MANAGING WORK & COSTS

Lecture 1 – Project Implementation

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1 Chapter Introduction

While managing work and costs, the project manager's focus at all times should be directed towards the objectives of the project and on how the work is progressing to those objectives. The Project Manager should be aware of the dangers of managing for the sake of fully utilizing resources (keeping people busy!) or managing in order to "tick the boxes" (doing the paperwork!) The principles outlined in this chapter will help a project manager to fulfill one of his/her basic responsibilities - Monitoring & Controlling the work of the project. We will introduce some practical aspects of setting up a project which will allow us to track its progress to completion.

2 Principles of Monitoring and Control

Once work has started the Project Manager can move more fully into a "monitor and control" mode. Let's start with some definitions from the PMBOK:

Monitor: Collect project performance data with respect to the plan, produce performance measures and report and disseminate performance information.

Control: Compare actual performance with planned performance, analyse variances, assessing trends to effect process improvements, evaluate possible alternatives, and recommend appropriate corrective action as needed.

Therefore monitoring is concerned with the collection and distribution of data while controlling involves detecting variation and a making a decision in response to the variation. (Note: This decision may be to do nothing!)

2.1 Some Practicalities of Monitoring and Control

Before a PM enters into the monitor & control cycle above she needs to determine:

a) What parameter of the projects to measure
b) Which metric is appropriate for each parameter
c) How (and when) to collect the information

Given that the project manager is responsible for all that happens on the project, the scope of control could be extensive. Here is a representative list of possible monitor & control points:

In practice monitoring of progress is largely measured using parameters similar to those below:

Parameter	Possible Measures
Achievement	Milestones passed, Work packages completed
Money	Labour costs, fixed costs, capital costs
Effort	Person hours expended
Deliverables	Lines of code tested, houses built etc.

Having decided the appropriate parameters the PM must ensure that monitoring and reporting processes and systems will deliver the required information in a timely manner. On larger projects project management software will be used to support this requirement.

2.2 Project Authorisation

Before committing time or resources to a project a project must be satisfied that the initiation of the project has been approved at the appropriate level. The form of authorisation can vary depending on the nature of the project engagement (internal or external) and on the profile of the project. Authorisation acts as a blocker to inappropriate project progress without proper sign off. This prevents money being wasted needlessly on projects.

Reasons for project authorisation include to:

- Control the use of capital expenditure in the best interests of shareholders and other stakeholders;
- Announce that approval has been given for the project to start;
- Communicate details of the project nature and scope throughout the organization;
- Announce the project's name and number as it will appear in all accounts and reports;
- Announce key project milestones and financial targets;
- Announce the name of the project manager and confirm his or her authority to manage
  the project;
- Define any restrictions or limits on expenditure, in cases of provisional authorizations.

Authorisation usually triggers a chain reaction and gets others formally engaged in the project - contractors, subcontractors, suppliers, consultants etc. 3rd parties engaged in a project may instigated their own authorization procedures – orders, contracts etc.

2.3 Project Authorisation – contractor's viewpoint

Project authorization - means that the contractor has been instructed by the owner, customer or client to proceed with the project on terms – can be a contract, a purchase order or (less desirably) a letter of intent.

Can be issued as a 'project authorisation' or perhaps 'works order'. This document carries essential data that define the levels of expenditure authorized (the departmental and purchasing cost budgets), planned start and finish dates, details of the customer's order, pricing information, invoicing and delivery instructions and so on.

One vital item on a project authorization is the signature of a member of the contractor's senior management. That is the signal that the project is properly authorized, that work can begin and that costs can be incurred or committed.

3 Managing from the Start – Initiating the Project

Start as you mean to proceed!

The project must be established correctly in order for a Project Manager (PM) to be able to monitor & control effectively. In particular, the project manager must make sure that:

- **The project is authorised appropriately**
- **The project is described and understood to a sufficient level of detail**
- **The project is registered and linked to necessary systems**
- **The project starts!**

Let's look at these in some more detail:

3.1 The project is described

The project manager must secure the clearest possible authorised description of the project. This description is important as it will become the reference point for all future elaboration and expansion (or reduction) of the project. It will act as a **baseline** against which to measure the progress of the project.

There are many documents types which can be used to describe projects:

- Statement of Work (SOW)
- Contract
- Project Charter
- Scope Statement

- Work Breakdown Structure
- Project Specification/Project Plan
- Technical Specifications
- Pro Forma checklists

For engagements involving external contractors, SOW's and contracts will prevail. Charters and Projects Specifications are more likely to be used on "internal" projects. At a minimum the project charter should include:

- Identification of the project manager and his/her authority to apply resources to the project
- The business purpose that the project was undertaken to address, including assumptions and constraints
- Summary of the conditions defining the project
- Objectives and constraints
- Project scope (inclusions and exclusions)
- Key stakeholders and their roles
- Risks Involvement by certain stakeholders

3.2 Authorisation Documents issued by the project owner:

Can depend on size and impact of the project

3.3 Charter and contract

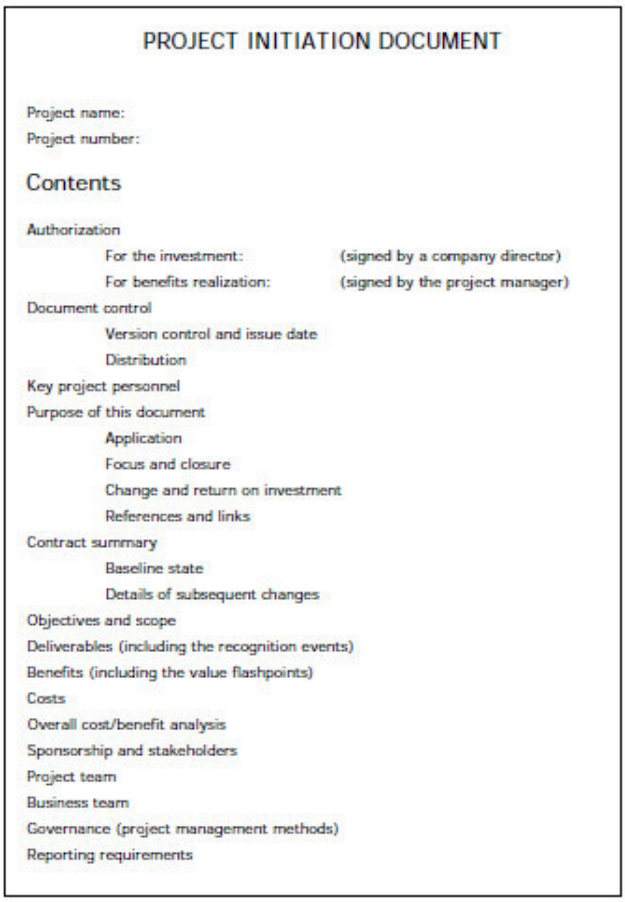
Charter – sets out objectives – prepared for approval by senior managers. The business plan is reflected item by item. Chartered then gets translated and described in a c contract.

Contract - working document that establishes the project in the organization under the nominated project manager. The contract is internal, between the project manager and the board of directors.

Somewhat cumbersome, expensive to administer and can delay the start of work unnecessarily for many months.

3.4 Project Initiation Document (PID)

Alternative to the contract / charter - Can fulfill the dual role of charter and contract



PROJECT INITIATION DOCUMENT

Project name:
Project number:

Contents

Authorization
For the investment: (signed by a company director)
For benefits realization: (signed by the project manager)
Document control
Version control and issue date
Distribution
Key project personnel
Purpose of this document
Application
Focus and closure
Change and return on investment
References and links
Contract summary
Baseline state
Details of subsequent changes
Objectives and scope
Deliverables (including the recognition events)
Benefits (including the value flashpoints)
Costs
Overall cost/benefit analysis
Sponsorship and stakeholders
Project team
Business team
Governance (project management methods)
Reporting requirements

3.5 Internal Memorandum

Used sometimes on small projects – issued by senior managers to the department / project manager responsible. Binds the project owner and the departmental / project manager. It is important that the project is authorised by signature of the senior manager who sponsors the project, irrespective of the physical form of authorisation document used.

3.6 Project Registration and Numbering

Formal 'entering into system' of the project – for accounting, planning, progressing and other admin procedures can now be put in place.

ID Number to project – used in drawings, documents and other project documentation. Project authorisation used to track staff costs / time sheets etc.

Typical items of information included o the Project register include:

- Project title
- Start date and (eventually) closure date
- Project manager responsible
- Project number
- The customer
- The customer's order number or letter reference.

3.7 The project is registered and linked to systems

The project needs to be linked to the ongoing work of the organisation and project information needs to be made available to people within and outside the project team. Customers of this

information include the project manager & team, portfolio & Programme managers, accounting, purchasing, IT, contractors etc.

The first step in this process is to register the project according the practice of the organization. Registration on a log or a database will usually assign a unique reference number to the project. Other information required could be:

- Project name
- Project brief summary
- Project manager name
- Sponsoring manager
- Budget reference
- Date initiated
- Due end date

Additional Information is required if it is an external contract:

- Customer name
- Customer reference

PROJECT REGISTER				Date of last revision		
Project number	*Project title*	*Project manager*	*Customer*	*Date opened*	*Comments Special restrictions*	*Date closed*

3.8 The project is started

A key success factor in all projects is the presence of a motivated team with a strong sense of purpose and a clear understanding of individual roles and responsibility. Bearing in mind the old proverb “A good start is half the battle” the project manager will aim to build such a team from the earliest possible opportunity. A project kick- off (or handover) meeting is frequently used for this purpose.

This meeting should be convened by a senior manager and attended by:

- The Project Manager
- The sponsoring Senior Manager or Client
- The Project Team
- Managers of Functional Departments providing resources to the project
- Any others who provide input to or will receive benefit from the project

The overall objectives of a kick off meeting are:

- To clarify and communicate the objectives and features of the project to all those involved
- To secure or reinforce the commitment required to the project
- To enable the project team to meet (possibly for the first time)
- To set any strategic context for the project and begin to focus everyone on the end objective and on their role in achieving it.
- To Start the Project!

3.9 Starting the Work

MANAGING WORK & COSTS

Following the project kick off meeting the PM must move swiftly to keep the momentum going. At this point he must ensure that his Project Communication Plan is in place.

This plan outlines for the team how information will be captured, reported and acted on. It should include:

- Process for managing documentation
- Organisation charts & reporting lines
- Governance & Meeting schedules
- Progress Reporting Process
- Task Responsibility matrix

An initial project team meeting should be held as soon as possible after the kick off meeting. The PM can use this opportunity to brief the team on the communications plan and any other information which may not be covered at the kick off meeting.

Part of this briefing should be an agreement on the work tasks to be completed. The task responsibility matrix (or RASI) is a powerful tool for achieving understanding and commitment to tasks. A sample is given in appendix 1. This can be supported at the initial meeting by a short term task list for each individual which may be extracted from the project schedule

Appendix 1

Responsibility Assignment Matrix (RACI)		
R	Responsible	Those who work to achieve the task
A	Accountable	Ultimately accountable for completion of the task / project
C	Consulted	Those whose opinions are sought (2 way communication)
I	Informed	Those who are kept up to date on progress (1 way communication)

Project Task	**Sponsor**	**Project Manager**	**Head of Sales**	**Designer**
Purchase Enquiry		C	A	R
Preliminary Design	C	R	I	A/R
Approve Designs	A	R	I	R
Planning	I	A/R	C	C

Lecture 2 – Managing Progress

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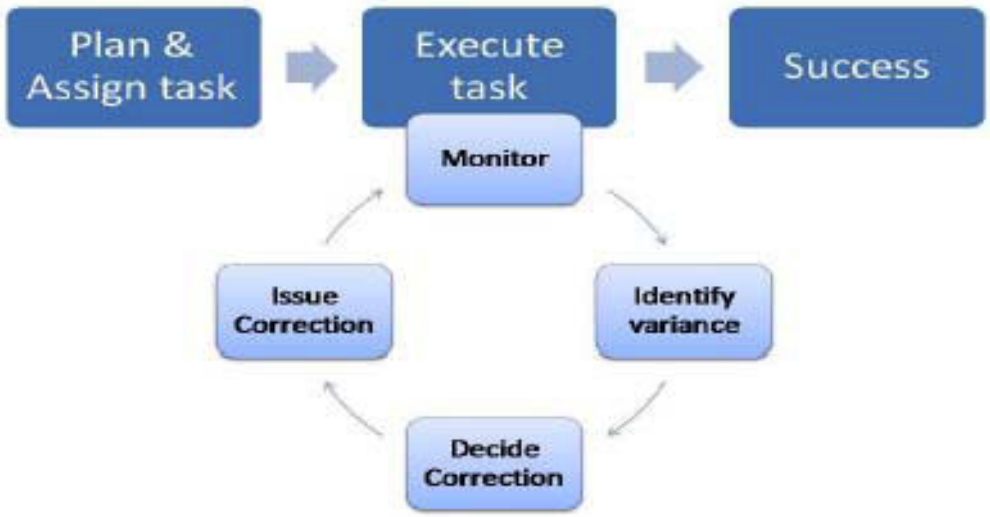
1 Assumptions

- An effective schedule has been produced
- Everyone knows their role & responsibilities

2 Control Systems: - Open vs. Closed loops

Open loop – makes no use of feedback / error signals.

Closed loop – An instruction is met with corresponding feedback – preferable



3 Management by exception vs. management by surprise

3.1 Management by Exception

Error signals generate corrective action – errors from divergences are called variances or, alternatively ex captions. Concentrating on exceptions is known as management by exception

3.2 Management by surprise

No explanation needed – no feedback or error signals are gathered or analyses.

4 Progress Data

4.1 Planning what to measure

Measurement of variance requires a fixed baseline (no moving goalposts!) –You should work from the base lined project documentation. This represents the agreed direction of the project (If you don't know where you are going – you will never know when you get there!)

Measure the right thing! - Gain agreement and make sure it is related to the objectives of the project.

Measure at the right time – Question the value of the measurement if it is always going to be too late to analyze and control any issues identified by the measurement.

Standard parameters to measure are Cost, Time and Quality. Information may also be gathered on risk, resource utilization and actual activity

Remember – high levels of "busyness" do not always indicated a high rate of progress. Measurements of output are usually more valuable than measurements of activity (presuming you are also measuring the performance)

Question the value of gathering significant amounts of data that is unlikely to change throughout the life of the project. This provides very little information.

Management by exception - Ensure you can clearly identify exceptional events which indicate potential problems

4.2 Designing how to gather information

Be aware: The Uncertainty Principle applies to projects – i.e. the observation of a system affects how the system performs … the act of gathering information tends to distort the process being monitored and the information produced!!

Build a culture of open and transparent reporting – Ensure that the monitoring system works equally well for detecting bad news as good. The project manager needs to be tuned to detecting and fixing problems before they become significant.

Following on from the point above ….don't shoot the messenger! Encourage the identification of potential issues within the project team.

Information gathering forms should as simple and unambiguous as possible. Structure your capturing of data in line with the baseline estimates- same format, same measures etc

Method of Communication – Written is best, but don't underestimate the value of formal meetings and on-site walkabouts.

Specific project objectives are contained in documents such as the three described in table 1 in the Appendix below. The table also shows the relevant triple objective – managing cost, time quality.

4.3 Project Budget

This document defines the total budget for the project. This budget is normally allocated across some convenient categories in order to assist in measurement and control. A common method is to subdivide the work of the project into a hierarchy of convenient work packages. Such a hierarchy is called a Work Breakdown Structure (WBS). When costs are allocated across the packages this becomes a Cost Breakdown Structure. When ongoing cost information is to be gathered it can be measured with reference to this baseline breakdown structure. The numbering system used for the classification can also be reflected in the project accounting systems. The figure below shows a simple example based on a project to construct a wooden sundeck consisting of a concrete foundation and a wooden deck structure finished with appropriate wood treatments and landscaping.

