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PRODUCT DESIGN SCOTLAND TOOLKIT

09

ENGINEERING CHANGE MANAGEMENT IN PRODUCT DEVELOPMENT

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PDS PRODUCT DESIGN SCOTLAND

ABOUT US

With a long tradition of innovation, entrepreneurship and commercialisation, the product design sector is one of Scotland's key industries. Through advances in technology, designers are providing innovative products across a number of global markets, including healthcare, energy, communications and mobility. Integration of these technologies into viable, efficient and commercially attractive products is key, and the partnership between technology and product design is becoming ever more important.

Product Design Scotland, managed by Technology Scotland, the representative body for Scotland's Enabling Technologies Sector, has been established to support the product and industrial design sector in Scotland. The network aims to be the focal point for the community, raising awareness of the critical importance of design to future growth and competitiveness and creating a thriving, collaborative network to drive innovation.

By working with companies and organisations across Scotland, we support the sector through:

- Promoting the value of strategic design to government and industry
- Raising the profile of Scotland's product/ industrial design sector
- Increasing visibility of those operating within relevant supply chains
- Improving competitiveness through collaboration and knowledge exchange
- Creating new networks to shape the future of design in Scotland.

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TOPIC INTRODUCTION

ENGINEERING CHANGE MANAGEMENT

Design & Product Development are iterative processes and as a result there can be multiple revisions or iterations during a design project lifecycle and the subsequent product lifecycle.
If such changes are made in an uncontrolled manner then undesirable effects may come into play such as incompatibility, unintended obsolescence and possibly even scrapping of stock.

Being aware of these risks and considering how to mitigate them is of the utmost importance. You are not the first organisation to encounter this, all manufacturers / product developers need to deal with this topic. This guide will introduce a number of best practices for your consideration.

This topic will introduce and discuss:

- Different drivers for change
- Stakeholders impacted by engineering changes
- Design documentation often subject to change
- Revision / version control
- When to use a revision versus when to create a new part
- Impact of change
- Change implementation
- Engineering Change Management Processes
- Software to facilitate change management

KEY CONSIDERATIONS IN ENGINEERING CHANGE MANAGEMENT

DRIVERS FOR CHANGE

The need for changes to an engineering design can often be attributed to one of the following:

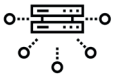
- Errors
- Improvement opportunities
- Vendor or production requests for concessions or non-conformances to be accepted
- Obsolescence and subsequent replacement of BoM items
- Change in requirements (including but not limited to customer requests)

STAKEHOLDERS

Product development is a multi-disciplinary activity and therefore engineering changes must clearly be communicated to all relevant stakeholders. Not least because some of these parties will influence and / or implement the change but also as it ensures all parties are working to the latest or correct revision of a part or document, eliminating costly oversights.

Stakeholders generally include:


Wider design team


Interfacing product owners (if change affects part of a bigger system)


Purchasing personnel


Warehouse personnel including Stock Controllers


Supply chain (vendors)


