Advanced project management

Overview

This session will look at competing methods in the management of time, cost, scope and quality on projects. The two methods assessed are theory of constraints and earned value. Understanding which method is appropriate when and using the method effectively can significantly improve the outcome of any project in any of the four dimensions described; time, cost, scope and quality. Improve any of these and you will obviously improve the benefits of the project and thereby the investment return to the organisation.

Learning outcomes

The learning outcomes of the session are:

1. Explain the concept of theory of constraints (ToC)
2. Describe the benefits of implementing ToC
3. List the key indicators that are found in ToC
4. Explain the concept of earned value
5. Describe the benefits of implementing earned value
6. Calculate the cost performance and schedule performance indicators of a project

Theory of constraints

Theory of constraints is an overall philosophy for managing organisations as systems. It can be applied to specific practical situations and has been done so with regards to time management on projects. Theory of constraints was developed by Eliyahu M. Goldratt. The underpinning principle to all of its applications is that a series of activities is constrained by its bottlenecks and only by isolating and resolving the bottlenecks can efficiency be achieved.

In relation to project management, theory of constraints extends the concept of critical path management to include the facts of life problem of limited resources. It does this through a practice known as critical chain project management.

The main features that distinguish the critical chain from the critical path are:

1. The use of resource dependencies. This does not necessarily mean that they are included in the project network but have to be identified by looking at the resource requirements and the over allocation.
2. Lack of search for an optimum solution. This means that a "good enough" solution is enough because:
    a. As far as is known, there is no analytical method of finding an absolute optimum (i.e. having the overall shortest critical chain).
    b. The inherent uncertainty in estimates is much greater than the difference between the optimum and near-optimum ("good enough" solutions).
3. The identification and insertion of buffers:
    a. project buffer
    b. feeding buffers
    c. resource buffers.

Activity – Estimating methods for task duration

What estimating methods do you use to estimate the task duration on projects you are working on? Confer with the people around you to see the variation in methods used.

Estimating Methods

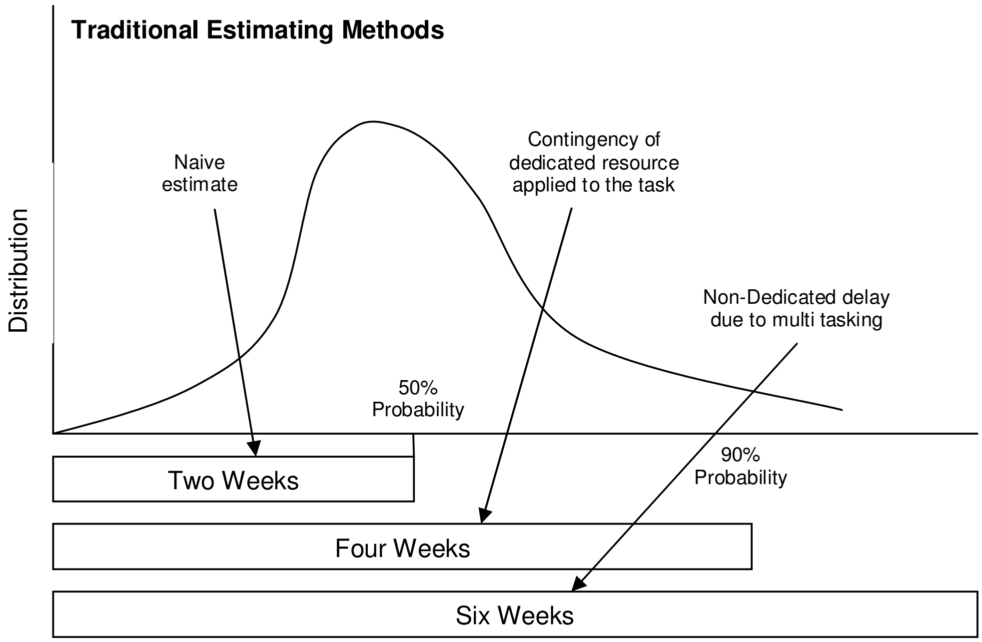
Traditional project management estimating methods like Earned Value, PERT and Monte Carlo utilise a probability distribution of task durations. Each task is given a duration that contains a contingency for the unknown. Critical Chain Project Management incorporates this contingency into a project buffer. The task duration remains the base case estimation with the end date of the project pushed out by the project buffer.