4.4 The Project Schedule

This is a list of activities and planned dates for performing them. A simple table can be used in cases where the number of tasks is relatively small and the dependencies between them are clearly understood. Appendix 1 shows an example of such a schedule used for a software deployment project. A more common method is the Schedule Bar chart (or Gantt chart). This consists of a list of activities down the left hand side of the chart set against a time scale on the top. The figure below shows a simple Gantt chart for the sundeck project.

5 Capturing Progress

Methods of data capture include:

- Progress Return Forms
- Task/milestone status reports

Both types can be captured using standard forms based on the project schedule. Alternatively, the information can be entered directly into a project management system by the person responsible for completion of the task.

See the example in Appendix 1 below of a simple Progress Return. It is set up to calculate the percentage completion based on the amount of expected work done on a given day.

6 Progress Meetings

It is possible that project team meetings could be enjoyable but only after they have served their primary purpose, which is to review progress of the project and address any issues that require addressing at the meeting. As well as being a useful method for gathering progress information the meeting can also be used by the project manger to provide direction. They are an important addition to the distribution of written reports.

There are a number of issues that the PM should be aware of:

6.1 The Chairperson

The project manager should chair the meeting (in the absence of the project sponsor).

6.2 Timing of the Meeting

In most circumstances a weekly meeting is sufficient. However the frequency should be adjusted to suit the timescales of the project or even the current phase. A daily meeting may be more appropriate in the final stages of some projects where the level or intensity of the activity is high. For example in the final days leading to live deployment of a software system it may be necessary to monitor multiple tasks which are a very short duration and are performed by multiple functional areas or personnel. Similarly in the final phase leading up to handover of a new building there will be multiple small items (snag list), which must be addressed, in a compressed period of time.

6.3 Purpose

Be absolutely clear about the purpose of the meeting.

Is it to:

- Review and record progress alone? (Do you really need a meeting to do that?)
- Identify and resolve cross project issues? (More useful!)
- Reinforce the team's common objectives (Always a good thing to do!)

And allow some time to reflect on some success? (This is also a good thing but would never be the sole reason for a weekly meeting!)

6.4 The Agenda

The agenda should be used to clarify the purpose of the meeting and guide its progress. There should always be an agenda and it should be issued in advance of the meeting. This should allow all participants to prepare required material or responses to issue.

6.5 The Minutes

A standard minutes template should be used and the minutes issued immediately after the meeting. They should be concise and reflect the agenda. Action points should clearly identify the action owner and a precise date for completion of the action.

A Meetings control form is included in the Appendix. This can be used to quickly distribute the main agreed points and actions ahead of the minutes being issued.

7 Reaction to Project Reports – Analysis

Having reviewed progress reports the project manager will need to determine what action, if any, is required. If the progress reports indicate that all tasks are starting and completing exactly on time then he should count himself lucky and take no action. If he continues to receive similar reports for every week of the project, then he would be advised to dig a little deeper!
It is possible that some tasks may start or complete earlier than planned. This is welcome but the PM must be happy that nothing has been neglected or that quality has not been sacrificed for speed.

The more likely scenario the project manger will encounter is that jobs will begin to take longer than planned and will possibly end up completing late. If this happens the PM must assess the impact. He can do this by first understanding the impact on the start or end time of other activities or on the overall end date. This type of analysis will be covered in detail later in the course when you look at the Critical Path Method. Here is a brief introduction to the terms used:

Float is a measure of the flexibility of task. In other words it measures how late it can be delayed before it will affect the completion of the project.

Total float is the total amount of time that a task can be delayed without delaying the project finish date.

Free float measures the amount of float that an activity can be delayed without affecting the start of another activity (i.e. without affecting the float of another activity).

Zero float. A task with zero float cannot be delayed without affecting the end date of the project. Such tasks are called critical tasks and all such tasks in a project are said to be on the **critical path.**

Negative float - In this scenario, an activity has fallen behind its planned progress and needs to start before the previous ones have finished.

7.1 Possible float scenarios

Scenario 1 – There are late jobs but they have some free float. No action required other than to monitor closely to ensure that it completes within its free float period.

Scenario 2 – There are jobs late and some total float available. The PM should be careful about using up total float early in the project. The first action should be to try and expedite the task itself and bring it back within the planned schedule.

Scenario 3- there are late jobs which have zero or negative float. Such tasks require urgent attention in order to try and eliminate or mitigate impact on the end date. This may require investment of further resources or money.

8 Correcting Progress Problems – Approaches

Having an effective reporting system will allow the project manager to monitor and adjust the progress of the project. When variances are detected she has a number of options. In general, the earlier the variance is detected, the greater will be the available corrective options. Options may include:

8.1 CRASHING

Get the team to work overtime over a number of evenings or weekends until the schedule is recovered: Useful in small doses but can be counter productive in the long run. Should be reserved for emergency situations.(It's costly as well!)

Secure additional resources: the project manager is unlikely to secure good resources quickly particularly if already using external resources or subcontractors. (Can be even costlier)

8.2 FASTTRACKING

Examine the sequencing of tasks with a view to eliminating or tasks or performing some tasks in parallel, which would normally be done, in sequence. For example - you may decide to start your building work before all of the design work is completely finished. There are risks associated with this approach. Sometimes it is just not feasible.

8.3 COMBINATION

In some cases the answer is to use a combination of additional resources and some skilful juggling of the task schedule. Some ingenuity and imagination from the project manager (and his team) also helps. Lock provides a number of non-standard approaches!

8.4 RE-BASELINING

The last resort is to investigate if the client may agree to an extension to the delivery date. Depending on the commercial arrangement this will involve a cost on the client or the contractor (or both) Above all else, make sure that the customer or sponsor is aware of the problems and is party to any hard decisions.

9 Immediate Action Orders

Lock outlines this particular procedure and a document template, which can be used to gain the attention of the relevant parties and ensure that required corrective actions get absolute priority in the organization. The purpose and operation of the order is outlined clearly in the text. You should note, in particular, the circumstances in which it should be used- as excess usage can
devalue its effectiveness (…the boy who cried Wolf?)

10 Correcting Progress Problems – Keeping the Balance

When determining the appropriate action to take in response to delays, the project manager has to maintain the balance of triple objectives – Cost, Time and Quality. We have seen above that any corrective action is likely to add costs to the project.
However there is a risk also that the quality may suffer because of:

- Reducing time to test and prototype designs
- Increased workload leading to reduced quality of work
- Excessive hours worked leading to loss of concentration and reduces quality of work
- Using "best available now" resources rather than "best fit"
- Using additional temporary resources without time for adequate training

Note: Lock makes the point that management of quality can be compromised even when project is on schedule and gives the example where pressure is applied to complete paperwork for a task before the deliverable itself was tested.

This could possible be viewed as a professional ethics issue rather than a progress management issue!

11 Issues With External Resources

Lock identifies some particular issues to be aware of when managing external resources. These are people who are contracted to the project but are not permanent employees of the project organization. They can be referred to as subcontractors, temps, agency staff etc. The use of external resources is common practice and any major project can have a large number of such people. They are commonly used to complete specialist work, which is not within the normal capability of the organization. Alternatively they can be used to supplement the existing staff.

The main issues associated with such resources are:
a) Unfamiliarity with the organization
b) Lead time to secure additional staff
c) Supervision
d) Monitoring progress and quality from remote staff
e) Release of project information

11.1 Unfamiliarity with the organization

External staff will require a period of time to tune themselves to your organization. It is recommended that you provide some form of induction course to accelerate this process. It can take some time to make such people fully productive. Even the simplest things such as securing temporary security passes and access to email systems need to be catered for. Make sure to plan in advance for this to avoid unnecessary delays. Even when fully installed on the team, lack of experience can make these resources less productive, particularly when they are required to interact with people within the organization. You should allow for this when estimating work rates. Ideally you will be able to identify and secure proven staff or subcontractors who may have worked with you already on previous projects.

11.2 Lead time to secure additional staff

When the need for external resources is identified, the project manager must move swiftly to identify and secure competent people. A last minute search for necessary temporary resources is unlikely to result in a bargain price.

11.3 Supervision

Apart from the induction and supervision required because of unfamiliarity with the organization, there is the added overhead of the invoicing for hours worked. Appropriate arrangements need to be in place for returning and authorizing timesheets and recording on the cost system for payment to the subcontractor or agency.

11.4 Measuring progress and quality from remote staff

Staff who work offsite or in the subcontractors premises will not benefit from the normal supervision provided by your organization. It will be difficult for the project manager to get a full sense of progress or attention to quality. One possible solution is to get agreement from the subcontractor to allow access to some form of liaison person either permanently on site or as a frequent visitor. (Possibly the project manager herself)

11.5 Release of project information

The subcontractor's liaison or project lead is likely to want to understand the amount of slack available in the time allotted to their tasks. Your own organization may have a protocol for how much to reveal. There is a case to be made for being completely transparent with the subcontractor in order to allow full sharing of any risk involved. At the other extreme there is a view that the subcontractor should focus only on the task at hand and their given end date.

It is rarely necessary to reveal the full extent of a subcontractor's project budget.

	Cost	Time	Quality	Description
Project Budget	X			Approved estimate, detailed and classified
Project Schedule		X		List of activities, start & finish time, milestones, float and resources to complete
Project Specifications			X	Drawings, specific requirements

Table 1 – Project Budget, Project Schedule & Project Specification

Project: garage		Garage Project Activity progress update			Report date: 19/05/10		
ID	Description	Orig. Duration	Start	Finish	Rem. Duration	% Complete	Comment
1	Project Start	0	13/05/10	13/05/10	0	100	
2	Dig Foundations	4	14/05/10	14/05/10	0	100	All foundations complete & checked by engineer
3	Position steel frame	4	15/05/10	19/05/10	3	75%	Awaiting additional members from fabricators
4	Steel Cladding	5	19/05/10	24/05/10	5	0	Manufacture complete & awaiting delivery & installation

Table 2 – Progress Report

Meeting Action Sheet		
Reference Number		
Date, time & place		
Those to attend		
Purpose of meeting & agenda		
Decisions agreed	1. 2. 3. 4.	
Actions agreed	By Whom	By when?
1.		
2.		
3.		
4.		
5.		
6.		

Table 3 - Meetings Control Form

MANAGING WORK & COSTS

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1 Introduction

Change is inevitable on projects. In this chapter we look at particular techniques and processes designed to manage planned changes to the project scope.

These notes are based on "Chapter 25 – Managing Changes" in the core text book by Dennis Lock.

2 Managing Changes

The Project Management Body of Knowledge (PMBOK) defines scope as 'The sum of the products, services and results to be provided as a project' The scope of a project is established and agreed during the planning phase. This scope or work will probably have been derived from a Work Breakdown Structure.

The agreed scope of work is an important document as it:

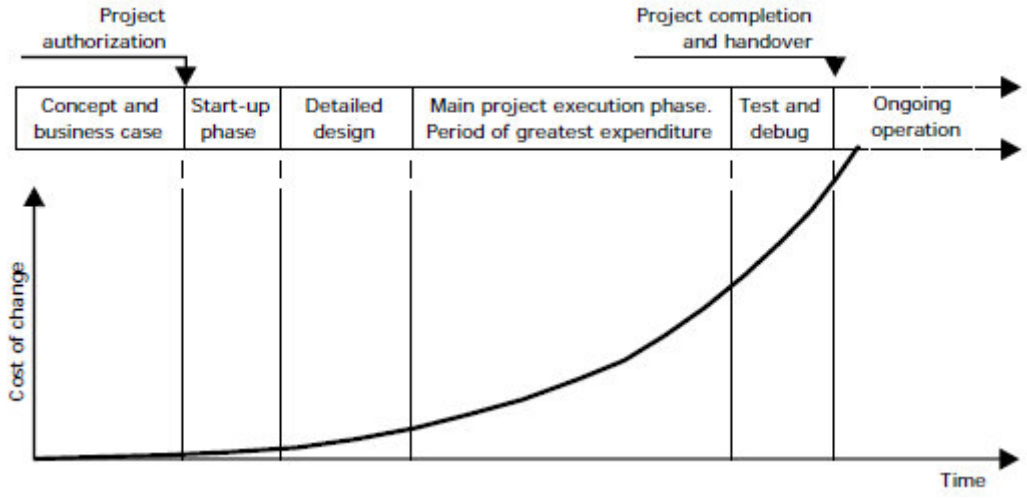
- Defines clear understanding of project boundaries for all stakeholders
- Forms the basis for contractual agreements
- Is the basis for project change control

However as Lock says "no project can be expected to run from start to finish without at least one change". Although change is inevitable, its effects must be managed in order not to jeopardize the project as a whole…hence the need for a formal change control process. Lock goes further to suggest change is"…..*a departure from the approved project scope or design as indicated by a change to any contract, drawing or specification after its approval and issue for action"*

Change Control is defined as: Identifying, documenting, approving or rejecting, and controlling changes to the project baseline. (Lock)

3 Changes in the Project Life Cycle

Generally, the later the change occurs the harder it will be to implement it without significant disruption to the project (including resultant costs).



4 Sources of Changes

Lock identifies two distinct groups of changes for an engineering type project:

4.1 Customer funded changes

These normally result from a request by the customer for a modification which is not catered for in the contract. If the modification results in any increase in costs for the contractor then a renegotiation of the contract price is normally required. If the change will result in a change in delivery date then this must also be communicated and agreed. Customer funded changes are an opportunity for the contractor to extract extra value from the contract.

Opportunities for improvements in the final delivery should not be ignored; however a large volume of change requests may be unwelcome as this can disrupt the progress of the project. It may also indicate a fundamental weakness in the customer's definition of the baseline statement of work and could be a cause for concern. Other terms used are extras, add-ons, variations etc

4.2 Contractor funded changes

These can happen at any stage of the project cycle and tend to originate from issues identified
during some type of quality review.

- Modifications or additions are required in order to meet the customer's expectations. This could be as a result of poor design in the first place.
- Rework is required because of substandard build. (e.g. a level of specification or a piece of functionality was not included in the finished goods)

Sometimes there's an element of overlap between the two categories or change, so Lock prefers to use the terms funded (i.e. the customer pays as the originator of the change) and unfunded (contractor absorbs the cost) changes to differentiate.

4.3 Other items that may generate change

4.4 Non conformance reports (NCR's)

By quality control – product outside required condition. For example a product that fails to meet the project specification.

4.5 Concession

Request to client to accept an item that's not within the required specification.

4.6 Scope Creep

'Adding features and functionality (project scope) without addressing effects on time, cost & resources or without customer approval' (PMBOK). Effectively taking on additional works to a project that may impact on time and cost (mostly).

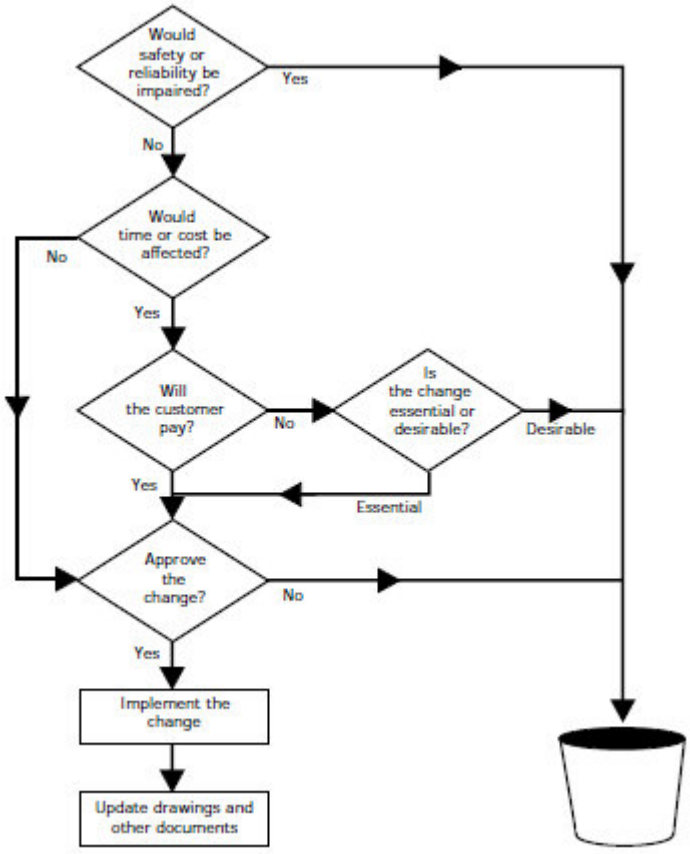
5 Authorizing Change

As the impact of change is wide ranging, it's worth while putting a robust system in place that all change can be considered not only by its impact on the project but on the potential impact on the wider organization as well.