Production personnel

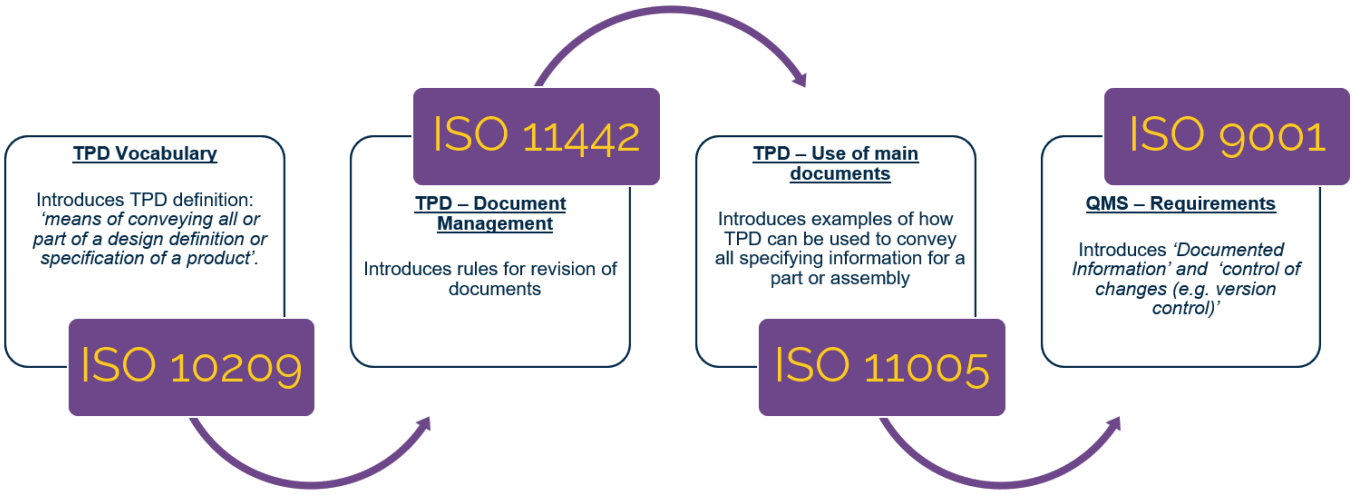

Quality control personnel


Stockists

DESIGN DOCUMENTATION OFTEN SUBJECT TO CHANGE

You could be forgiven for immediately thinking of drawings as the only form of design documentation, in reality there can be many document types driven by design and there are many other documents influenced by design which need to be considered when making changes too.

The ISO documents summarised below introduce a number of useful considerations with respect to design documentation.



TPD: Technical Product Documentation
QMS: Quality Management System

Design documents are sometimes referred to as technical product documentation (TPD), this is an International Standards Organisation term as defined in ISO 10209 – Technical Product Documentation - Vocabulary as a "means of conveying all or part of a design definition or specification of a product".

Examples of such design documentation or TPD include but are not limited to:

- Component Drawings
- Assembly Drawings
- Document Lists
- Parts Lists / Bills of Materials (BoM's)
- Assembly Instructions
- Technical Specifications

These are all examples of design data (technical product documentation) which in turn is a form of 'documented information' as defined in ISO 9001 - Quality Management System Requirements. ISO 9001 requires that such documented information is subject to "control of changes (e.g. version control)".

Even if you are not currently ISO 9001 accredited it is good practice to implement revision / version control and it will stand you in good stead should you ever wish to gain such accreditation, adding traceability whilst enabling better quality control.

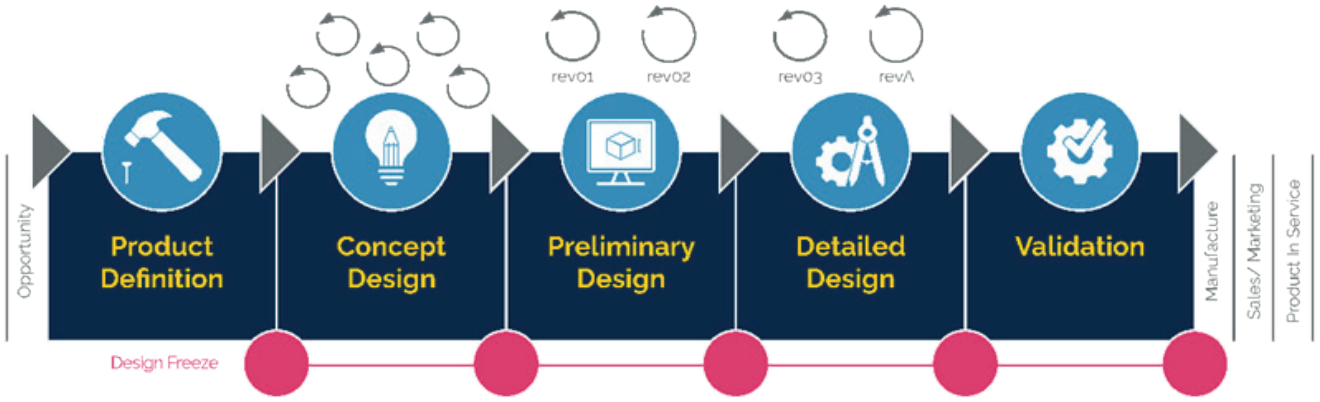
Other examples of documents which are often impacted by design changes, in addition to the common technical product documentation identified above, include:

- Purchasing documents (e.g. Purchase Orders)
- Production Orders
- Test documentation
- Assembly & Test records
- Transport & Handling Instructions
- Preservation Storage & Maintenance Manuals
- Installation & Commissioning Procedures
- User manuals

REVISION / VERSION CONTROL

Whilst ISO 9001 highlights the need for version control it is ISO 11442 – Technical product documentation – Document management which introduces rules for revision of documents. ISO 11442 discusses simplified rules which can be applied early in the product development process and more formal rules to apply later in the product development process.

