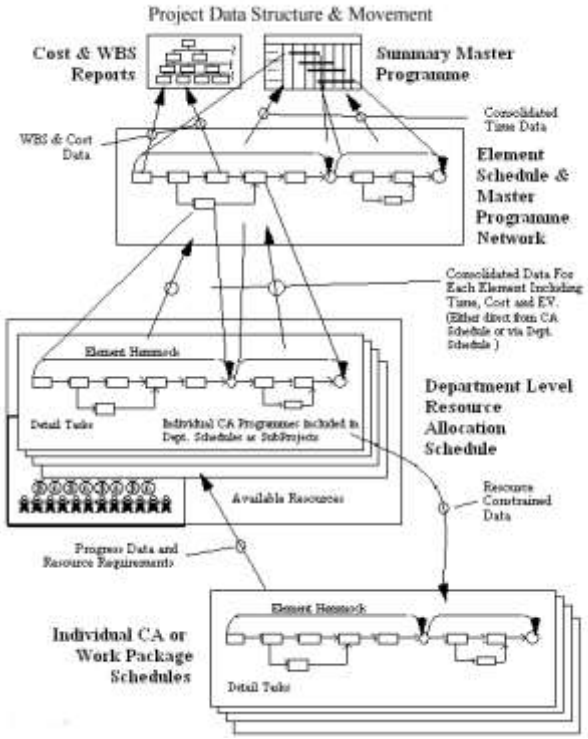

Figure 9. Programme Levels and Data Movement

Some areas of the data need to be identical for the transfers to work, these include: -

- Calendars (including names, structure and holidays / overtime)
- Labels and Code Structures (for reporting)
- WBS Elements within the one project
- OBS Elements within the one project
- Resources (the same resource name needs to mean the same person, team, etc, in all projects.)
- Milestone Identification

Other areas of the data need to be unique to allow the transfers to work, including: -

- Event and Task identifiers always need to be unique
- Resource names (different projects cannot use the same name for different resources)
- WBS Elements between different projects
- OBS Elements between different projects

Other areas may need to be common but can vary depending on the software used to process the information, e.g. If Micro Planner or Open Plan is being used to process the consolidated project data, the "Time Now" or status date for the progress information needs to be identical on all of the data being imported.

Data exchange between the Department and CA level is relatively straight forward, the relevant CA programmes are simply absorbed into a larger version of the whole, complete with all of the relevant details and then down loaded after analysis. No data conversion takes place unless different types of software are used to overcome capacity problems and then all that is required is appropriate Import / Export systems. Moving data between the CA programmes and the master programme is more complex as summary data from each CA programme has to be transformed into detail (or actual) data for import into the Master Programme. This is not particularly difficult using a spreadsheet or database to make the changes on the way across and as suggested above, stopping the data at this point for verification and authorisation can be an advantage. The more difficult problem is the efficient transfer of Milestone data between different CA projects, e.g to transfer the date the design is finished (from the design CA) to the manufacturing CA. Typically these may be separate projects on different computers under the control of different CAM.

Progress Control - Time

EVPM assumes a dynamic planning and cost control process. As earlier CAs are completed, the information becomes available to detail the processes required to complete later CAs. The essence of EVPM time management falls into two parts; the first is to attempt to plan the work required for each Work Package so as to allow a local time buffer (or float) to take account of progress problems within the single CA.

If this is not possible, the Project Manager may authorise the release of some of the Projects time contingency (float) or decide to accept the negative cost variance involved in using additional resources and release appropriate management reserves. Generally a negative programme variance that impacts on the overall project baseline will not be accepted unless a full project rebaseline is authorised.

Once the CA Programme is agreed and has its baseline locked in, the management cycle set out in Figure 7 comes into play. The results of each status processed being passed on to the Master programme and the Departmental Programme. This process is the same as that used in any project that is being effectively managed and does not require much further comment other than to refer to the linkage between progress on the critical path measured by time based reporting and the quantity of work being completed that is discussed below.