Some large organizations may have Change Committees or Change Boards who sit regularly and review project changes. People on the committee may consider safety, reliability, performance and timescale of changes. May be common in nuclear or aerospace industries. The change committee can elect to:

- authorize the change as requested;
- give limited approval only, authorizing the change with specified limitations;
- refer the request back to the originator (or elsewhere), asking for clarification or for an
- alternative solution;
- reject the change, giving reasons.

Lock sets out a useful chart which guides the Project manager through the Change Control process:



6 Administration of Change

It is wide that the project manager implements a system of standard change request forms early in the project. All changes should be generally be sought in writing to avoid confusion or ambiguity. Change request forms can be tailored to each project and given the flow chart above they may be triggered at different points along the project's life cycle.

6.1 Using a Change Coordinator

One person may be elected in this role and given the responsibility of coordinating changes.

- registering each change request and allocating serial numbers;

- distributing and filing copies of the change documents;
- following up to ensure that every request is considered by the change committee without avoidable delay;
- distributing and filing copies of the change documents after the committee's instructions
  have been given;
- following up to ensure that authorized changes are carried out and that all drawings and
  specifications affected by the change are updated and re-issued.

6.2 Numbering & Registering Changes

It is important to number and register changes for a number of reason, including:

- to provide a base from which each change request can be progressed through all its stages,
  either to rejection or to approval and full documentation and implementation;
- to record changes in budgets and, if appropriate, prices so that the current valid budgets
  and prices will always be known;
- to provide a search base that allows tracking back ('traceability') so that the origins of all
  design and commercial changes can be found or verified, both during the life of the project
  and afterwards.

When this is complete, the distribution of these documents should be considered. Change requests should also be entered into a registered and clearly highlighting the ones that are 'active'. His will assist in monitoring and progressing each change.

7 Estimating the True cost of change

It is almost inevitable that changes will altered the project costs in some way (not always upwards!). Not only the costs of a change needs to be considered, but also the impact on other operations, or the possibility that this change will require items to be reworked or even scrapped entirely.

Changes generally cost more as the project progresses, and one items to bear in mind is that the cost of change may be difficult to asses later into a project. An estimator tasked with assessing change may want o pose the following questions:

- Is there to be no inspection and retesting on this job?
- Will existing stocks be affected?
- Will there be any purchase order cancellation costs?
- Will this change affect the prototype too?
- What about work-in-progress – how much of that will have to be scrapped and done again?
- How much will all the resulting delays cost?

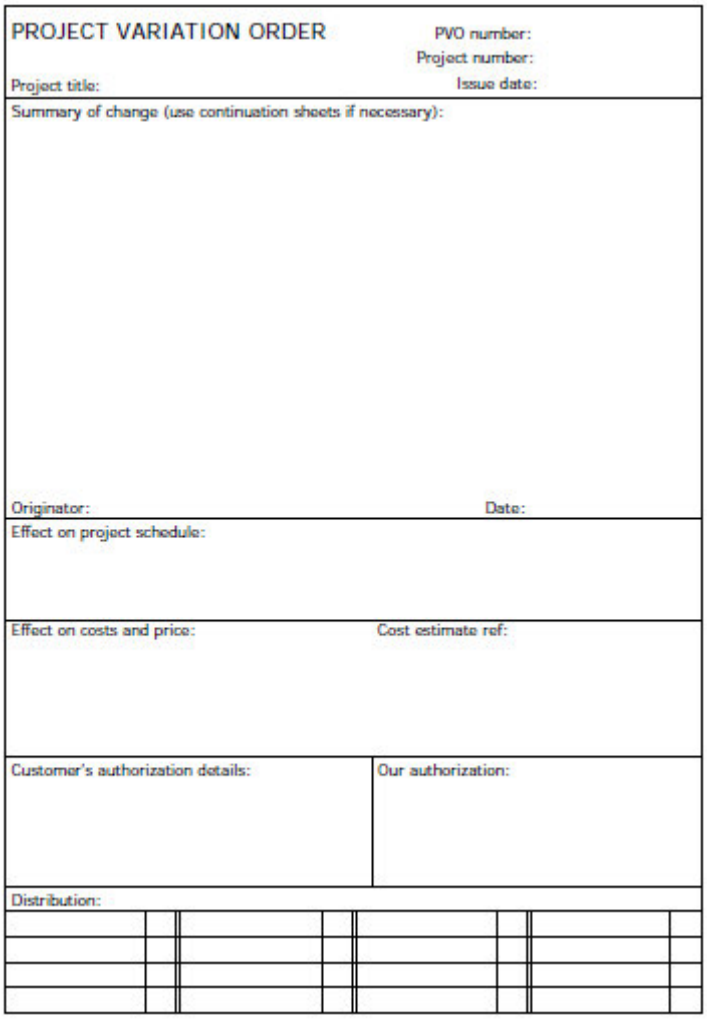
8 Forms and Procedures

Change can be identified in a number of ways. One is to capture these in drawings or specifications that are marked 'for construction' or 'for manufacture' that change during the project life cycle. A system of revising these document (Revision A, B, C etc) may be used to identify the reason for the change (for example, a client request to change something). In this case, the organization may choose to have a formal system in place, whereby the proposed revision is presented for change with the reasons for the revision and any resultant impact of

costs (and don't forget about schedule!). Early on in the project, a project manager would be wise to seek a 'design freeze'. By this, we are trying to achieve that drawings and specifications are literally frozen (i.e. as the set from which all future revisions may invoke some change). In fact, a well disciplined organization may refuse to entertain any changes after design freeze if the views of all stakeholders have been taken on board during the early outline and design phases of a project.

A structured change control system would be fronted by a Variation Order, a document which:

- Amends the purchase order or contract and describes the change.
- Authorizes the contractor to make the change.
- Promises payment.
- Records agreement to any associated timescale revision.



PROJECT VARIATION ORDER

PVO number:
Project number:
Project title:
Issue date:

Summary of change (use continuation sheets if necessary):

Originator:
Date:

Effect on project schedule:

Effect on costs and price:
Cost estimate ref:

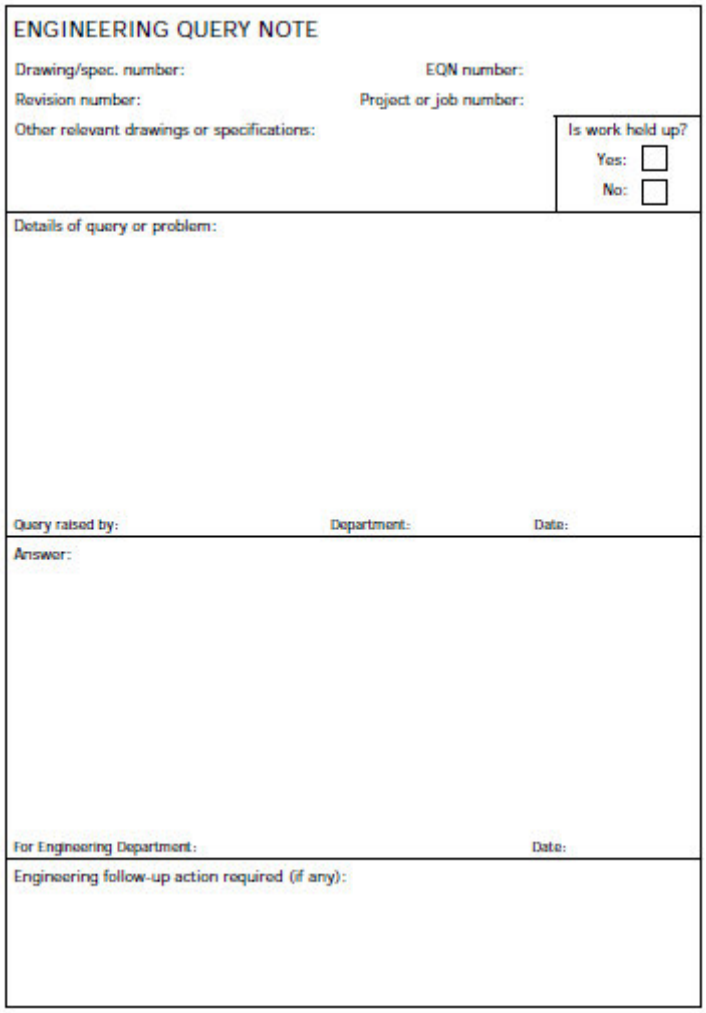
Customer's authorization details:
Our authorization:

Distribution:

9 Engineering Change requests

Sought where there is a change in the process due to ongoing design development. Used where a designer is seeking approval form the project manager.

ENGINEERING CHANGE REQUEST	ECR number:
Project title:	Project number:
Details of change requested (use continuation sheets if necessary):	
Drawings and other documents affected:	
Reason for request: Originator:	Date:
Emergency action requested (if any):	
Effect on costs: Will customer pay, yes ☐ no ☐	Cost estimate ref: If yes, customer authorization ref:
Effect on project schedule?	
COMMITTEE INSTRUCTIONS: CHANGE APPROVED ☐ NOT APPROVED ☐ Point of embodiment, stocks, work in progress, units in service, special restrictions etc: Authorized by:	Date:



ENGINEERING QUERY NOTE

Drawing/spec. number: EQN number:

Revision number: Project or job number:

Other relevant drawings or specifications:

Is work held up?
Yes: ☐
No: ☐

Details of query or problem:

Query raised by: Department: Date:

Answer:

For Engineering Department: Date:

Engineering follow-up action required (if any):

10 Version control – modified drawings and specifications

Issuing incorrect versions - This needs to be monitored carefully – unauthorized documents can be potentially dangerous and implement changes in the project without the proper stop gaps being in place. A new revision number on a document or drawings should minimize the changes of such and occurrence.

10.1 Emergency Modifications

Some changes may require these – there is a wrong and a right way. The PM should be wary about being pressured into a quick change without considering all the circumstances or consequences of this,.

One way to safeguard against changes slipping through is to rigidly stick to the process of version control on all documentation. Also to ensure that various stages are rigidly adhered to (emergency change request by originator). This document is then traced though the various stages of design & production to ensure it is implemented.

11 Appendix 1 - Change Request Form

Scope Change Request

Date Submitted	
Change Manager	

Scope Definition and impact on other projects / programmes

Business and system drivers

Business and System impact

Scope change benefit

Implication of not making change

Scope change cost estimate

Related documentation

Scope change approved for progression?

Assigned to	
Approved by	
Date of approval	
Comments	

12 Appendix 2 - Change Request Log

Serial Nr	Originator		Date Requested	Brief Details or title	Approved (Yes or No)	Date of final distribution	Budget changes (if any)
	Name	Dept					

13 Appendix 3 – Impact Analysis Form

The impact analysis form will normally be tailored to the needs of the project or the industry. The
sample below is freely available on the Internet and is used for managing changes when developing software products for clients. For engineering projects using engineering drawings normally specifies the customer's needs. In the software industry their needs are generally documented in software requirements documents. The principles however are the same. In this form a checklist is included at the start in order to prompt the reviewer to consider all areas for impact. Having considered all the areas the impact findings are summarized at the end of the document.

Impact Analysis Checklist for Requirements Changes

1 Implications of the Proposed Change

- Identify any existing requirements in the baseline that conflict with the proposed change.
- Identify any other pending requirement changes that conflict with the proposed change.
- What are the consequences of not making the change?
- What are possible adverse side effects or other risks of making the proposed change?
- Will the proposed change adversely affect performance requirements or other quality attributes?
- Will the change affect any system component that affects critical properties such as
- safety and security, or involve a product change that triggers re-certification of any kind?
- Is the proposed change feasible within known technical constraints and current staff skills?
- Will the proposed change place unacceptable demands on any computer resources required for the development, test, or operating environments?
- Must any tools be acquired to implement and test the change?
- How will the proposed change affect the sequence, dependencies, effort, or duration of any tasks currently in the project plan?
- Will prototyping or other user input be required to verify the proposed change?
- How much effort that has already been invested in the project will be lost if this change s accepted?
- Will the proposed change cause an increase in product unit cost, such as by increasing third-party product licensing fees?
- Will the change affect any marketing, manufacturing, training, or customer support plans?

2 System Elements Affected by the Proposed Change

- Identify any user interface changes, additions, or deletions required.
- Identify any changes, additions, or deletions required in reports, databases, or data files.
- Identify the design components that must be created, modified, or deleted.
- Identify hardware components that must be added, altered, or deleted.
- Identify the source code files that must be created, modified, or deleted.
- Identify any changes required in build files.
- Identify existing unit, integration, system, and acceptance test cases that must be modified or deleted.
- Estimate the number of new unit, integration, system, and acceptance test cases that will be required.

- Identify any help screens, user manuals, training materials, or other documentation that must be created or modified.
- Identify any other systems, applications, libraries, or hardware components affected by the change.
- Identify any third party software that must be purchased.
- Identify any impact the proposed change will have on the project's software project management plan, software quality assurance plan, software configuration management plan, or other plans.
- Quantify any effects the proposed change will have on budgets of scarce resources, such as memory, processing power, network bandwidth, real-time schedule.
- Identify any impact the proposed change will have on fielded systems if the affected component is not perfectly backward compatible.

Effort Estimation for a Requirements Change Task Effort/Labours/Hrs

- Update the SRS or requirements database with the new requirement
- Develop and evaluate prototype
- Create new design components
- Modify existing design components
- Develop new user interface components
- Modify existing user interface components
- Develop new user publications and help screens
- Modify existing user publications and help screens
- Develop new source code
- Modify existing source code
- Identify, purchase, and integrate hardware components; qualify vendor
- Modify build files
- Develop new unit and integration tests
- Modify existing unit and integration tests
- Perform unit and integration testing after implementation
- Write new system and acceptance test cases
- Modify existing system and acceptance test cases
- Modify automated test drivers
- Perform regression testing at unit, integration, and system levels
- Develop new reports
- Modify existing reports
- Develop new database elements
- Develop new data files
- Modify existing data files
- Modify various project plans
- Update requirements traceability matrix
- Review modified work products
- Perform rework following reviews and testing
- Re-certify product as being safe, secure, and compliant with standards.
- Other additional tasks

TOTAL ESTIMATED EFFORT €/HRS/Resources

Procedure:

1. Identify the subset of the above tasks that will have to be done.
2. Allocate resources to tasks.
3. Estimate effort required for pertinent tasks listed above, based on assigned resources.
4. Total the effort estimates.
5. Sequence tasks and identify predecessors.

6. Determine whether change is on the project's critical path.
7. Estimate schedule and cost impact.

Impact Analysis Report Template

Change Request ID: _____

Title: _____

Description: _____

Analyst: _____

Date Prepared: _____

Prioritization Estimates:

- Relative Benefit: (1-9)
- Relative Penalty: (1-9)
- Relative Cost: (1-9)
- Relative Risk: (1-9)

Calculated Priority: (relative to other pending requirements)

Estimated total effort: _____ labor hours

Estimated lost effort: _____ labor hours (from discarded work)

Estimated schedule impact: _____ days

Additional cost impact: _____ euro €

Quality impact: _____

Other requirements affected: _____

Other tasks affected: _____

Integration issues: _____

Life cycle cost issues: _____

Other components to examine_____

References & Resources

- Lock, Dennis (2007) Project Management, 9th. Edition, Gower – Chapter 25
- Project Management Institute (PMI), Guide to the Project Management Body of Knowledge (PMBOK), 3rd edition, PMI
- Burke, Rory, (2001) Project Management, Planning & Control Techniques, 3rd edition, Wiley (Page 92 - 99)
- Hamilton, Albert (2001), Managing Projects for Success, Thomas Telford, (Page 454 – 461)
- Mantel / Meredit / Shafer / Sutton (2005) Project Management in Practice, John Wiley and Sons, (Page 228 – 236)

Managing Works & Costs

Lecture 3
Managing Changes

Recap on Managing Progress

- Close Loop Control System
- Management Styles
- Collecting Progress Information
- Corrective Measures – ortyhodox / unauthordox
- Meetings
- Managing External Resources

Managing Changes - Scope

Scope

The PMBOK defines **Scope** as *'The sum of the products, services and results to be provided as a project'*

Managing Changes - Scope

- Scope is derived from the Work Breakdown Structure (WBS) and established at the planning phase
- It defines project boundaries for all stakeholders
- Scope forms the basis for contractual agreements
- It is the basis for project change control

Scope Creep

- *'Adding features and functionality (project scope) without addressing effects on time, cost & resources or without customer approval'* (PMBOK)

Definition of Change

What is change?