It is important to control specifications at the start of the product development process, particularly in the product definition phase (see image below). However, there are likely to be many permutations of design concepts during the concept design phase and it is not strictly necessary to formalise and revision control all these concept iterations. It does make sense however, after initial concept evaluation and filtering, to capture and control revisions, particularly when you begin to share concepts out with the design team, doing so can reduce confusion and frustrating duplication of effort.



Revision control typically makes use of a revision naming convention, this is individualistic and must be agreed at an organisational level. Some organisations use letters (A,B,C..), some use numbers (01,02,03...), whilst some may even use an alphanumeric combination.

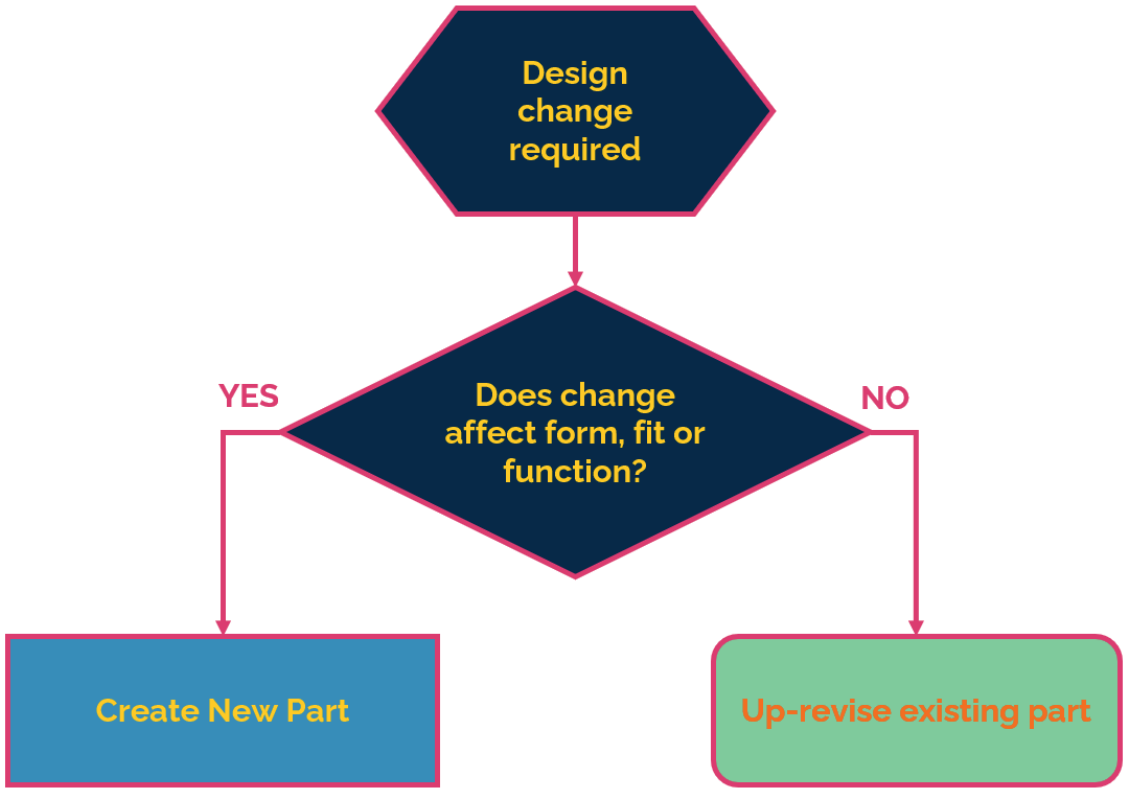
It is not unusual for engineering design work in progress to use different revision control from approved / released for manufacture revisions. An example might be for development work to be rev 01, 02, 03 etc. and once approved for release it changes to rev A (see image above). This approach is especially useful to prevent preliminary designs finding their way to the supply chain or shop floor as it provides an obvious differentiator between preliminary designs and designs released for manufacture.

DO I NEED A REVISION OR A NEW PART?

Changes made during a product or system development may be categorised into two types:

1. Changes which are interchangeable between the old and new version i.e. where the form, fit and function is not affected and the same part number can be retained.

2. Changes where the revised version and old version are no longer interchangeable i.e. the form, fit and function are affected. In these scenarios it is recommended that the revised part uses a different part number from the original.