The Analysis Process

Many if not most of the CA plans will change quite regularly and attempting to understand what the current position is within one CA or over the whole project vis a vis the original plan is quite difficult. Milestone and time based progress reporting of the Current Status -v- the Original Plan only gives a part of the picture, I previously mentioned that EVPM gives the rest. Re-iterating my previous statements, EVPM is a simple but effective way of understanding how a project is currently performing against the original plan in terms of the value of work completed and is at the heart of the methodology. The original plan (both time and costs) is stored as the BASELINE SCHEDULE containing the original (ABV) cost plan as its BUDGET. As time progresses, tasks are being completed and the budget is being expended in the form of outlays that may or may not be in line with the original intentions and require controlling.

Unfortunately, there are many variations in the way different software packages approach resource and cost management, to avoid confusion; I will discuss the way Micro Planner X-Pert operates which is reasonably consistent with EVPM requirements. Micro Planner X-Pert calculates the Baseline costs by defining for each task its' resource requirements and multiplying that requirement by the appropriate rate for the resource against time (cash outlays can be added to an activity as a "Total Cost").

From this information the Resource Analysis segment of the program whilst allocating the resources calculates the cost of each activity against time. The program then is able to produce a cash flow curve showing how and when the costs will be expended. Once the original plan is agreed, this is stored in the Master Archive to become the Baseline Schedule and Original Budget against which future progress can be measured.

Through the effluxion of time and effort, activities will progress and expenses will occur. This is reflected within Micro Planner by the process of reporting progress. Time Now is moved forward to show the passage of time and each activity that has incurred progress and actual costs is updated. The program is run once more and the actual costs and progress are plotted on the cash flow curve against the original expectations.

Figure 2, clearly shows that the actual expenditure on this project is falling behind the planned expenditure. The problem the project manager is faced with is, 'what does this mean'? It could be that in the current economic climate cheaper and more efficient ways of working have been found. If this trend is continued then the project team will come home on time and under budget! It could be due to the fact that the program is behind schedule because of inclement weather or strikes etc. This would then trend out showing the project finishing well behind programme. All that the cost curve shows is that the project is not running to schedule in terms of the money expended. Whether the project is better or worse off is not apparent and this comparison gives no useful information in regard to the project's real status.

Consider for a moment a project that is in trouble and too much has been spent to achieve the little work that has been Completed. The actual costs (money spent) may appear to be on or close to target but the real situation is very different, more information is required! Cost monitoring on its own cannot provide the answer, cost reporting is normally carried out in a historical way, which in normal accounting circles in some contractors requires 4 to 6 weeks to process. Given this lag of 4 - 6 weeks for accurate cost information, it becomes very difficult for management to know where the project is and without management being able to effectively monitor the situation there cannot be control.

Micro Planner's 'Short Term Progress Bar chart' and / or its 'Progress Report' can help. These reports are designed to compare actual progress against planned work using time and dates as the basis. This may help to pinpoint the areas where the project is slipping and allow corrective action to be taken but if the works on the critical path are largely holding programme, identifying the problem areas in a large network may still not be easy as neither time reporting nor the cash spent to date are a measure of the VALUE of work achieved. Even if the problem has been identified, effective control is still required to carry out the corrective actions.

EVPM is as I have already stated is a methodology that allows the project manager to compare the value of real work done with the value of work that was supposed to be done. The use of BCWS and BCWP as well as ACWP provides a most valuable story of how the project is performing.

It must be remembered that indirect costs should also be considered when using EVPM, with Micro Planer this is a simple matter of including a Hammock activity and placing the various indirect cost types on it. One of the key decisions in setting up a EVPM system is to decide where and how each of these overhead costs are to be accounted, either in the Master Programme or in the CA Programmes.

The key to successful EVPM is deciding on the extent of progress achieved to the status date. Completed activities, and activities that have not yet started are easy to measure, values for partially completed activities are, however, a little more difficult. If part of the steel hull has been welded how much have we earned?