The difference in these methods can be demonstrated through the following case study:

Case Study – Traditional versus CCPM estimating methods

A task has a 50/50 chance of finishing in 2 weeks. People new to estimating will use this duration as there base case estimate for the task. PERT and Monte Carlo will use the range of probabilities to come up with a best case and worst case scenario. Contingent team members who are assigned the task in a dedicated fashion will allow for a 90% confidence interval. In this instance, the 90% confidence interval is 4 weeks. However, if the team member is not allocated as a dedicated resource to the task, they will put in contingencies for multi-tasking, queue time and ahead/behind schedule delays. In this instance the task may blow out to 6 weeks.

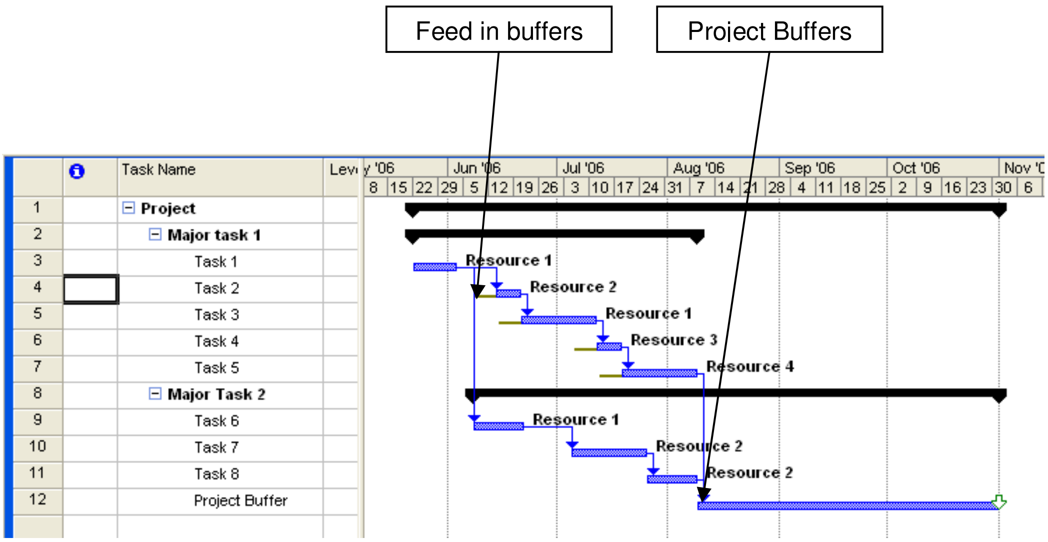
Critical Chain will estimate the task to take 2 weeks and will put 2 weeks into the project buffer. This means that the person assigned the task knows that they need to finish in two weeks but the project has a contingency of two weeks for the 90% confident interval of 4 weeks duration.



Using Buffers

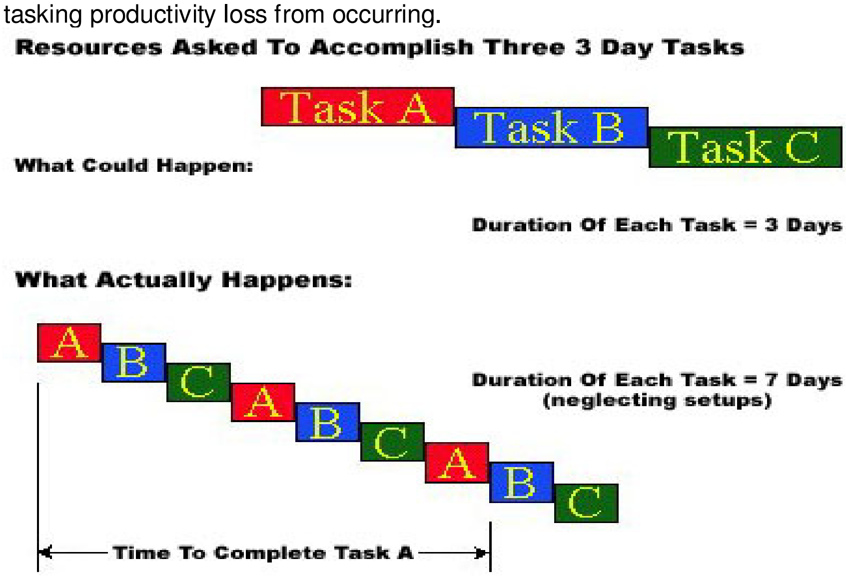
A project buffer is placed before the project due date to protect the commitment to the stakeholders. Feeding buffers are placed on each non-critical activity to protect against precedence conflicts of non-critical tasks. This is in essence an "as late as possible" constraint on the task. Resource buffers are placed on tasks where a resource is overallocated. This is achieved through levelling lag. A task is delayed due to the inability for the existing resources to work on all the tasks scheduled in the way they dropped out through the network diagram.