IMPACT OF CHANGE

Before effecting a design change it is important to consider the impact the change will make. This impact could be in relation to any of the stakeholders identified earlier and might affect any of the technical product documentation or other document types also identified earlier.

Consideration should be made as to whether a change needs to be implemented now or in the future, some examples of questions that must be considered with every engineering change are:

- Does the change impact the performance of the product or system?
- Are any interfaces impacted therefore requiring corresponding changes to mating parts?
- Does the change invalidate any design qualification or certification?
- Does the change impact the cost of the product or system?
- Does the change affect customer expectations of the product / system?
- Does the change require approval from the customer to avoid breach of contract?
- Has all work in progress been identified and it is certain it does not need to be stopped?
- Have all products or systems already on the market (which use the affected part) been identified, and it is certain they don't need to be recalled / reworked?
- Do any components need to be made obsolete?
- If obsoleting components, do they need to be scrapped or can they be phased out?
- Which functions (stakeholders) need to be made aware of the change?

IMPLEMENTING CHANGE

Once it is known that a change is required and the impact of the change has been established it is necessary to assign someone responsibility to champion the change.

Then either create new technical product documentation (for new parts e.g. at rev 01), or create new revisions of all affected technical product documentation (e.g. at rev 02 if the documentation is still work in progress or at rev B if the documentation is already released).

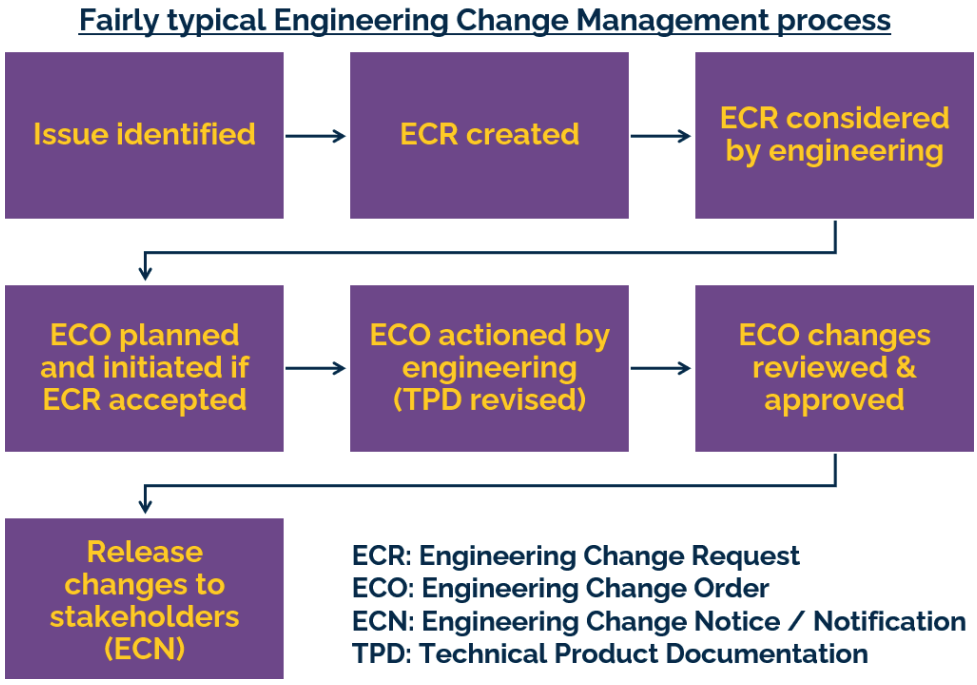
The resulting technical product documentation will need to be reviewed and approved for release, consequently it is necessary to identify a competent approver for the changes.

The exact approach will depend on how an organisation is setup, i.e. whether any engineering change management processes are in place and whether any software to facilitate change management is in place.

ENGINEERING CHANGE MANAGEMENT PROCESS

Perhaps more common in organisations with larger design functions and/or those with ISO 9001 (or similar) design and development processes in place. Engineering Change Management (ECM) relates to a defined process as used within an organisation to control both requests for engineering change and the implementation of engineering change.

There are no standard ECM process, they are often variations on a theme, but the process must be agreed and understood at an organisational level. The image below shows a typical ECM process.



ECM processes introduce sub processes like Engineering Change Requests (ECRs) which provide a mechanism for anyone in an organisation to formally request a change.