The Federal Government has for many years in its tenders stated that activities should be specified with durations no longer than 10 working days! Unfortunately many planners tend to create long duration activities and measuring progress value on these is more complex and less accurate than on short activities. However, EVPM has been designed to cope with this, even though most activities will be measured on completion, it is possible to specify Earned Value on partially completed tasks. As a hangover from the days of manual calculations of the Earned Value, one of three different ratios can be used to bring the EV to account, 0/100, 50/50 or 100/0. 0/100 method says no Earned Value is achieved until the task is complete, 50/50 method says 50% of the value is earned as soon as the task has started, with the balance not being taken to account until the task is complete. 100/0 method allows 100% of the earned value to be taken to account as soon as the task is started.

Another option (a variation on the 0/100 method) is to identify a series of "Payment Milestones", the EV only being available to the Contractor after the Milestone is achieved. The key factor is to be consistent in the method adopted so that the Baseline Budget and Earned Value are calculated in the same way.

From this relatively simple start the complications set in, the full EVPM system requires Contractors to account for Change Orders, Budget and Time Contingencies and adjustments, Trends, Inflation, Accruals, Variance and many other factors. As well as calculating the situation at "Time Now", the consequences of progress to date need to be projected on to the completion of the project. A similar set of ratios and values to the ones at "Time Now" are used including; Budget At Completion (BAC), Recoverable Budget Ceiling, Estimate To Complete (ETC), Estimate At Completion (EAC), and Variance At Completion (VAC). Figure 10 show a project with most of these factors taken into account, full definitions of the terms used are included in the Glossary attached to this paper.