CCPM Gantt Chart representation



Prevention of student syndrome and multitasking

Properly implemented critical chain project management will eliminate multi-tasking as resources are levelled and are only working on the critical activities. Activities that are not critical are delayed until they become critical. This is in contrast to traditional scheduling methods that allow for an as soon as possible constraint on tasks. As the plan is levelled, resources are rarely if ever scheduled to do more than one task at a time preventing the multi-tasking productivity loss from occurring.



Source: **David V Hodes The TOC Centre of Australia**

With all activities, in essence, being completed only when they are critical, student syndrome is avoided. Student syndrome is a theory that states that two thirds of work is completed in the last third of the task duration as the task deadline approaches. This eliminates any of the contingency that has been placed into the schedule for that task.

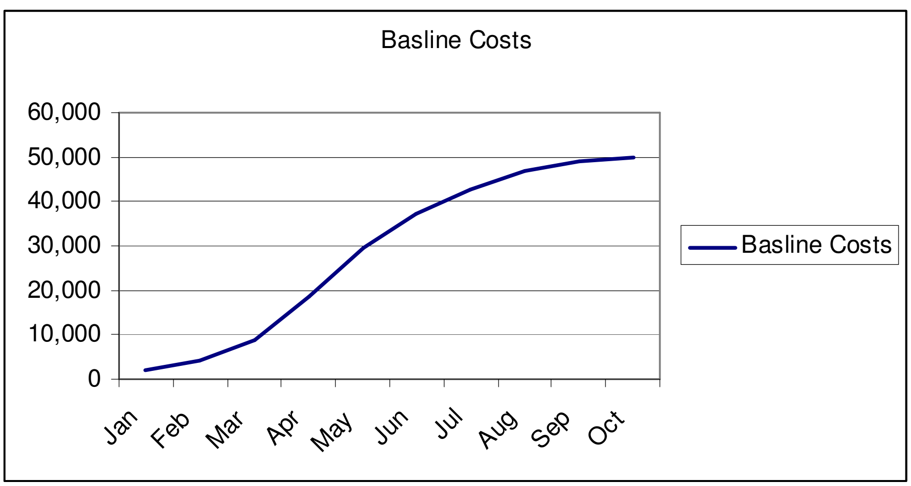
CCPM Summary

Recognition of uncertainty and its associated risk are at the core of the initial stages of developing Critical Chain schedules. The emphasis on dependencies in the usual approach to developing a project network for a Critical Chain schedule helps to avoid risks of missing interactions of different parts of the project. The use of 2-point estimates to assess and address the early view of schedule risk associated with task uncertainty sets the tone up front for the appreciation of risk in the real world. In addition to task uncertainty, iteration uncertainty (a topic not written of much to date in the Critical Chain literature) can also be taken into account in the sizing of Feeding and Project Buffers. These resulting buffers themselves become a highly visible and direct assessment of the schedule risk associated with the project as a whole.