This might be someone from quality control asking for a change to avoid the same recurring concession requests arising from the supply chain, or a manufacturing engineer requesting a change to avoid the same recurring issue on the shop floor.

If upon review an ECR is accepted for action, then a separate Engineering Change Order (ECO) process is initiated. When the ECO has been actioned, reviewed and approved an Engineering Change Notice (ECN) will communicate the changes and any remedial actions to the stakeholders identified.

The ECO process will typically require:

- Reviewer and Approver to be identified
- Stakeholders to whom the change needs to be communicated to be identified
- All affected documents (TPD) to be listed
- A description of the change
- A description of the impact of change for each affected piece of technical product documentation

SOFTWARE TO FACILITATE CHANGE MANAGEMENT

Product Data Management (PDM) and Product Lifecycle Management (PLM) software are commonplace.

	PDM	PLM
CAD Data Management	✓	✓
Part & BoM Management	✓	✓
Engineering Change Management	Basic workflows for CAD Data only	More advanced workflows, not limited to CAD Data
Document Management	×	✓
Supplier Collaboration	×	✓
Manufacturing BoM's	×	✓
Service BoM's	×	✓
Etc.	×	✓

PDM is specifically for managing CAD data and revisions, allowing checking in and out of documents to ensure only single users are editing at once and so on.

PLM software is common in larger organisations and includes all the functionality of PDM but PLM goes further and includes change processes and workflows, BoM management, filing of other design / product related documentation as opposed to just CAD data (i.e. technical product documentation).

PLM systems massively streamline the engineering change management process and can largely automate/facilitate the process through the use of workflows.

PLM software will enable you to:

- Add details of the change, providing traceability
- Create new technical product documentation (TPD)
- Create revisions of TPD
- Add impact of change details against each new or revised TPD
- Attach new or revised TPD to an ECO for review, approval and release
- Populate a list of users to notify of the change (ECN)
- Initiate a review workflow
- Initiate an approval workflow

PLM software also makes it easier to perform ground work associated with establishing impact of change, particularly with features such as 'where used' which enables the user to see what higher level assemblies the part or document subjected to design change is used in.

PLM can also be setup to automatically communicate with enterprise resource planning (ERP) software to ensure the latest engineering data is being used commercially.

PLM software need not only be for larger longer established organisations, there are some open source versions available.

KEY TAKEAWAYS

- Changes are inevitable whether correction errors or making improvements.
- There are multiple stakeholders who must be informed of changes, without consideration for all stakeholders you aren't fully considering the impact of a change.
- Changes to a design are likely to require changes to other technical product documentation.
- Any organisation designing components, products or systems should have a robust, documented version control system in place.
- Implementing engineering change requires planning to ensure all affected stakeholders and documents are addressed.

NMIS
National Manufacturing Institute Scotland

NMIS PROFILE

The National Manufacturing Institute Scotland (NMIS) is the future of manufacturing at the heart of the Advanced Manufacturing Innovation District Scotland.

Hosted by the University of Strathclyde, it is a place where industry, academia, and the public sector work together on ground-breaking manufacturing research to transform productivity levels, make companies more competitive and boost the skills of our current and future workforce.

A group of industry-led manufacturing research and development facilities with a network of Partners across Scotland, NMIS is focused on revolutionising skills, productivity, and innovation to help attract investment and make Scotland and the wider UK a global leader in advanced manufacturing.

Later next year NMIS will open its new HQ next to Glasgow Airport, bolstering the support already provided by nearby specialist technology centres, the University of Strathclyde's Advanced Forming Research Centre (AFRC) and Lightweight Manufacturing Centre.

The new NMIS facility will comprise of a Digital Factory, Skills Academy and Collaboration Hub and will help the NMIS Group continue to support manufacturing and engineering firms of all sizes and from all sectors across the country, and internationally, to innovate and grow their businesses.

Already operating under the Digital Factory is the NMIS Design Engineering Team, who work with SME and OEM clients alike to obtain funding to develop novel products and systems towards cost effective, sustainable and manufacturable solutions. The team champion mechanical design, material and manufacturing process selection, design and systems thinking, tooling and fixture design and verification & validation activities with a view to robust technology qualification.

NMIS is a group of industry-led manufacturing and engineering research and development facilities operated by the University of Strathclyde and supported by the Scottish Government, Scottish Enterprise, Highlands and Islands Enterprise, High Value Manufacturing Catapult, Skills Development Scotland, Scottish Funding Council and Renfrewshire Council.

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