

MANAGING WORK & COSTS

Lecture 3 – Managing Changes

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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:

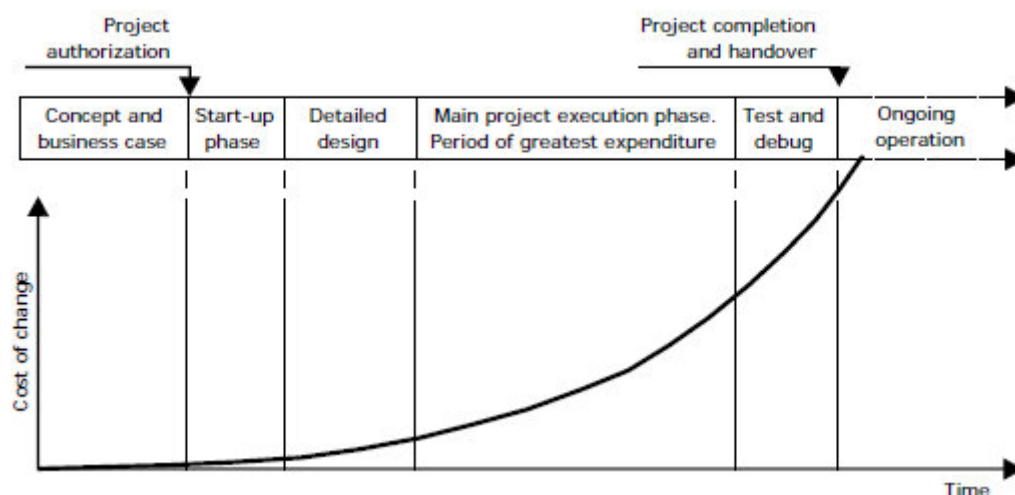
- Defines clear understanding of project boundaries for all stakeholders
- Forms the basis for contractual agreements
- Is the basis for project change control

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).



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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 of 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

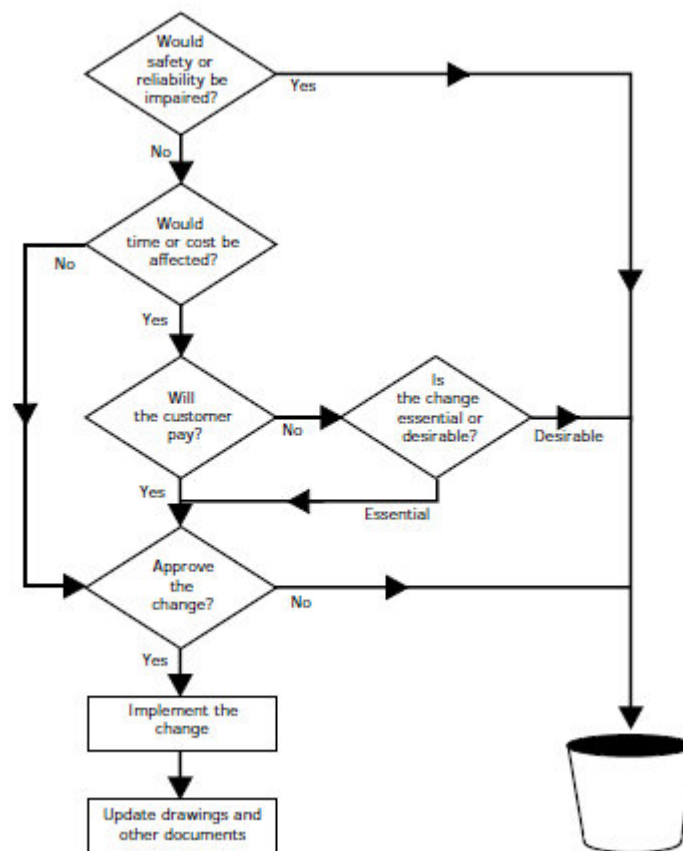
As the impact of change is wide ranging, it's worth while putting a robust system in place that all change can be considered not only by its impact on the project but on the potential impact on the wider organization as well.

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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 wise 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;

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- 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 reasons, 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 register and clearly highlighting the ones that are 'active'. This will assist in monitoring and progressing each change.

7 Estimating the True cost of change

It is almost inevitable that changes will alter the project costs in some way (not always upwards!). Not only the costs of a change need 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 item to bear in mind is that the cost of change may be difficult to assess later into a project. An estimator tasked with assessing change may want to 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 documents (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

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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 title:		Project number:	
		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 from the project manager.

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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:	Cost estimate ref:	
Will customer pay, yes <input type="checkbox"/> no <input type="checkbox"/> If yes, customer authorization ref:		
Effect on project schedule?		
COMMITTEE INSTRUCTIONS: CHANGE APPROVED <input type="checkbox"/> NOT APPROVED <input type="checkbox"/>		
Point of embodiment, stocks, work in progress, units in service, special restrictions etc:		
Authorized by:		
Date:		

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ENGINEERING QUERY NOTE		
Drawing/spec. number:	EQN number:	<div>Is work hold up? Yes: <input type="checkbox"/> No: <input type="checkbox"/></div>
Revision number:	Project or job number:	
Other relevant drawings or specifications:		
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 through the various stages of design & production to ensure it is implemented.

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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

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12 Appendix 2 - Change Request Log

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

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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 is 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.

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- 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.

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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 _____

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References & Resources

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