Critical Chain-based project management is more than just Critical Chain Scheduling and Buffer Management. The genesis of Critical Chain in the Theory of Constraints (TOC) has yielded a holistic view of project management that provides effective risk-focused approaches not only to scheduling and control, but also to initial scoping and planning, effective resource behaviors, and minimizing cross-project impacts. These key aspects of the methodology have a range of implications for the support of basic risk management processes and outcomes, including identification and assessment of risks, response development -- bit it avoidance, mitigation, or acceptance, and guidance for response control (Pritchard, 1997).

Earned Value Method

Earned value is a method used to determine performance on a project that is in implementation. Once a project has been baselined and signed off by the higher project authority (e.g. the Project Board or Steering Committee), it provides for a benchmark to measure the performance of the project in execution. Typically, a curve of project expenditure can be charted for the baseline and it will look like the chart below:



Once the baseline is set, a project manager can utilise Earned Value to:

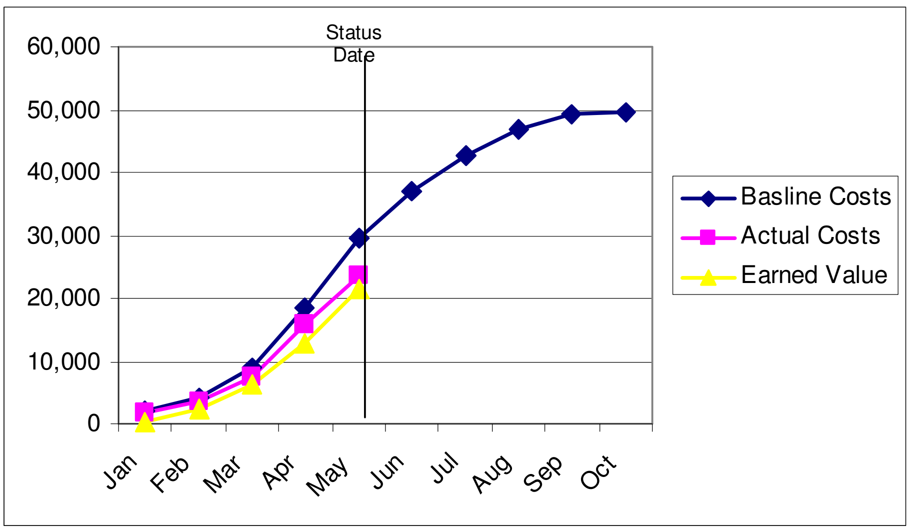
- Measure performance and status
- Forecast future completion dates and costs
- Compare performance of one project versus the performance of another project across the business (remember, this is only performance against time and cost, not against scope and benefits)

This is done by utilising statistics to measure performance and predict the future. It is obviously easy to see variances of costs versus baseline, but what is difficult is determining the causal factors of the variance. Another difficulty is determining the value or performance that has been generated from the money spent. Earned value statistics assist the project manager in determining the above causal factors and value or performance. The statistics used in earned value are based on a progression of formula's (i.e. the calculation of one statistic is then used as the basis for the calculation of another). A summary of the statistics, in progressive order of their calculation, is outlined below:

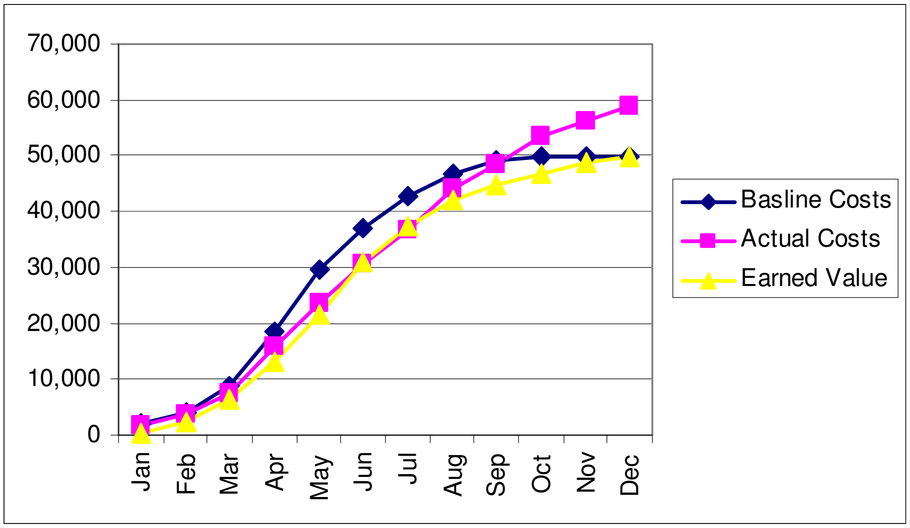
Statistic	How calculated	Description
Actual Cost (ACWP)	**Actual work completed** x **actual resource rate** + any material **invoices accrued** for and **paid**	This is the costs actually incurred as at the reporting date. This statistic is referred to in Earned Value terms as the Actual Cost of Work Performed or ACWP
Budgeted cost of work performed (BCWP)	**Actual Work Completed** x **Budget resource rate** + Actual Material used at budget rate	This statistic is known as the Earned Value. As it mixes actual completion with budgeted cost, it represents the amount earned for the money that has been spent.
Budgeted Cost of Work Scheduled (BCWS)	Baselined work due to be completed by the status date x Budget Resource rate + Baselined material to have been used by status date at Budget rate	This is the scheduled cost of work to date and would represents that amount of money that was expected to have been spent by the status date.
Cost Variance (CV)	Budget cost of work performed - Actual Cost	This shows how the project is tracking on a cost basis. By comparing how much has been spent to complete the tasks at status date versus how much should have been spent. Most people will compare actual costs against the budget cost of work scheduled as this represents how much was planned to be spent as at status date. This is incorrect as it disregards how much work was meant to be completed versus how much actually has. E.g. A project has spent $100k at status date but the baseline was for $110k. It looks like a favourable variance, however, if the project was meant to be 50% complete and is only 40% then it is unclear whether the 10k variance represents more or less than the costs required to do the 10% that has not been completed yet.
Scheduled Variance (SV)	Budget cost of work performed – budget cost of work scheduled	This variance shows how far behind in $ terms the project is. (i.e. a project has earned $50k at status date – this is the budget cost of work performed or the earned value of the project. It should have spent $70k as at status date hence it is $20k behind schedule.

Cost Performance Index (CPI)	Budget cost of work performed / actual cost	Demonstrates how well the project is performing on a cost basis. This performance measure forms the basis for forecasting the estimated cost at completion. A number > 1 represents a project that is below budget and < 1 is a project that is over budget
Schedule Performance Index (SPI)	Budget cost of work performed / Budget cost of work scheduled	Demonstrates how well the project is performing on a schedule basis. This index is used for estimating the completion date. A number > 1 represents a project that is performing better than baseline, < 1 is a project that is performing worse than baseline
Budget at completion (BAC)	Total Budget for the project	Set when the project is originally baselined
Estimate at completion (EAC)	The current total forecast cost for the project	Set by using the Cost performance index the actual costs, budget cost of work performed and the budget at completion. E.g. EAC = ACWP + (BAC-BCWP)/(CPI x SPI)

At status date, there will be 3 lines on our time chart, an example of this could be as per below:



Utilising the estimate to complete re-forecast, the project manager can objectively extrapolate out the actual cost and earned value lines to the completion date, as per below: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Sep
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Nov
Dec
Basline Costs
Actual Costs
Earned Value

Case Study - **Earned Value linear relationship and progress reporting**

It is the 1st October and you are 3 months into the Vacuum Cleaner Project. Total time for the project is baselined at 9 months, and the launch date is at 8 months. Statistics taken from your Gantt chart are summarised below:

Total tasks for the project – Baselined	500
Total tasks for the project – Forecast	500
Actual Costs to date	$12m
Scheduled Costs to date	$14m
Baseline Tasks Completed by status date	220
Actual Tasks Completed by status date	200
Critical Path Tasks Baselined	200
Critical Path Tasks Baselined to be Completed	110
Critical Path Tasks Actually Completed	100
Capex	40% of budget
Opex	60% of budget

Activity – Fill in the progress report based on the case study data

Assuming a linear relationship between task percentage complete and cost, calculate the following Earned Value statistics

BCWS
BCWP
ACWP
CPI
SPI
EAC using the example formula in the manual.