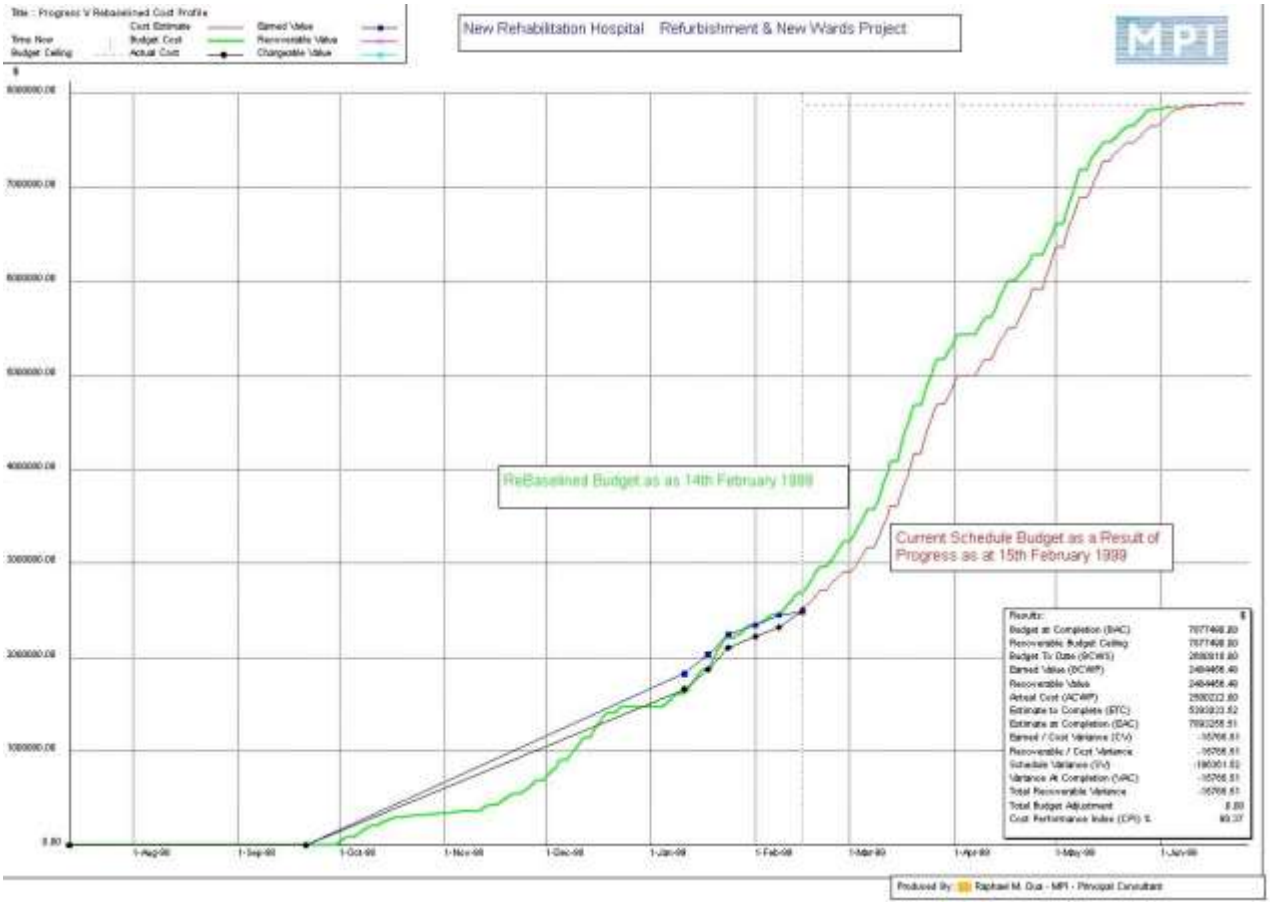

Figure 10: Rebaselined EVPM Curves and Ratios

EVPM the Future

Currently there is a major thrust by some members of the project management community to bring EVPM to a wider audience. In order for this move to succeed the criteria currently defined within the Def (AUST)s need to be reviewed and brought into the non-defence arena. This is being achieved by the writing of a new standard by Standards Australia, which has formed committee OB14 Earned value

Conclusion

I have only looked at a simple view of the full EVPM (C/SCSC), if you are interested in the total picture then copies of the Def (AUST) are available form the DMO site. In the areas I have covered, such as the actual Earned Value Analysis, the full reporting requirements of EVPM have not been detailed (ref. Def (AUST) 5658 – Cost Schedule Status Reporting (CSSR) Specification and Implementation Guide).

However, EVPM (Cost/Schedule Control Systems Criteria) is now an essential project management tool for the Department of Defence and its projects and cannot be ignored in the general Project Management community. Already many non-defence projects, have however, benefited from using some of the EVPM methods, particularly Earned Value Analysis without submitting to the full rigors of C/SCSC certification.

The basic philosophies of breaking a project into manageable chunks, setting cost, quality and performance targets for managers and monitoring progress at the Cost Account level are all effective techniques.

C/SCSC is as the original name suggests, Criteria for measuring management performance. The criteria can be achieved in different ways and (unless you are seeking certification) may be implemented in stages. In many situations even a few of the criteria, if implemented correctly, will be of significant benefit to your projects.

Appendix 1 the C/SCSC Criteria

The criteria are divided up into five main areas these are shown as follows:

Organization

a. Define the authorized work elements for the program. A work breakdown structure (WBS), tailored for effective internal management control, is commonly used in this process.
b. Identify the program organizational structure including the major subcontractors responsible for accomplishing the authorized work, and define the organizational elements in which work will be planned and controlled.
c. Provide for the integration of the company's planning, scheduling, budgeting, work authorization and cost accumulation processes with each other, and as appropriate, the program work breakdown structure and the program organizational structure.
d. Identify the company organization or function responsible for controlling overhead (indirect costs).
e. Provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.

Planning, Scheduling, And Budgeting

a. Schedule the authorized work in a manner, which describes the sequence of work and identifies significant task interdependencies required meeting the requirements of the program.
b. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress.
c. Establish and maintain a time-phased budget baseline, at the control account level, against which program performance can be measured. Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefined work. Budget for far-term efforts may be held in higher-level accounts until an appropriate time for allocation at the control account level. On government contracts, if an over target baseline is used for performance measurement reporting purposes; prior notification must be provided to the customer.
d. Establish budgets for authorized work with identification of significant cost elements (labour, material, etc.) as needed for internal management and for control of subcontractors.
e. To the extent it is practical to identify the authorized work in discrete work

packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire control account is not subdivided into work packages, identify the far term effort in larger planning packages for budget and scheduling purposes.
f. Provide that the sum of all work package budgets plus planning package budgets within a control account equals the control account budget.
g. Identify and control level of effort activity by time-phased budgets established for this purpose. Only that effort which is unmeasurable or for which measurement is impractical may be classified as level of effort.
h. Establish overhead budgets for each significant organizational component of the company for expenses, which will become indirect costs. Reflect in the program budgets, at the appropriate level, the amounts in overhead pools that are planned to be allocated to the program as indirect costs.
i. Identify management reserves and undistributed budget.
j. Provide that the program target cost goal is reconciled with the sum of all internal program budgets and management reserves.

Accounting Considerations

a. Record direct costs in a manner consistent with the budgets in a formal system controlled by the general books of account.
b. When a work breakdown structure is used, summarize direct costs from control accounts into the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements.
c. Summarize direct costs from the control accounts into the contractor's organizational elements without allocation of a single control account to two or more organizational elements.
d. Record all indirect costs, which will be allocated to the contract.
e. Identify unit costs, equivalent unit costs, or lot costs when needed.
f. For EVPM, the material accounting system will provide for:

(1) Accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the budgets using recognized, acceptable, costing techniques.
(2) Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of progress payments or actual receipt of material.
(3) Full accountability of all material purchased for the program including the residual inventory.

a. At least on a monthly basis, generate the following information at the control account and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system:

(1) Comparison of the amount of planned budget and the amount of budget earned for work accomplished. This comparison provides the schedule variance.
(2) Comparison of the amount of the budget earned and the actual (applied where appropriate) direct costs for the same work. This comparison provides the cost variance.

b. Identify, at least monthly, the significant differences between both planned and actual schedule performance and planned and actual cost performance, and provide the reasons for the variances in the detail needed by program management.
c. Identify budgeted and applied (or actual) indirect costs at the level and frequency needed by management for effective control, along with the reasons for any significant variances.
d. Summarize the data elements and associated variances through the program organization and/or work breakdown structure to support management needs and any customer reporting specified in the contract.
e. Implement managerial actions taken as the result of earned value information.
f. Develop revised estimates of cost at completion based on performance to date, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify variances at completion important to company management and any applicable customer reporting requirements including statements of funding requirements.

Revisions And Data Maintenance

a. Incorporate authorized changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revisions on the amount estimated and budgeted to the program organizations.
b. Reconcile current budgets to prior budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.
c. Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data.
d. Prevent revisions to the program budget except for authorized changes.
e. Document changes to the performance measurement baseline.

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11. Risk Analysis for Large Projects, Models, Methods & Cases, Dale Cooper & Chris Chapman, John Wiley & Sons, 1987.
12 Def (AUST) 5655 – Australian Cost Schedule Control Systems Criteria
13 Def (AUST) 5657 – Australian Cost Schedule Control Systems Criteria; Implementation Guide (ACSIG)
14 Def (AUST) 5658 – Cost Schedule Status Reporting (CSSR) Specification and Implementation Guide
15 Def (AUST) 5664 – Work Breakdown Structures for Defence Materiel projects – Policy and Guidance
16 Australian Standard 4817-2003 Project performance measurement using Earned Value
17 Sarbanes-Oxley Act June 2002
18 Corporate Law Economic Reform Program 9

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Notes :-

1) For access to the US DoD and 'Mil' References, write to or contact

The Superintendent of Documents,
U.S. Government Printing Office,
Washington, D.C.,
U.S.A. 20402.

2) For access to the Def(AUST)s go to the following URL's,

http://www.dao.defence.gov.au/IPI/AMS/EVM/pol_docs/5655.htm

http://www.dao.defence.gov.au/IPI/AMS/EVM/pol_docs/5657/5657.htm

http://www.dao.defence.gov.au/IPI/AMS/EVM/pol_docs/5658.htm

http://www.dao.defence.gov.au/IPI/AMS/EVM/pol_docs/5664.htm

3) The author recognises all registered trade and business names referred to in this paper.