Defined as a

"*departure from the approved project **scope** or design as indicated by a **change** to any contract, drawing or specification after its approval and issue for action"*

(Lock)

Definition of Change

What is Change control?

"Identifying, documenting, approving or rejecting, and controlling changes to the project baseline"

(Lock)

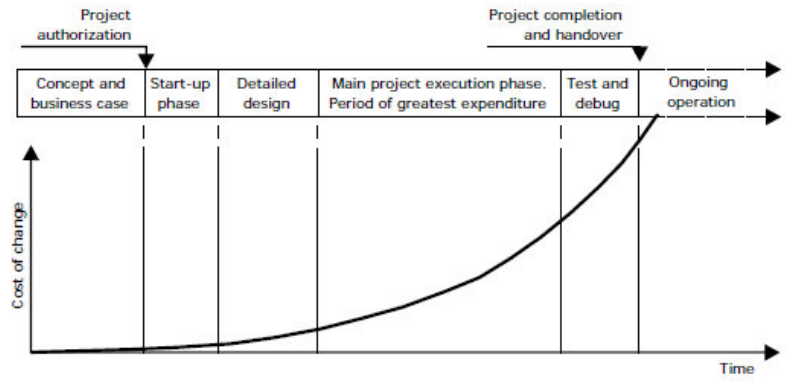
Changes – some Ground Rules

- Request for change must be in writing! Some contracts set this out as a requirement.
- If change request is verbal – it must be followed up with a written request. Some contracts allow for verbal changes to be followed up in writing
- Identify the person responsible to co-ordinate the change control process

Change in the Project Lifecycle

- Change has a higher impact on a project (time and cost) the later it is instigated on a project.
- Early changes – easier the accommodate
- Generally, the later the change occurs the harder it will be to implement it without significant disruption to the project (including resultant costs).

Change in the Project Lifecycle



Sources of Changes

1. Customer Funded Changes

- Request by the customer for a modification
- May result in an increase in costs
- May result in renegotiation of the contract price
- If there is a large volume of change requests, it may indicate weakness in the customer's definition – refer back to the scope

Sources of Changes

2. Contractor funded changes

- Often issues identified during quality review
- Modifications /additions required to achieve specification
- May be a result of inadequate design (level of specification) if contractor responsible e.g. rework required due to substandard installation / build

Other Items to look out for – Sources of Change

Non conformance reports (NCR's)

- Revealed by quality control – item is found to be outside required condition / specification.

Concession

- Request to client to accept an item that's not within specification.

Analysing the Impact of Change

The PM will need to consider the following when assessing a potential change to a project:

1. Quantify the impacts (Time, Cost, Quality)

2. Consider a number of perspectives e.g.

- Technical Feasibility – Is it possible?
- Procurement – Can it be bought (and in time?)
- Production - Can this be resourced?
- Planning - consider the time impact
- Cost – consider the budget impact
- Quality – can this be maintained? Concession sought?
- Legal and Contractual implications – is the change permitted in the first place?

Impact Analysis

Impact Analysis Report Template

Change Request ID: _____
Title: _____

Description: _____

Analyst: _____
Date Prepared: _____
Prioritization Estimates:
Relative Benefit: (1-9)
Relative Penalty: (1-9)
Relative Cost: (1-9)
Relative Risk: (1-9)
Calculated Priority: (relative to other pending requirements)

Estimated total effort: _____ labor hours

Estimated lost effort: _____ labor hours (from discarded work)

Estimated schedule impact: _____ days

Additional cost impact: _____ euro €

Quality impact: _____

Other requirements affected: _____

Other tasks affected: _____

Integration issues: _____

Life cycle cost issues: _____

Other components to examine_____

Authorising Change

- Consequences of changes can be far reaching
- Not always apparent at the project team level
- All changes be approved by agreed set of stakeholders e.g. Change Control Board (CCB), the Change Committee, the Change Board etc.

Authorising Change

The Project manager may ask the following questions of a proposed change:

- Would safety or reliability be impaired?
- Would time or cost be affected?
- Will the customer pay?
- Will the change be approved?

Depending on the outcome of the above, the PM may decide to Implement the change.

When the change is implemented, the PM shoukd ensure the update drawings and other documents is carried out.

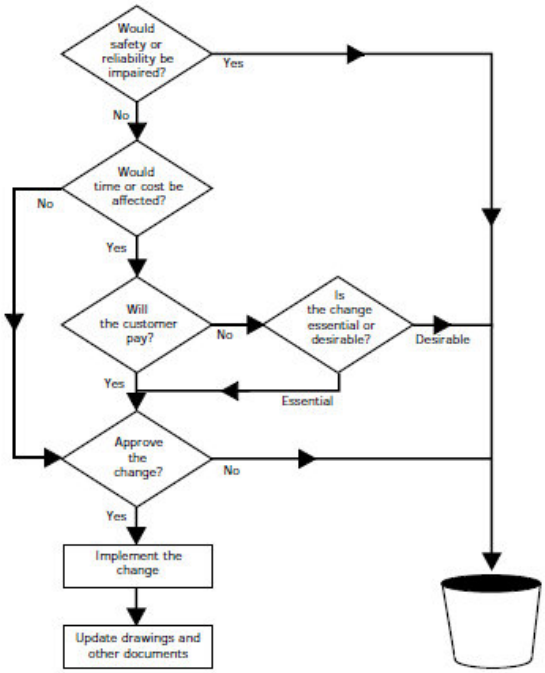
Authorising Change

Objective of the Change Control Board to make a decision on each Change Request

- Authorize
- Reject
- Defer
- Refer for further information
- Authorize, subject to conditions or limitations

Impact analysis presented to CCB should have sufficient information

Change Control Flow Chart



Using a Change Coordinator

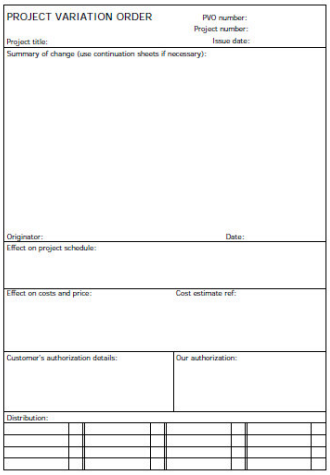
One person may be elected in this role and given the responsibility of coordinating changes. What would be expected of this person?

- Registering each change request and allocating serial numbers;
- Distributing and filing copies of the change documents;
- Following up to ensure that every request is considered by the change committee (aka Change Control Board) without avoidable delay;
- Distributing and filing copies of the change documents after the committee's instructions have been given;
- Following up to ensure that authorized changes are carried out and that all drawings and Specifications affected by the change are updated and re-issued.

Implement Change

1. The Change co-coordinator follows through on the agreed action
2. Decision of the CCB issued clearly and quickly
3. Change Control Log must be updated
4. If decision is to reject, defer then further information may be required
5. Action taken to update all baseline documents, amend contracts, issue purchase orders etc

Change Control Request



PROJECT VARIATION ORDER

PVO number:
Project number:
Project title:
Issue date:
Summary of change (use continuation sheets if necessary):
Originator:
Date:
Effect on project schedule:
Effect on costs and price:
Cost estimate ref:
Customer's authorization details:
Our authorization:
Distribution:

Numbering & Registering Changes

Why?

- To provide a base from which each change request can be progressed through all its stages, either to rejection or to approval and full documentation and implementation;
- To record changes in budgets and, if appropriate, prices so that the current valid budgets and prices will always be known;
- to provide a search base that allows tracking back ('traceability') so that the origins of all design and commercial changes can be found or verified, both during the life of the project and afterwards.

Change Control Register

Number	Originator		Date	Brief Details / Title	Approved (Y/N)	Date of final distribution	Budget changes (if any)
	Name	Department					

Lecture 4 – Cost Management – Principles

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1 Objectives of Project Cost Management

Lock would define Project Cost Management as "….ensuring that no preventable wastage of money or unauthorised increase in costs is allowed".

We can further expand on this:

- To ensure that the correct costs are incurred for each cost component
- To ensure that costs are allocated to the correct component
- To ensure that costs are incurred at the correct time
- To minimise the occurrence of fraudulent costs
- To minimise the costs of waste and other unnecessary costs
- Ensure sufficient funds are available to support project activity
- To help us to track project progress

The output of the budgeting process usually defines two things:

a. The budgeted costs, allocated to project areas or work packages
b. The expected timing of the spend on budget costs

Both of these components need to be monitored and controlled by the project manager. The project manager will also need to monitor the flow and timing of funds **into** the project. At its simplest he may have to ensure that the project budget is established on the accounting system and that appropriate authorisations are in place to allow release of funds to the project. Failure to establish this can cause delay in starting a work package.

Lock outlines three reasons why Cost Management is carried out:

a) To ensure the general control of costs i.e. "..to ensure that no preventable wastage of money or unauthorized increase in costs is allowed"
b) To make sure that a contractors own budget is adhered to.
c) To fulfill a responsibility to the project purchaser for project costs

What are the objectives of cost management? In this chapter we will use Locks approach to answer this question in a little more detail.

Cost management is a function of project management and many people involved in the project have an influence on the overall cost management of a project.

Cost reporting and cost control sometimes get used as terms interchangeably. Cost reports that are produced in a timely fashion are indeed important, but it is not the same as cost control. It is a comparable concept to earlier definitions of /.mentoring' in a passive manner as opposed to control, the active part of cost control.

2 The Basics of Cost Estimating & Budgeting

In its broadest definition, the process of Cost Management can be broken down into three components:

- Estimating the project costs
- Budgeting for those costs and
- Controlling and managing the costs during the lifetime of the project.

This chapter will focus mostly on the third component – Cost Control. The topics of estimation and budgeting are explored in depth elsewhere on this course but we will introduce them briefly here in order to appreciate their role in successful cost control.

According to Lock - *"…a good estimate of project costs is necessary for subsequent management decisions and control".* A good estimate is particularly important if you are using it as the basis for contract tendering, particularly if it's for a fixed price contract. Any underestimation of cost will eat directly into the contractors profit from the venture.

Subsequently, costs estimates will be important because they will also be used to allocate individual budgets to the project components (possible using a work breakdown structure). Cost estimating is an iterative process and the level of accuracy of your cost estimates will increase over time. At some stage, however, they will have to be labelled as "definitive" i.e. where the accuracy is regarded as being within 5% (plus or minus). At this stage the costs are baselined. The process of **Cost Budgeting** takes these definitive estimates and creates a **cost baseline**. This allocates the costs of the project over a time period (the duration of the project). Frequently, a separate baseline is created for each cost component of the project, for example: Labour costs, Management costs, subcontractor costs etc. This now represents the **approved estimate of costs.**

This cost baseline will be used throughout the project to measure variance between the planned use of resources and the actual use of resources. If the estimation is repeatedly shown to be inaccurate t en a high proportion of the project manager's time will be expended in managing the variances and re-forecasting the baseline.

Another useful output from the budgeting process might show the cash flow over the project cycle. The diagram in the appendix is used to below shows a cost baseline mapped alongside a cash flow baseline (the cost baseline is also know as an Expense S-Curve)

3 Additional Cost Control Factors

3.1 Adherence to Contractors Budget

As a project manager for the contractor, there is the immediate responsibility to ensure that the project is completed within the limits of the contractors planned costs. For most managers this is their one and only cost consideration. Lack of attention in this area can lead directly to reduction in expected profits for the contractor, particularly in low margin business environments.

On internal projects the profit motivation does not exist. However, the success of the project may be dependent on strict control of the allotted project budget. Significant overruns may undermine the case for executing the project in the first case.

3.2 Responsibility of a contractor to the project purchaser

The project manager is always required to pay attention to the costs likely to be incurred by the client. The client will expect to pay only for approved and agreed costs and for additional costs which are legitimate and reasonable. For fixed price contracts the situation is relatively straight forward. However for contracts which allow for additional undefined costs (e.g. "Cost plus" contracts) the project manager has an ethical duty to ensure that:

- only legitimate costs are claimed
- work is carried out as efficiently as possible

In this situation each additional cost may represent additional profit – So the project manager has often a difficult balancing act to perform!

4 The Main Elements of Project Costs – variable & Fixed Costs

It is important for the project manager to appreciate the amount of different cost categories that exist in a project. These are generally broken down into 'Variable' and 'Fixed' costs.

4.1 Definition of Variable costs

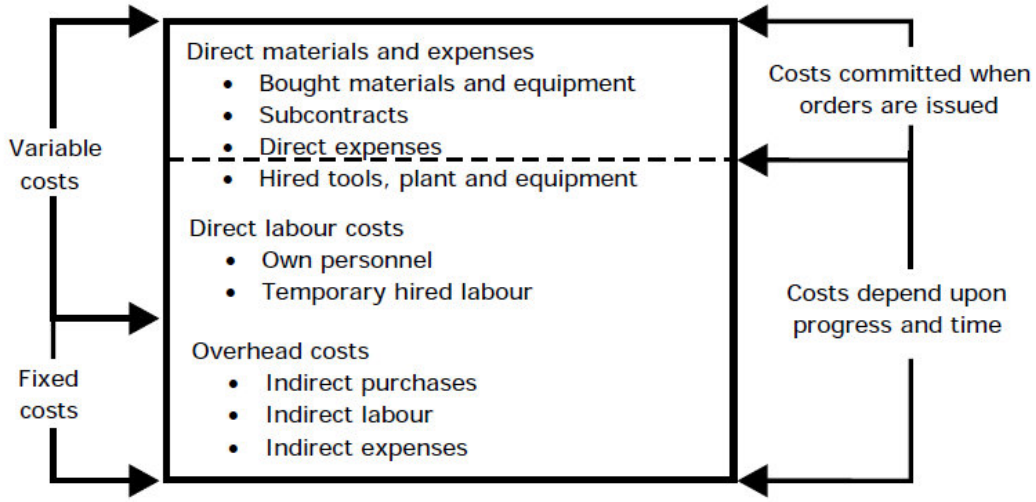
These costs are incurred as a proportion to the rate of working on the project – generally these are 'direct' costs. Direct Costs – costs which can be associated directly with project activity. Examples:

- Labour (working on activities/ managing activities/ project support activities)
- Materials
- Dedicated project equipment costs
- Direct project expenses

4.2 Definition of Fixed Costs

Generally defined as a company's overhead or indirect costs. 'Indirect' means that these are costs incurred generally in running the business. Indirect costs cannot be directly associated with projects. Examples:

- Travel, training, insurance, depreciation etc
- Heat/light
- Accommodation
- Use of photocopiers etc



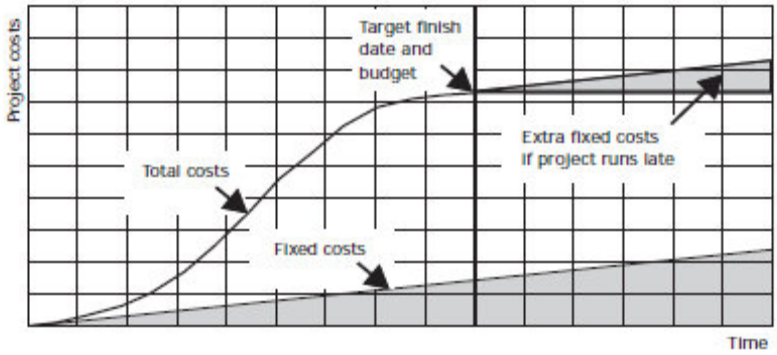
5 Controlling Variable Costs

5.1 Materials and Expenses

These can constitute a large proportion of a project's costs. Sensible purchasing strategies (summarize elsewhere) can exercise cost control over a project. Cost negotiations must be done before the purchase order or contract is signed as at this point it is too late to exercise any influence over this..

5.2 Direct Labour Costs

Controlling progress and ensuring projects run on time will prevent resources being wasted on projects that overrun.



6 Recovery of Fixed Costs / Overhead Costs

The basic aim of any business is to keep Fixed Costs (indirect) as low as possible in proportion to the variable (direct) costs.

6.1 Recovering Fixed costs

The project manager may have little influence on fixed costs as they are set by the business as an entity. In relation to projects, a project manager must understand that these costs continue to accrue even when no work is taking place on the project. One example is temporary site accommodation.

The boundary between fixed and variable costs can sometimes be blurred. Communications, printing / photocopying – these are costs in running a business, cannot be linked with particular jobs but will rise or fall depending on the level of business activity.

Some contract structures (reimbursable) allow claiming of sundry costs (phones, printing) if these can be proven as project costs. Architects and solicitors can use this to recover costs.

Simultaneous projects can make this exercise difficult. Being able to change as many costs as possible (once it is justified).

How can this be done?

- the use of a simple requisition system for all bulk photocopying and other reprographics services, with mandatory use of client or cost codes;
- mandatory use of cost codes on petty cash vouchers and all expense claims forms;
- the installation and proper day-to-day management of an automatic call logging system covering all telephone, and facsimile lines.

6.2 Recovering Overhead Costs

Hourly rates multiplied by the time expended (i.e. Cost / hour or cost per day) are used to works out hat's known as 'absorption costs'. This is worked out by calculating the hourly rate and applying a mark up (for overheads and an element profit). Working out the percentage of overheads may depend on the type of business the company is operating in. Companies who can keep indirect costs to a minimum can enjoy competitive pricing advantage.

6.3 Under Recovery

Where the amount of direct costs falls below what's forecast. Happens where projects do not materialize / over optimism.

- Increasing the overhead rate (thus increasing prices, which might reduce the quantity of products or project work sold);

- Increasing sales by a marketing drive to sell more products or project work; persuading each new project client to agree to pay for some jobs previously regarded as indirect. This will depend on being able to identify those jobs and record their costs in a way that would satisfy subsequent audit. Examples of such costs are special printing and copying of project drawings and other documents, telephone calls, travel expenses and so on;

- Making economies to reduce the overhead costs. That can lead to painful actions, even to the extent of dismissing administrative staff and managers

6.4 Over Recovery

Occurs where direct labour billings exceed what's expected. Can increase profitability but indicate the competitiveness is not very well aligned.

7 "Total Cost" Approach

This concept treats costs holistically, this involves resolving logistical issues or other issues that may impact on costs with a view to making them as minimal as possible.

Project managers an other team members may consider in this approach who their influence or impact on the project is affecting projects costs. A design change that involves more reworks of a design but results in production / construction methods.

8 Setting and Resetting Cost Budgets

Budgets will be derived from the original project estimate – these budgets are before 'below-the-line' allowances (for example contingency) and indirect costs. These budgets become the maximum authorized level of spend.

WBS & CBS – these allow costs to be distributed on the sub-project parts. This CBS will have been created when defining the scope of the project. This source CBS will also be used when planning and controlling other aspects of the project. So, used in this way, the budget becomes the project plan in "money" form as below:

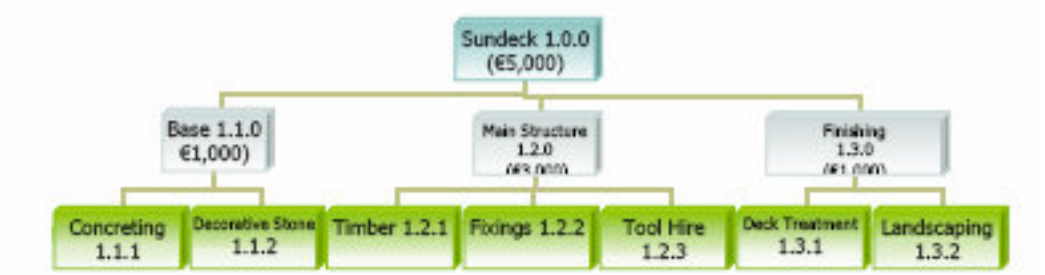


Figure 2 - A Budgeted CBS

Variation orders will reset the budget on a project. Budgets may be described as the original amount plus and addition for variations for clarity. A project budget may be plotted as an S curve, with time on the horizontal axis and expenditure on the vertical to describe the expenditure of the budget over time.

Cost escalation and (for foreign project) exchange rates may have to be considered for projects of longer durations carried out aboard. Some 'below the line' costs can be adjusted almost as mini budgets in themselves

8.1 Labour Budgets

A project manager should be familiar with the allocation of budgets in terms of person hours (sometimes called 'man hours).

9 Cost Collection Methods

The collection, analysis and recording of project costs will be set down by each company, employing different methods as varied as the companies themselves. Care mist be taken in the reporting of historical costs – what happens if these costs re more than a month old when the reach the project manager?

9.1 Collecting costs - Bought-in materials and equipment

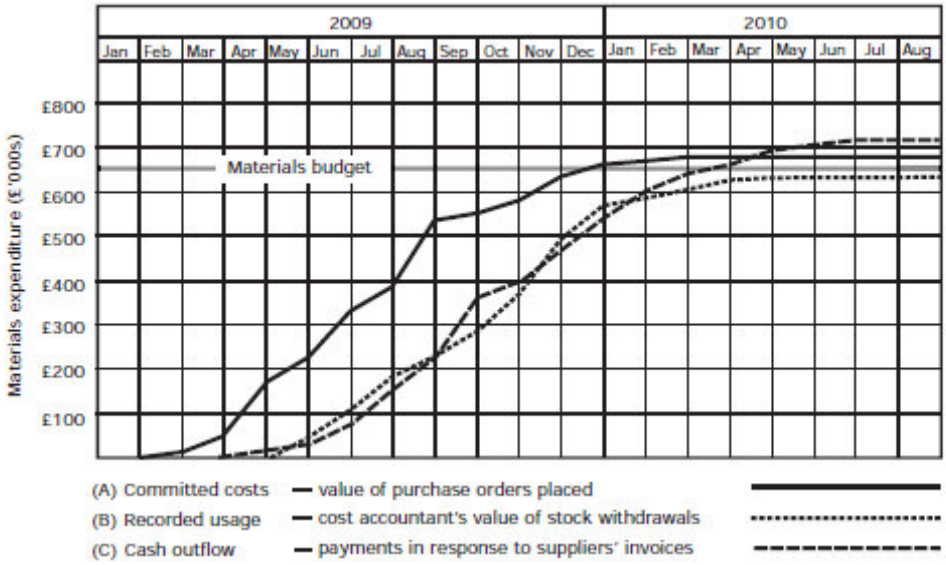
These will be collected using the company;' procedures - purchasing, accounting and stores. Note the three different methods:

Committed costs Date when the order is placed. Earliest time which costs of materials can be monitored and most useful for assessing performance against budget

Actual costs Dated when supplier's costs are to be paid.

Job costing Depends on stores' feedback on the inventory

These are summarized in the graph below:



9.2 Collecting Labour Costs

Timesheets are generally used – the time allocated to each project being allocated on a weekly basis.

Time sheets are the time honoured method for recording labour hours used on the project. Project members record the time spend weekly on the project and associate the time to the appropriate or cost code. This sheet is reviewed for accuracy by the appropriate manager or

supervisor and submitted for recording. This ensures that two cost management principles are adhered to, namely:

- The approval validates the number of hours and controls expenditure
- Recording time against the work package allows for subsequent monitoring against the cost baseline.

For maximum accuracy, time sheets should be completed daily and submitted for approval weekly.

There are particular issues associated with recording the time spent by external and agency staff on contracts. Issues of alignment between timesheets occasionally arise. Also, the project manager needs to consider whether additional measures are required to validate such work, particularly if it is being carried out in an off-site location.

This issue is further complicated when information is input directly to the accounting systems and re-keying of information may be required by the project team.

Timesheets can also be used to track the input of agency staff that may be hired or seconded into an organization.

Some PM software allows staff to direct-enter project time sheet data for sophisticated tracking against project activities.

9.3 'Day works' sheets

Used in the construction industry mainly, these are used to track sub-contractors works that may be carried out on a piece meal basis. They can be problematic in that tracking costs can be difficult and predicting the costs of an activity can be somewhat open-ended. Contractors often avoid these as the costs of sub-contractors can quickly get out of control.

10 Appendix 1

10.1 The Budget as a Graph: Drawing an S-Curve

We have seen earlier that the cost baseline can be represented by a graph which maps the accumulated cost against project time. This curve is typically a broad s-shape. This curve can be
used to understanding issues such as cost baseline and cash flow on a project. To draw an s-curve:

STEP 1 Determine the project activities and total cost (from your Baseline Budget)

Activity	Duration (days)	Total Cost
A	3	150
B	4	160
C	4	320
D	2	100
E	4	60
F	5	300

STEP 2: Determine the Average daily cost of each Activity

Activity	Duration (Days)	Total Cost	Average Daily Cost
A	3	150	50
B	4	160	40
C	4	320	80
D	2	100	50
E	4	60	15
F	5	300	60

STEP 3 – Using your project schedule spread the daily rates across the duration of the activity

SCHEDULE										
Activity	Nov-01	Nov-02	Nov-03	Nov-04	Nov-05	Nov-06	Nov-07	Nov-08	Nov-09	Nov-10
A	50	50	50							
B			40	40	40	40				
C					80	80	80	80		
D					50	50				
E				15	15	15	15			
F						60	60	60	60	60

STEP 4 – Total up the daily costs and then calculate the accumulated costs each day working from left to right.

SCHEDULE										
Activity	Nov-01	Nov-02	Nov-03	Nov-04	Nov-05	Nov-06	Nov-07	Nov-08	Nov-09	Nov-10
A	50	50	50							
B			40	40	40	40				
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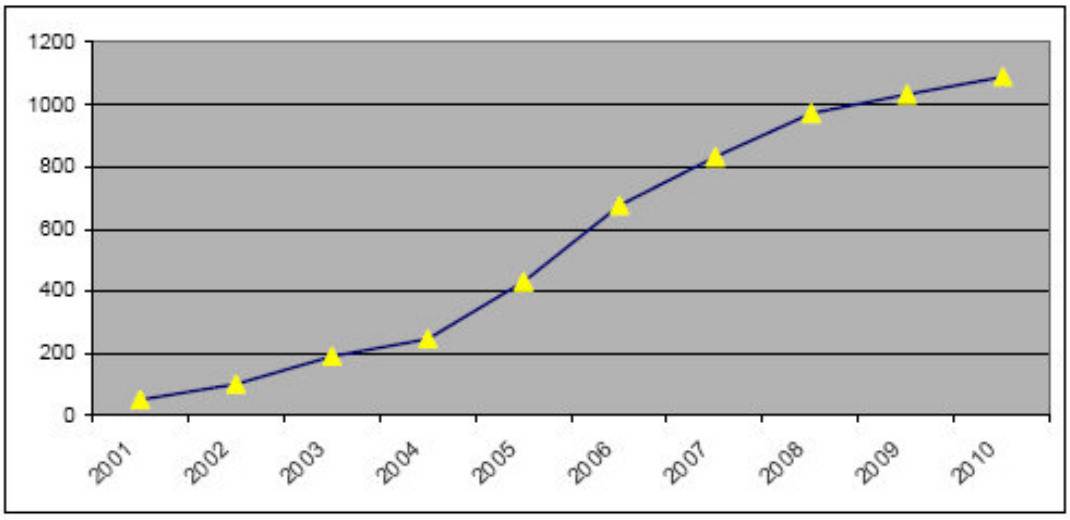
E				15	15	15	15			
F						60	60	60	60	60
Daily Cost	50	50	90	55	185	245	155	140	60	60
Accumulated Costs	50	100	190	245	430	675	830	970	1030	1090

STEP 5 - Draw a graph plotting the accumulated values against the schedule. Put the schedule on
the X-Axis and the Accumulated Costs on the Y-Axis. This graph represents your budgeted costs
over the scheduled duration of the project



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Burke, Rory, (2001) Project Management, Planning & Control Techniques, 3rd edition, Wiley
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Managing Works & Costs

Lecture 4

Cost Management - Principles

Objectives of Cost Control

To ensure….

"that no preventable wastage of money or unauthorized increase in costs is allowed"

Depending on which side of the project the PM sits:

- To make sure that a contractors own budget is adhered to.
- To fulfill a responsibility to the project purchaser for project costs

(per Lock)

Objectives of Project Cost Management

In other words:

- Ensure that the **correct costs** are incurred for each cost component
- Ensure that **costs** are **allocated to the correct component**
- Ensure that **costs** are incurred at the **correct time**
- Minimise the occurrence of **fraudulent costs**
- Minimise the costs of waste and other unnecessary costs
- Ensure sufficient funds are available to support project activity
- To help us to track project progress

Basics – Cost Estimating and Budgeting

- **Estimating** the project costs
- **Budgeting** for those costs and
- **Controlling** and **managing** the costs during the lifetime of the project.

Cost control will be the main point considered for this lecture

Additional Cost Factors

- Costs incurred (especially by the client) should be closely monitored, tracked and reported by the PM.
- Contracts which allow for additional undefined costs (e.g. "Cost plus" contracts) may pose a potential ethical issue for the PM.
- In this situation each additional cost may represent additional profit – So the project manager has often a difficult balancing act to perform!

Project Costs – Variable Costs

Variable Costs

- These costs are incurred as a proportion to the rate of working on the project.
- Generally these are 'direct' costs.
- Direct Costs – costs that can be associated directly with project activity.

Examples:

- Labour (working on activities/ managing activities/ project support activities)
- Materials
- Dedicated project equipment costs

Direct project expenses

Project Costs – Fixed Costs

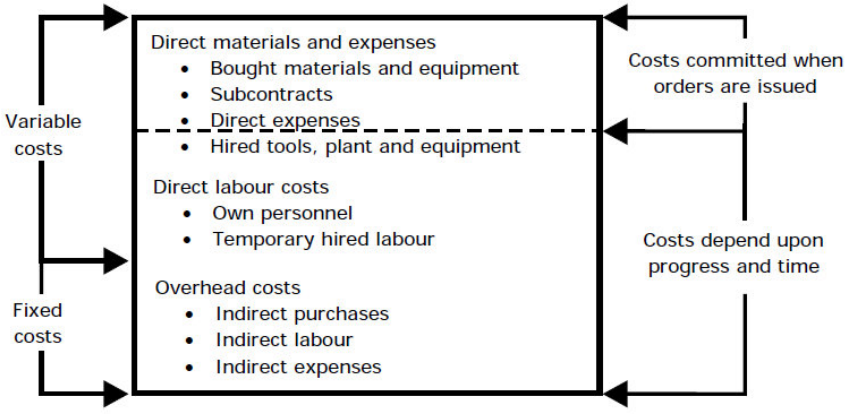
Fixed Costs
Company's overhead or indirect costs.

'Indirect' means that these are costs incurred generally in running the business. Indirect costs cannot be directly associated with projects.

Examples:

- Travel, training, insurance, depreciation etc
- Heat/light
- Accommodation
- Use of photocopiers etc

Variable & Fixed Costs - Graphic



Controlling Variable Costs

Materials and Expenses

- Constitute a large proportion of a project's costs;
- Sensible purchasing strategies can exercise cost control over a project;
- Cost negotiations must be done before the purchase order or contract is signed as at this point it is too late to exercise any influence over this;

Controlling Direct Labour Costs

- Controlling progress
- Ensuring projects run on time - prevent resources being wasted on projects
- Preventing project overruns.

Recovery of Fixed Costs / Overhead Costs

What is 'recovery'?

- The basic aim of any business is to keep Fixed Costs (indirect) as low as possible in proportion to the variable (direct) costs.
- Costs continue to accrue even when no work is taking place on the project. Examples of this??
- The boundary between fixed and variable costs can sometimes be blurred.
- Some contract structures (reimbursable) allow claiming of sundry costs (phones, printing) if these can be proven as project costs. Architects and solicitors can use this to recover costs.
- Simultaneous projects can make this exercise difficult. Being able to charge as many costs as possible (once it is justified).

How can costs be recovered

- Use of a simple requisition system for printing - use of client or cost codes;
- Mandatory use of cost codes on petty cash vouchers and all expense claims forms;
- The installation and proper day-to-day management of an automatic call logging system covering all telephone / fax lines.

Recovering Overhead Costs

Absorption Costs

- €/hr or day multiplied by the chargeable unit (hour / day) works out what's known as 'absorption costs'.
- Calculating the hourly rate and applying a mark up (for overheads and an element profit).
- Overheads % may depend on the type of business the company is operating in.
- Companies who can keep indirect costs to a minimum can enjoy competitive pricing advantage.

Under & Over Recovery

Under Recovery - Where the amount of direct costs falls below what's forecast. Happens where projects do not materialize / over optimism.

Over Recovery - Occurs where direct labour billings exceed what's expected. Can increase profitability but indicate the competitiveness is not very well aligned.

Total Cost Approach

- Treats costs holistically,
- Involves resolving logistical issues or other issues that may impact on costs with a view to making them as minimal as possible.
- The influence or impact on the project design and projects costs.
- Example - A design change that involves more reworks of a design but results in more efficient production / construction methods.

Setting and Resetting Cost Budgets

Budgets - derived from estimate

Budgets before 'below-the-line' allowances (for example contingency) and indirect costs.

These budgets become the maximum authorized level of spend.

WBS & CBS

- These allow costs to be distributed on the sub-project parts.
- This CBS will have been created when defining the scope of the project.
- This source CBS will also be used when planning and controlling other aspects of the project.

Collecting Costs – Bought in Materials & Equipment

These will be collected using the company's procedures - purchasing, accounting and stores. Note the three different methods:

Committed costs

Date when the order is placed. Earliest time which costs of materials can be monitored and most useful for assessing performance against budget

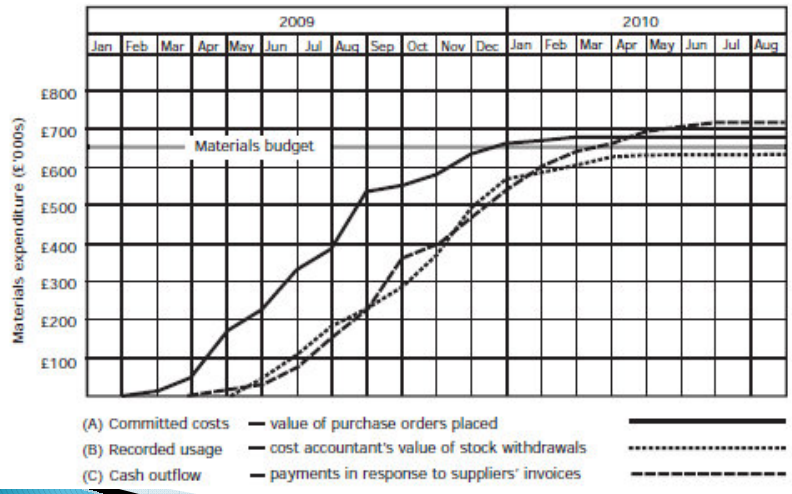
Actual costs

Dated when supplier's costs are to be paid.

Job costing

Depends on stores' feedback on the inventory

Illustration – Materials Purchasing



Collecting Labour Costs

- Timesheets
- Time against work is recorded – approved by a manager / PM
- External staff – sub-contractors – how to record their time?
- Day Works

Drawing and S-Curve

The cost baseline can be represented by a graph
Maps the accumulated cost against project time.
This curve is typically a broad s-shape.
can be used to understanding issues such as cost baseline and cash flow on a project.

We will briefly run through the drawing of an s-curve:

STEP 1 Determine the project activities and total cost (from your Baseline Budget)

Activity	Duration (days)	Total Cost
A	3	150
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D	2	100
E	4	60
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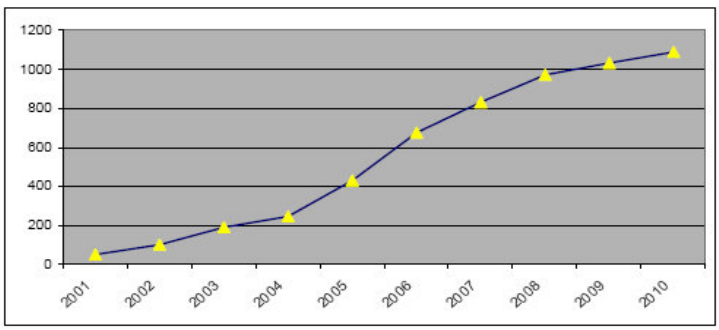
STEP 5 - Draw a graph plotting the accumulated values against the schedule. Put the schedule on the X-Axis and the Accumulated Costs on the Y-Axis.

This graph represents your budgeted costs over the scheduled duration of the project



Week 5 – Cost Management – Earned Value Analysis and Cost Reporting

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1 Learning Objectives for this Chapter

Having completed this chapter you will:

- Complete a simple milestone analysis
- Appreciate the need for Earned Value (EV)
- Be able to calculate EV figures
- Construct a simple EV analysis
- Be able to interpret the findings of an EV Analysis

2 Introduction

We reviewed the general steps needed to ensure that our cost management activities will be effective:

- Get the systems/processes in place to collect and report on costs.
- Configure our systems to provide information that will allow analysis and action (Cost codes /WBS)

We also looked at some issues with the collection of labour information using time sheets. We concluded by looking at a method of calculating the cost baseline for a project.

When this baseline was drawn as a graph which showed the accumulated cost over the lifetime of the project it resembled an s-curve shape. All subsequent cost measurements could be made with respect to this baseline curve.

3 Overview of Earned Value

Many of the simple methods for assessing project progress are incomplete as they do not take into account more than one aspect of project performance. They can measure schedule progress or cost progress or quality progress. There was a need to use some form of integrated view of cost and time in order to achieve a holistic assessment of project performance.

A simple integrated method called Milestone analysis which combines analysis of:

- Achievement of significant milestones
- Budgetary spend for the work packages associated with those milestones

This approach has limitations; - its main drawback is that it is frequently too late to take action when you have detected a variance.

An S-curve is used as a basis for the earned value method of tracking cost and progress.

4 Milestone Based Analysis

Measurement of progress without reference to cost is only of limited value. The same can be said for the measurement of cost information alone without reference to progress. The Earned Value (EV) approach provides an effective integrated approach to the monitoring and control of project. However the EV approach requires quite sophisticated cost accounting techniques and significant amount of effort to set up and operate. There is a simpler but less rigorous alternative - milestone based analysis. A project manager will need to know:

- How much have we spent to date?
- What should we have spent to date?
- What have we achieved so far?
- What should we have achieved by this time?
- What are the final cost and delivery prospects for the project if our performance continues at the current level?

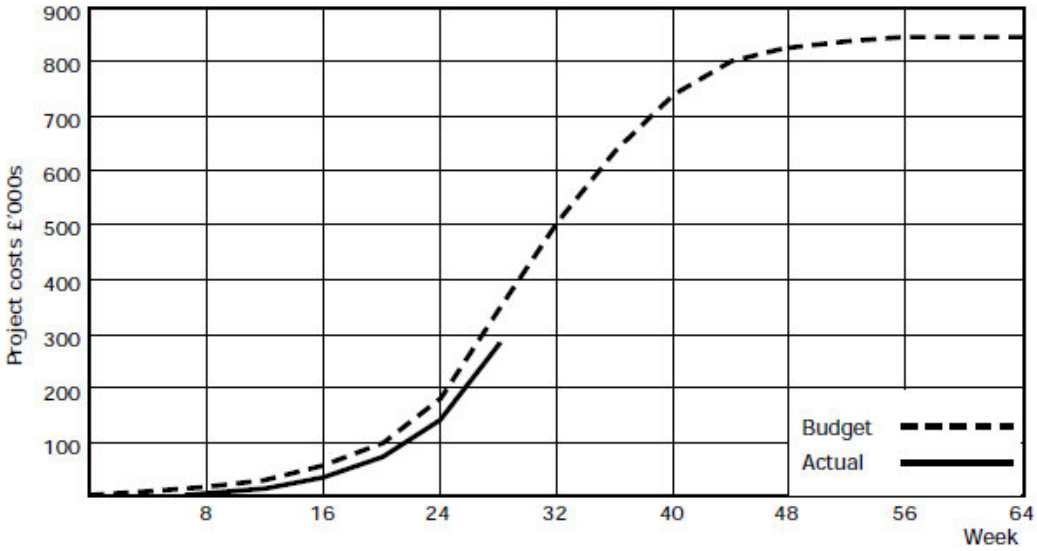

Figure 1 - Budget v actual spend

5 Steps to Milestone analysis

A) Firstly we need to Establish the milestones. A **Milestone** is defined as:" **"a significant point or event in the project and** is often marked by presentation of a significant deliverable or completion of a major body of work. This could be the publication of a draft report, successful completion of the testing of a piece of software etc.

B) Establish the date on which the milestone will be achieved

C) Establish the cost associated with achieving the milestone

D) Plot a milestone to budget curve. This should resemble the s-curve plotted for the budge Baseline

E) Plot actual expenditure against milestone achievement on the same graph as below (see the graph below)

F) Analysis of the graph shows that the week 1 milestone was achieved as per the schedule, however the level of costs is low. The low relative level of costs continues and milestone 2 appears to have been delivered slightly early! The following milestone has happened later than expected and the level of costs still remains low. Continued analysis done in this way will expose trends in progress and costs.

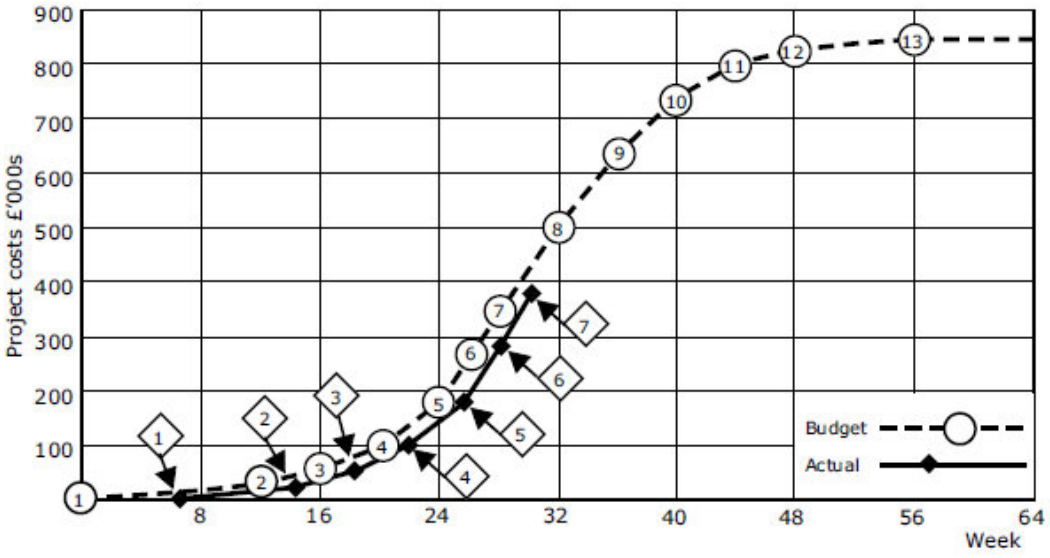

Figure 6 - Milestone Based Analysis

6 Limitations of Milestone Analysis

Coarser measurement than earned value so it can be too late to react to significant variances. It is also difficult to forecast project outcomes using its results.

7 Earned Value Analysis

Earned Value analysis is a more rigorous approach. In contrast to Milestone Analysis this approach was able to provide information in time to take corrective action. In addition it would even allow the project manager to make some predictions about the future performance of the project.

At its core it was all about comparing the cost incurred for a piece of work with the costs budgeted for it. Earned value calculations can be performed with three basic pieces of information:

1. Our Cost baseline figure at time now (BCWS – Budgeted Cost of Works Scheduled)
2. Percentage completion (PC) of the activity at time now.
3. The Actual Cost incurred so far for the activity (ACWP – Actual Cost of Works Performed)

From these three we can calculate a number of variances and indices.

Some of the terminology used in EV can be summarised as follows:

ACWP Actual Cost of the Work Performed at the measurement date (i.e. from invoices, labour records, timesheets etc)

BCWP Budgeted Cost of Work Performed – this is the amount of money or labour time that the amount of work actually performed at the measurement date should have cost to be in line with the budget or cost estimate. It is usually necessary to take into account work that is in progress in addition to tasks actually completed.

BCWS Budgeted Cost of Work Scheduled – this is the budget or cost estimate for work scheduled to be complete at the measurement date. It corresponds with the time-scaled budget.

CPI Cost Performance Index – this factor that indicates the measure of success in achieving results against budget. Anything less than unity indicates that the value earned from money spent is less than that intended.

Schedule Performance Index – this can be used as a measure of progress performance against plan, but is less commonly used than the CPI. Anything less than unity shows progress slower than that planned.

These quantities can be used in the following expressions:
CPI = BCWP / ACWP
SPI = BCWP / BCWS

8 Why Earned Value?

Ways of assessing the progress of the project can include:

- Getting reports on the amount of work completed at point in time
- Monitoring the achievement of certain milestone dates.
- Gathering information on project spend over time

To this list you could also add the task of reviewing the quality and completeness of the results produced by the project so far. However each of these measures reflects only a single aspect of the project and, considered in isolation, are unreliable as indicators of **total** project performance. Take for example the graph shown below which shows project progress over time

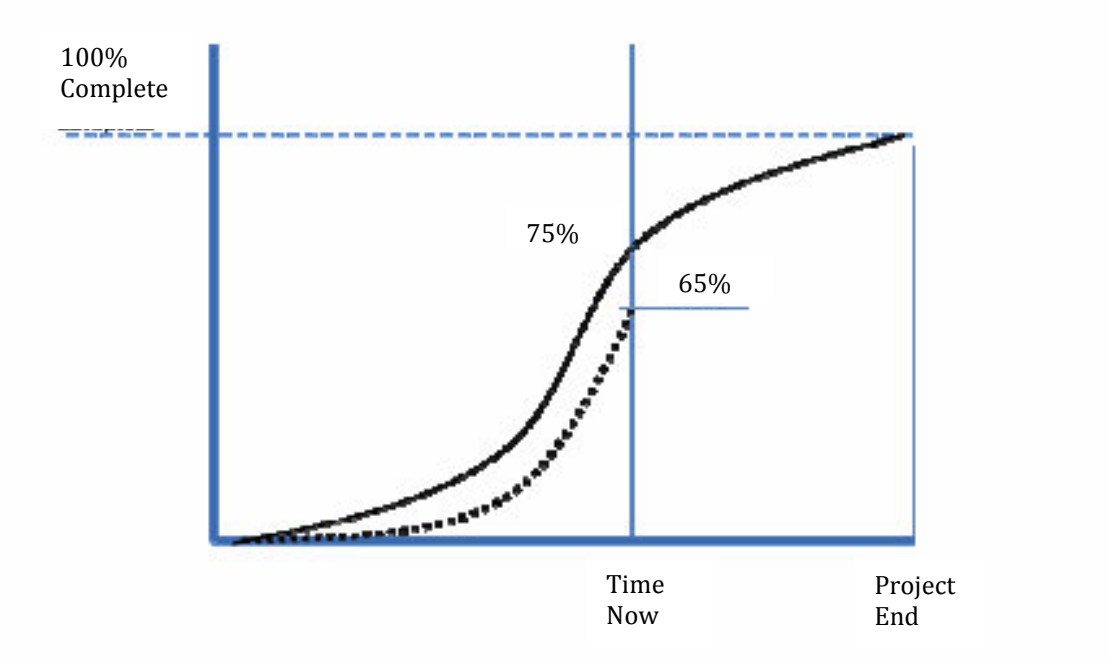

Figure 1 – Progress against Time

The solid curve represents the % of work planned to be completed at any point in time. At the time of measurement (called “time now”) the planned completion was 70%. However measurement indicates that actual completion stands at 65% (the dotted line). This may indicate to the project manager that the project will be late. The project manager may interpret this information as indicating that a faster pace of work by the team may bring things back into line.

However this analysis does not take into account the cost situation at this point in time. An analysis of expenses to date may reveal there is a corresponding cost under spend on the project. This would validate his assessment. However it is possible that analysis of expenses might instead reveal a cost overrun at that point. This may require an entirely different action to correct. Therefore, in order to achieve a holistic assessment of project performance, an integrated view of cost and time is required

9 Using Earned Value

Earned Value Analysis is an early warning tool that allows project managers to identify potential problems early enough to take corrective action. It measures actual accomplishment on the project and compares it to planned accomplishment. In other words it tracks and compares the costs incurred for a piece of work with the costs, which were budgeted for that piece of work.

To perform Earned Value Analysis you need the following to be in place first:

- A detailed Work Breakdown Structure
- A corresponding cost coding system
- An efficient mechanism for collecting cost data
- An efficient mechanism for collecting work progress data

10 Building up an Earned Value Graph

Earned value analysis can be constructed in tabular or in graphic form. We will use the graphic form here to illustrate the concepts. Graphs are a particularly useful reporting tool because they give clear and quick indication of performance trends. Graphs can be supported by more detailed information in tabular or spreadsheet format. Easy understanding of the concepts can be complicated by the various abbreviations used. However the principle of EV is based on a small number of simple arithmetic calculations and formulae. Let us start with the budget baseline we constructed in Chapter 3 (Illustrated below).

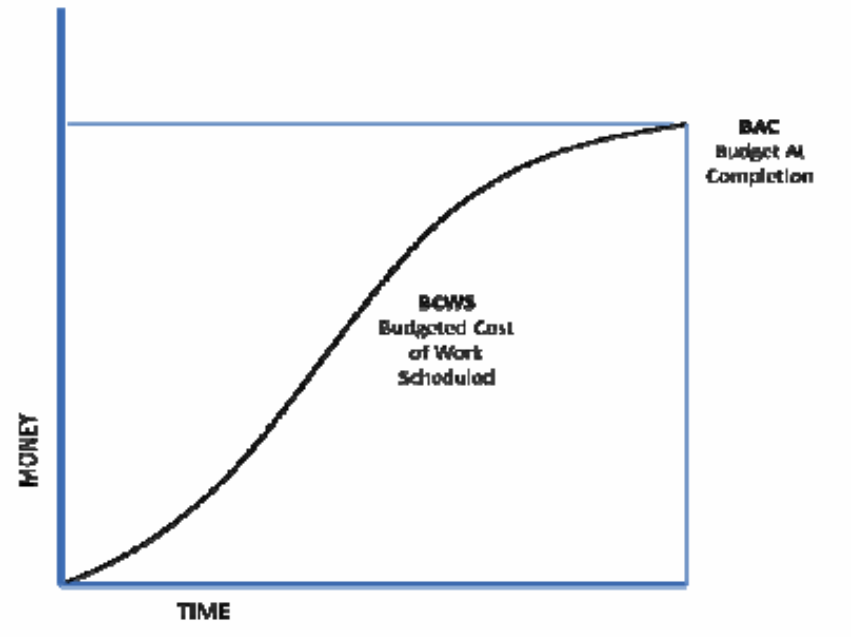

Figure 2 - BCWS & BAC

This is a representation of the cost baseline of the project over time. It represents the accumulated costs at each point in the project cycle. In Earned Value Analysis this is called “The Budgeted Costs of Work Scheduled“ or BCWS. It is also referred to as the Planned Value (PV).

BCWS is defined as:" **the budgeted cost for the work scheduled to be completed on an activity or a work package"**

At the end of the project this figure should equal **the approved project budget for the activities** i.e. the **BAC (Budget at Completion).** This graph becomes the centre of all earned value calculation.

Once the project starts it is almost certain that some planned schedule and costs baselines will vary. In order to detect these variances, measurements take place at regular intervals (each measurement time is usually referred to as **"time now"** or "date now"). The next stage is to complete some calculations on the value "earned" to date against what value had been "planned to be earned".

Our monitoring systems should be able to provide us with the following three pieces of information at "time-now" for each Work Package to be measured:

A) **PC (Percentage Complete) is a measure of the activities performance and measures the proportion of the activity which has been completed at 'time-now' (the earned progress)**

Note: Certain assumptions and rules may be required in order to give a realistic interpretation of this % progress figure. The three common rules are:

The 50-50 rule: When the task begins it is deemed to be 50% complete. It is 100% complete only when all work is done

The 0-100% rule: (The All or Nothing rule) The action remains at 0% until complete

T**he Proportionality rule:** Divide the time taken to date for the task by the total time scheduled for it.

B) **BCWP (the Budgeted Cost of the Work Performed) – this is a measure of the value of the actual work done to date. It is also known as the Earned Value (EV).**

It is calculated by applying your percentage complete figure (PC) to the Budget at Completion

Figure as follows:

BCWP = PC × BAC

C) **ACWP (the Actual Cost of Work performed) – this is the amount of money payable for the actual work completed to "time-now".**

Having gathered this information we can draw a graph, which might look like this one:

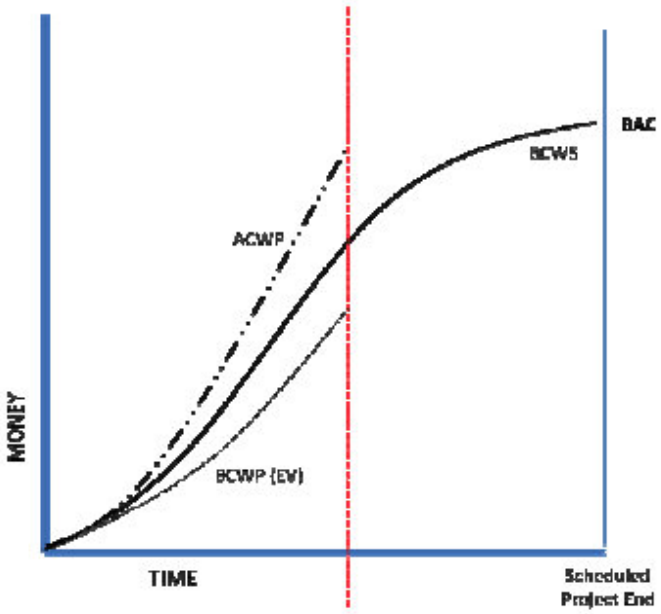

Figure 3 - Adding BCWP and ACWP to the graph

11 Analysis of the Graph

The first step in analyzing your information is to identify some variances. There are two common variances - I will show the two calculations together:

CV (Cost Variance) = **BCWP** - ACWP
SV (Schedule Variance) = **BCWP** – BCWS

(Note that each variance involves a subtraction from BCWP)

How should you interpret the result?

Well, in each case a negative number is a bad thing!

- A negative CV means a cost overrun.
- A negative SV means the project is behind.

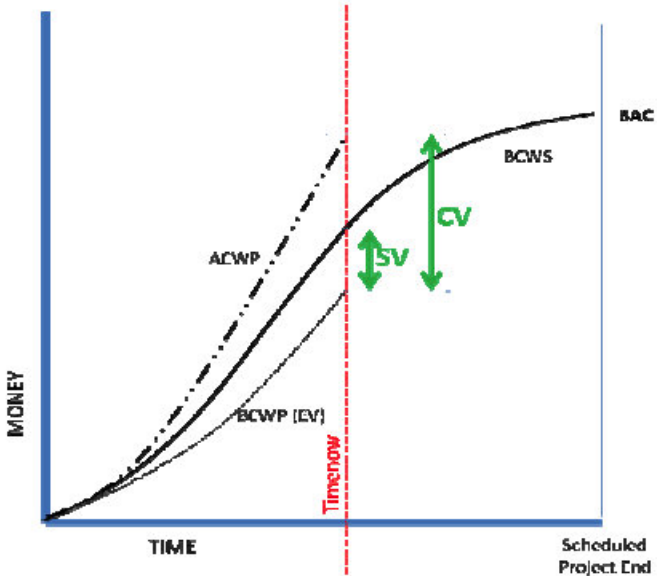

Figure 4 - CV and SV

12 Calculating Indices

Another approach is to calculate a performance index for the project. This can be useful when comparing the performance of a number of different projects. We can calculate Cost and Schedule performance indices.

Cost Performance Index (CPI) is a measure of the rate at which the project performance is meeting cost expectations

CPI = BCWP/ACWP

A value less than 1 indicates that the project is spending more than it is earning and may
ultimately exceed budget if not corrected.

Schedule Performance Index (SPI) is a measure of the rate at which the project performance is meeting schedule expectations

SPI = BCWP/BCWS

A value less than 1 indicates that the project is behind schedule and may finish late if not corrected.

13 Earned Value Example

Let's take an example to illustrate what we have learned so far:

Let's assume that our Project has a total activity budget of €3,000 (BAC) and project duration of 10 days. According to the Cost Baseline we had budgeted that work completed up to today would cost us €2,500. (BCWS)

By assessing the outputs of the work we reckon we are 50% complete on the activities so

BCWP = PC × BAC

BCWP = 50% × 3,000 = €1,500

Looking at our cost collection system we learn that we have spent €1,200 (ACWP)

How is the project doing?

If we look at schedule first we calculate the Schedule Variance as follows:

SV (Schedule Variance) = **BCWP** – BCWS

SV = €1,500 - €2,500

SV = - €1,000

This tells us we are behind schedule.

Let's look at Cost:

CV (Cost Variance) = **BCWP** – ACWP

CV = €1,500 - €1,200
CV = €300

..But our costs are lower than our original estimate!

Using Performance Indexes we get:

SPI = BCWP/BCWS

SPI = €1,500/ €2,500
SPI = **0.6**

CPI = BCWP/ACWP

CPI = €1,500/ €1,200
CPI = **1.25**

14 Forecasting

Earned Value Analysis also enables the project manager to make some forecast of future project performance. We have seen how CPI and SPI can indicate the rate of project performance. They can also be used to predict likely project outcomes if the rate of performance continues.

We can attempt to forecast a revised completion date by dividing our scheduled project duration (10 days) by the SPI, which gives a total revised project duration of 16.6 days! In the worked example above we also calculated a CPI of 1.25. We can predict the total project cost by dividing BAC by the CPI figure which gives a figure of €2,400, which is a saving of €600.

This revised estimate is also called the Estimate At Completion (EAC)

EAC = BAC/CPI

From the EAC figure we can estimate how much will be spent on the project (presuming past experience is a reliable guide). This is called the Estimate to Complete and is calculated by subtracting the actual costs incurred so far from the EAC.

ETC = EAC - ACWP

Finally we can estimate the budget variance at completion (VAC) as the difference between what was budgeted (BAC) and what will actually be spent (EAC)

VAC = BAC - EAC

The Graph below illustrates these calculations.

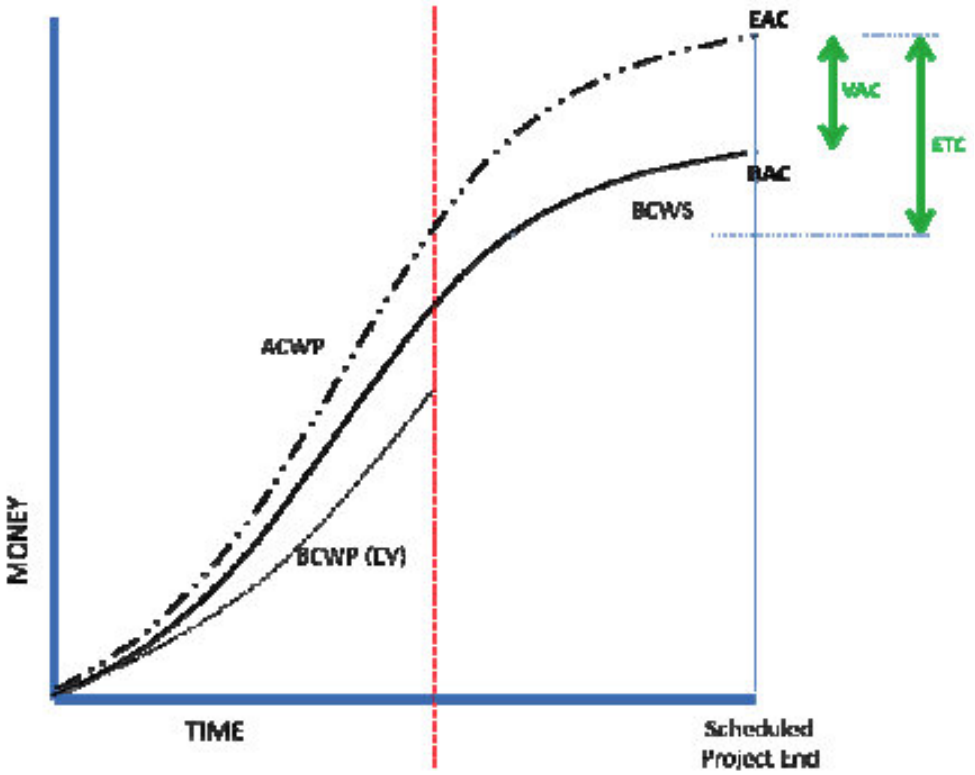

Figure 5- EAC, ETC and VAC

15 References & Resources

Project Management Institute (PMI), Guide to the Project Management Body of Knowledge (PMBOK), 3rd edition, PMI

Burke, Rory, (2001) Project Management, Planning & Control Techniques, 3rd edition,
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Lock, Dennis (2007) Project Management, 9th. Edition, Gower – Chapter 27

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MANAGING WORK & COSTS

Lecture 6 - Managing Closure

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1 Introduction

In this chapter we look at the important closure phase of the project. We will identify the important closure tasks and the required documentation.

2 Reasons for Project Closure

A project may come to an end in a pre-arranged way (for example, achieving a completion milestone) or it may be abrupt (for example, postponement due to project funding being cut). Some of the reasons are summarised by Lock as follows:

- The project has been completed and handed over to the project owner, with or without complete success.
- The project contractor has run out of funds, leaving the owner to find a new contractor.
- The project owner has permanently run out of funds, killing the project.
- The project owner wishes to make fundamental changes, causing the project to be scrapped and restarted.
- Changed economic or political conditions mean that the project will no longer be financially viable for the owner in the foreseeable future (for example, a fall in the price or demand for a commodity that removes financial justification for building new plant to increase production capacity).
- The customer asks for the project to be 'put on hold' (delayed indefinitely) pending a possible improvement in market conditions or to await the results of a reappraisal.
- Government policy changes (possible for many reasons) resulting in termination of some government contracts. Defence contracts for weapons systems, ships and aircraft are always subject to such risks.
- An Act of God (flood, tempest and so on) has intervened, causing further work on the project to be suspended or abandoned.
- Hostile activities have broken out in an internal or international conflict, making work on the project impossible.

3 Why Manage Closure

As with all other project work, closure of the project should be planned and controlled. The objective of the closure is to ensure a definite and complete conclusion of the project. Unmanaged closure can result in a tendency for the project to "drift". Late changes may then arise which further prevent closure and may increase costs significantly. A drifting project can also become a cause for concern to project members and result in lowered motivation for the project members involved.

There are a number of circumstances under which projects are closed:

It has achieved its planned objectives and run its full planned course **or** It is terminated prematurely because:

a) It has not achieved all of its objectives and is unlikely to in its present form
b) External events have overtaken it and made its objectives redundant or of lower priority

In each of these circumstances, it is the responsibility of the project manager to ensure that the closure is completed in a planned and professional manner.

4 Formal Closure Process

In "Successful Project Management", Young provides a useful step-by-step closure process. The following paragraphs outline the steps. Note: Sometimes the "Sign off" and the "Post Project Evaluation" steps are combined and a single closure report are produced which contains the closure agreement and the lessons learned. An additional sixth step may be

completed at a later date in order to review whether the project has delivered the benefits proposed. This review answers the question – "Was the project worth doing?" This step may not be the responsibility of the project manager.

5 Step 1 – Confirm Completion Criteria

During project planning and contract negotiations you should have agreed the criteria, which will be used to determine when, the project is actually complete and whether the project results are acceptable to the client or customer. You should also have agreed how these acceptance criteria will be measured and verified. It is important to have defined exactly what closure means to the customer or sponsor, particularly if the project scope has been through a number of changes along the way.

Typical acceptance criteria might include:

- All project tasks complete
- All deliverables produced
- Associated documentation handed over:

a. Design Material
b. Process & Procedure Manuals
c. Technical specifications etc
d. All testing completed and signed off
e. All required training completed
f. All project issues closed
g. No outstanding change requests
h. Name of person who will accept the project completion

6 Step 2 – Review Project Status

In preparation for formal closure, the project manager should verify that all project tasks have been completed. There should be no significant task uncompleted at close. He should note any minor tasks, which will be uncompleted before closure date and prepare action plan to complete them. He should review the acceptance checklist and make sure that all items are addressed and that he has supporting evidence for this.

7 Step 3 – Close-Out Meeting

The purpose of this meeting is to secure acceptance of the project completion from your customer. If the previous stages have been completed correctly then this should just be a formality and there should be no reason for the customer to delay closure.

At the meeting the project manager should:

- Review the deliverables
- Confirm completion of the confirmation checklist
- Explain any outstanding actions
- Review and close the project issues log (agree ownership of outstanding issues)
- Finally - Thank the team & customer!

8 Step 4 – Sign Off

- Get the Signature – who's accepting the project?

9 Step 5 – Post Project Review

As we know, all projects are unique - which means there is always something new to learn from each one. The purpose of the post project review is to establish what project activities went well and which didn't go quite as well. These learned lessons could be recorded and made available to the project manager and team and also to other people engaged on projects across the organization. When conducting such a review, ensure that they are not used as an opportunity to assign blame for any problems or project delays. Ideally, the project

team and key stakeholders should meet to perform the review. In practice this can be difficult to arrange as many of the team may have moved on to other projects.

As an alternative you could distribute a structured questionnaire and request detailed responses.
If you do hold a meeting, it can also be useful to issue a questionnaire before the meeting in any case. This allows the meeting participants to prepare for the meeting and to structure their thoughts. In order to ensure that all areas are covered, it is recommended that a suitable categorization of review topics is used.

Here are some examples:

- Review by Phase – Initiation / Planning & Design / Execution / Handover
- Review by WBS – First Fix / Second Fix or Building / Hardware / Software /Training
- Review by Project Management Area - Scope/ Contracts/ Risk /Resources etc

Whatever the approach, the tone of any communications or meetings should be positive, constructive and neutral in emotion. When you are finished, you should highlight the successes and celebrate the overall achievement.

The resulting Project review report should contain the following:

a) Review of Project Objectives:
   - Schedule & Milestones
   - Budget
   - Deliverables

b) What went well
c) What didn't go so well
d) Lessons learned
e) Actions that can be taken now (to improve methods & procedures etc)

The appendix contains a simple word document template, which can be used to structure the review report.

10 Cost Cut Off

At the appropriate point in the closedown process an instruction is required to stop spending against the project, effective from the agreed closure date. Otherwise personnel may continue to book their time in error (or deliberately!!). Hours can be booked mysteriously to projects, so it is important to formally close off the timesheet system.

If people are entering their work hours directly into the project accounting system then the close down can be enforced by blocking the relevant cost codes on the system. Otherwise the Project Manager (or Project Accountant) needs to remain vigilant in monitoring costs. In some cases there may be agreed budget to allow for some wind-down tasks after the closure date. These costs should be clearly segregated and can be referenced in the closure order. These tasks should not include any work on changes to the project deliverable and should be reserved for project administration, record completion and archiving.

11 Formal Project Closure

Announcing that the project is closing (either intentionally or prematurely) announces that project expenditure is going to cease. It is a similar process to authorisation in that it is a formal process instigated at project completion.

12 Project Closure Document

Giving formal notice that a project is coming to an end may be encapsulated in a Project Closure Document. Such a closure notice should clearly state:

- project title
- project number
- effective closure date
- reason for closure
- any special instructions
- signature authorizing the closure
- distribution, which should at least include all those who received the authorization notice
  when the project was opened.

Make sure to circulate this document to all involved in the project. Lock has suggested the following format which would cover most project situations and types:

NOTICE OF PROJECT CLOSURE

The following project will be closed to time bookings and all expenses with effect from the date given below

Client: Lox Chemicals Limited — Project number: LX 5150

Project title: Loxylene Plant (Huddersfield) — Closure date: 20 Apr 04

The following budgets are hereby authorized for the closedown activities marked in the checklist below

Department	hours by standard cost staff grade						£
	1	2	3	4	5	6	
Project engineering	10			20	40		960
Planning				10			140
Purchasing			15				240
Installation and commissioning							
Construction management	5						100
Computing				1			14
Records and archives			10		200		2560
TOTALS	15		25	31	240		4014

Special ins tructions:

Take special care with filing. A follow-up project is expected. All files to be destroyed after five years unless otherwise directed below.

CHECKLIST OF PROJECT CLOSURE ACTIVITIES	
Project case history	PM to write, keep it brief
Project specification	Has been kept up to date but needs checking
Project variations	List and check that the file is complete
Drawing schedules	Keep 10 years in engineering files
Design calculations	Keep indefinitely in engineering files
Our drawings	Check they are as-built and keep indefinitely
Client's drawings	Return to client
Purchase control schedules	Keep 10 years in engineering files
Vendors' drawings	Keep 10 years
Purchase orders	
Expediting/inspection reports	
Test certificates	Keep 10 years
Operating/maintenance instructions	Keep 15 years
Spares lists	
Maintenance contracts	
Subcontract documents	Keep 10 years
Correspondence files	
Final cost records	Keep 10 years in general reference files
Photographs	Edit. Discuss with publicity dept and client
Critical path networks	Destroy after 1 year and erase computer files
Management information system	Delete project from MIS at year end

Prepared by: A.Scribe — Project manager: I.Diddit — Authorized by: *B. I. G. Whitechief*

The cost of storage of materials (files, drawings) either physically or virtually will need to be considered, either as an ongoing cost to the company or perhaps already built into the agreed contract costs.

13 Final Project Cost Records

These costs can be used as a useful data base for future project cost comparisons

14 Disposal of Surplus Material Stocks

The PM may have to consider how to handle any excess material and stock associated with the project if these are not to be used elsewhere. Materials accumulated in this way represent an ongoing cost to the contractor- they should be sold on to the customer or disposed off otherwise as soon as possible.

15 As-Built Project Condition

Recording the as-built condition of a project is important. All drawings and specifications are typically identified and any changes to these recorded. Operating instructions for equipment and plant are also important for the customer and end user.

A final drawing register, recording the 'as-built' drawings, will serve as a useful document in identifying the drawings and specification that have made up the project.

Purchased equipment will need maintenance agreements set up to maintain it. There is a certain mount of responsibility to the customer to ensure it is operating as it was specified. Post-project service agreements will need a contractor coming fresh to the post-contract phase and taking responsibly for the installed equipment

15.1 Other Documentation

Design calculations – these may become useful if reference needs to be made to access structural calculations or, in a worst case scenario, investigation of structural failure where injury occurs and legal proceedings follow.

Change documents and inspections documentation, All contract variations, All contract variations, modifications, engineering change requests, concessions, production permits, final inspection reports, test certificates and similar documents that help to define the final design status and quality of the project should be filed and indexed. For example:

- Correspondence
- Letters to / from
- Emails
- Etc

Decide where this central depositary will be archived and maintained. You may chose to use the WBS as a basis for building up and organizing the archive, as each element can easily be retrieved if need be.

15.2 Managing Files and Archives

A baseline description of the scope and specification of the deliverables is normally defined at design stage for all projects. In engineering projects this is normally represented by a set of project drawings. In other applications this may be represented by a Functional Specification of the deliverables or by some other technical description. As change requests are accepted this description needs to be updated to reflect the changes. An important task at end of any project is to ensure that this description of the product delivered by the project reflects what was actually handed over. Lock calls this the "as built condition" In order to complete this task all of the descriptive documents should be gathered together into a project file (paper or electronic) and verified as being up to date. This up to date description is often supported by other documents such as Instruction manuals, Training manuals, technical specifications etc. In many cases this document set is itself a deliverable of the project.

Note: The contractor may also wish to keep a copy of all documentation for reference. This may be used to provide support and maintenance for the product. Alternatively the contractor might anticipate that further projects will arise which may reference the documentation. There should be clear action plan for the management of files remaining with the project team either paper or electronic. Options to consider are:

- Destroy immediately
- Return to client
- Store for X weeks/days /months
- Onsite /Offsite
- Allow access to files A,B C etc
- Archive for X months/Years
- Onsite /Offsite

16 Closing the Resources

Bearing in mind that your successful project was delivered using living, breathing people, the project manager must also ensure that the exit of these people from the project is managed professionally and sensitively. A possible approach is to prepare a re-deployment sheet for the project indicating, for each person:

- The source of the resource (Functional area/ Temporary hire/contractor etc)
- Date of joining the project
- Role on the project
- Date of leaving the project
- Target area for redeployment of the resource e.g.

a. Return to full time working in their functional are
b. To be released from the company
c. Reassigned to project X for Client Y

In this way there should be no confusion as to the future position of each person. This document can be including in a project closure report.

17 Appendix 1 – Template for Post Project Review Report

Post Project Review Report

Post Project Review Report
Name of Project:
Project ID:
Date and Location of meeting (if held):
Names of attendees/reviewers:

1. Overview by Project Manager: (brief list of highlights, accomplishment, etc.)
2. Review by team of goals, objectives/ deliverables and schedule as outlined in the (updated) Project Plan

	MET	MISSED	PARTIALLY MET	COMMENTS
Project Goal				
Objectives / Deliverables				
Success Criteria				
Schedule				
Budget				

3. What worked well; what could have gone better?

Worked well	Could have gone better

4. Lessons Learned

5. Next Steps / Improvement Plans

- Project Management Institute. Guide to the Project Management Body of Knowledge (PMBOK), 3rd edition, PMI
- Burke, Rory, (2001) Project Management, Planning & Control Techniques, 3rd edition, Wiley
- Lock, Dennis (2007) Project Management, 9th. Edition, Gower
- Young, Trevor L, (2000) Successful Project Management, Kogan Page

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1 Managing Work And Costs

1.1 Chapter 1

1.1.1 Project Charter/Initialisation

- Outline 4 of the key headings a Project Manager would include when drafting a Project Charter. (20)
- The Project Charter is a document which may be used to formally authorise a project and document initial requirements that satisfy the stake holders needs and expectations. Drawing on this statement, discuss 4 of the items that would typically be included in the Project Charter.
- Outline 4 of the key headings a Project Manager would include when drafting a Project Charter. (20 marks)

- The Project Manager should ensure that 4 key steps are taken when initiating a project. Drawing on this statement, discuss each of these steps.

1.1.2 Responsibility Assignment Matrix

- A Responsibility Assignment Matrix is a useful document in allocating project tasks between participants. Discuss the key headings of such a Matrix, briefly describing each of its constituent parts. (20)

1.2 Chapter 2

1.2.1 Closed Loop

- When exercising monitor and control over a project, we sometimes refer to a closed loop system. Discuss the 4 components of the closed loop system used to monitor and control a task.

- A closed loop control system is a good technique in maintaining control over a project. Discuss the 4 components of the closed loop system used to monitor and control a task. (20 marks)

- When exercising monitor and control over a project, we sometimes refer to a closed loop system. Discuss the 4 components of the closed loop system used to monitor and control a task. (20)

1.2.2 Progress

- Discuss each of the 4 main techniques available to the Project manager to address progress problems on a project. (20)

- Discuss four corrective actions available to a project manager when a project starts to run late.

  3.2.3 In addressing progress delays on a project, there are 4 main techniques available to the project manager. Discuss each of these, outlining the basic principles in each case. (20 marks)

1.2.3 External Resources

- A project manager will sometimes have to manage external resources on a project. Describe 4 issues that the project manager may have to consider in managing such resources.

1.3 Chapter 2

1.3.1 Change Control Process

- It is essential that a change control process is followed strictly adhered too when managing work and costs on a project. In light if this statement, outline four steps involved in the change control process on a project. (16 marks). Identify and briefly discuss a Change Control Process which may be used to prevent Scope Creep on a project. (4 marks)

- Describe the Change Control Process a project manager might implement on a project to ensure change was satisfactorily managed. (20)

- Identify and briefly discuss a Change Control Process which may be used to prevent Scope Creep on a project.

1.4 Chapter 3 and 4

1.4.1 Cost Management

- Answer (A) and (B) (a) In its broadest definition, the process of Cost Management can be broken down into three components. Discuss each of these, highlighting the key differences. (15 marks) (b) Name the two main cost categories that may be incorporated into a project budget, outlining 2 examples of each. (2 x 2.5 marks)

1.4.2 Cost Over runs

- Discuss 4 of the main causes of cost over runs on projects

- Discuss 4 of the main causes of cost over runs on projects (20 marks)

1.4.3 Cost Types

- Giving one example in each case, discuss two types of costs that need to be considered when building up a project estimate. (2x10)

1.4.4 Earned Value Analysis

- Answer (a) (b) and (c) An Engineering Project has a budget at completion of 6,300 and project duration of 11 days. The project manager has assessed that the project is 75A) Calculate the schedule variance and the cost variance for the project activity. B) Calculate the schedule performance index and cost performance index for the project activity. C) What is your interpretation of the results?
- Answer Part (A) and Part (B) An Earned value Earned Value Analysis is performed on day 8 of a 10 day project, and gives the following results: (a)Budgeted Cost of Work Performed - 4,900 (b)Budgeted Cost of Work Scheduled - 6,000 (c)Actual Cost of Work Performed 6,500 (d)Calculate the Cost Variance and Schedule Variances (10 marks) Describe the difference between Budgeted Cost of Work Scheduled (BCWS) and Actual Cost of Works Progressed (ACWP) in the context of Earned Value, outlining how are these figures calculated. (2 x 5 marks)

1.5 Chapter 5

1.5.1 Project Closure

- answer (a) and (b) On some complex projects, a significant amount of time and effort may be needed to administer the closure of the projects.
- (a) Drawing on this statement, discuss the 3 areas a project manager would need to ensure are satisfactorily closed out on a project at completion? (3x4) (b) Discuss 2 areas in a Project Review that a project Manager might discuss at project completion. (2x4)

1.5.2 Post Project Review Report

- Part of your role as a Project Manager includes the preparation of a Post Project Review Report at the Project Closure Stage. What should be included in this report and under what headings may the project be reviewed? (20 marks)

2 Nature of Project Management

2.0.3 xxxx

- Discuss

2.1 Chapter 1

2.1.1 Operations vs Project

- Discuss, using examples, the distinction between the following : Operations, Projects , Programme and Portfolio? [20]
- Using appropriate examples , explain how project work differs from operational work [20]

2.2 Chapter 2

2.2.1 Objectives and Lifecycles

2.3 Chapter 3

2.4 Chapter 4