How to Design for Manufacture and Assembly

Value Chain Competitiveness (VCC)

Version: 1

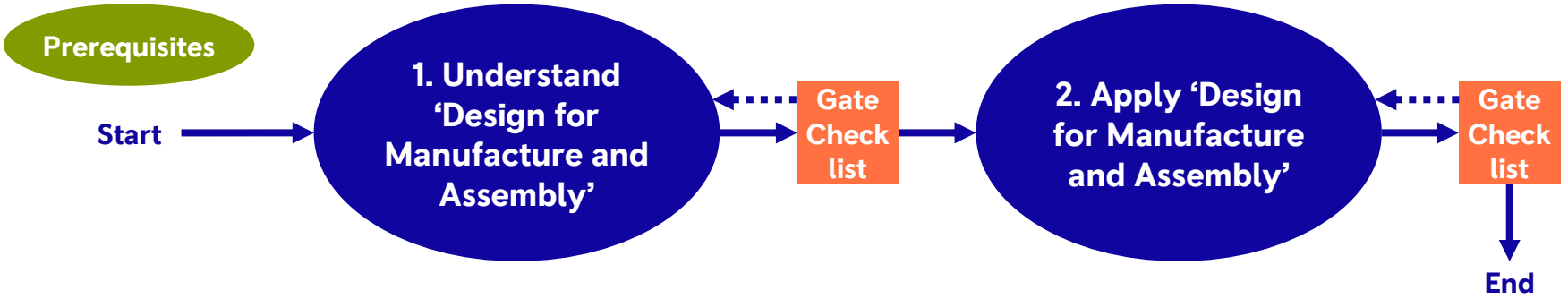
December 2019

How to Design for Manufacture and Assembly

BACK Map NEXT

Scope

Objectives & Principles



Scope

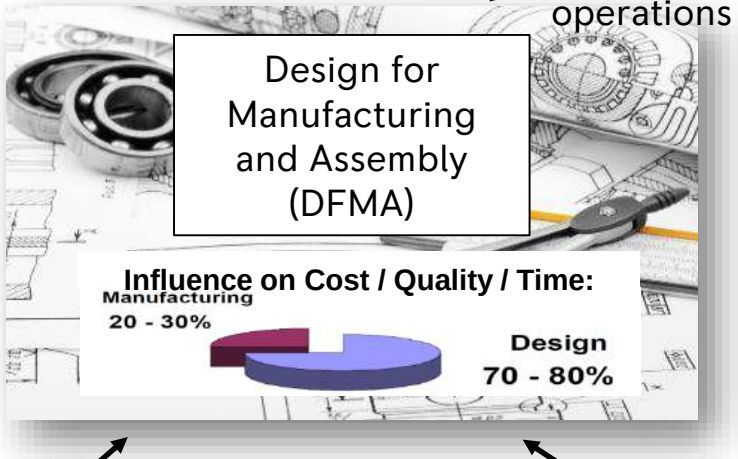
This ‘How To’ will enable you to:

- Identify and review the inputs needed to conduct appropriate Design for Manufacture and Assembly (DFMA) at different stages of the product lifecycle
  - Design for manufacture guidelines
  - Design for assembly guidelines
  - DFMA team members with knowledge and experience in cross-functional disciplines
  - The product, manufacturing and assembly requirements
  - Approach to conducting DFMA reviews for action capture and closure

Objective and Principles

1. DFMA influences design definition in the early stages of the product development

2. Design for Assembly aims to reduce the number of parts, easing handling and assembly operations



4. DFMA utilises cross-functional knowledge and experiences for idea generation and action implementation

3. Design for Manufacturing aims to select the most cost effective material and process to ease manufacturing operations

Prerequisites

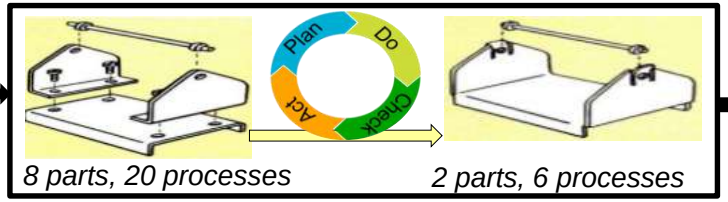
Knowledge:

- Existing design development process and potential benefits of adopting a DFMA approach

1. Understand ‘Design for Manufacture and Assembly’

Understand the process for DFMA

Concept Design



Design for Manufacture and Assembly

Detailed Design

Design for Manufacture and Assembly (DFMA)

- To minimise product cost from product design through its life-cycle
- Resulting in simpler products, collaboration in design & manufacture, lean thinking

A. Design for Assembly (DFA)

- Design the products for ease of assembly
- Focusing on the number of parts, handling and ease of assembly operation

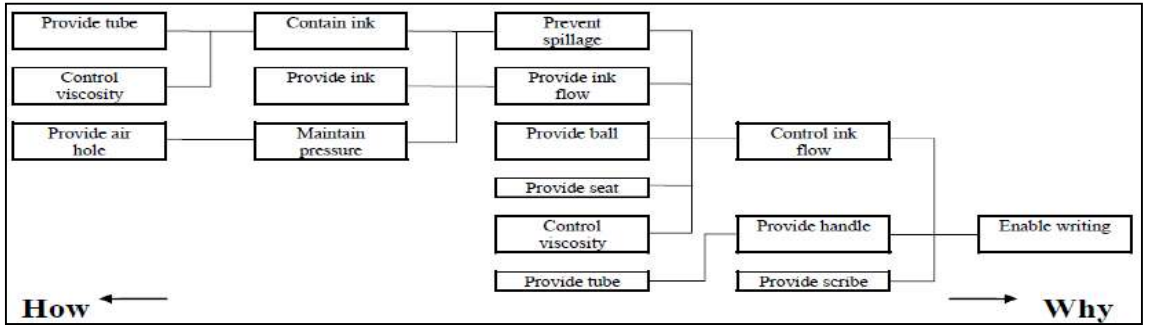
B. Design for Manufacturing (DFM)

- Design the components / products for ease of manufacture
- Selecting the most cost effective material and process to be used in production

1. Understand 'Design for Manufacture and Assembly'

Deign for Manufacture and Assembly – Functional Analysis

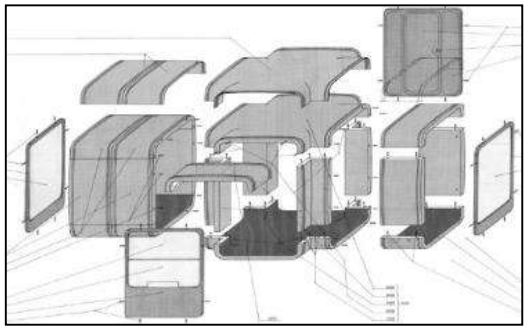
Functional analysis is a design method providing a complete view of design in terms of functions and relationships of those functions



Example functional analysis of a ball point pen

Advantages of functional analysis

- The product intended use is examined thoroughly giving a better understanding of the user and customer
- The technique aids creative thinking and idea generation (innovation) before selecting the best design solution
- It enables the identification and definition of modular functions, promoting the definition of modular product design and components



Modular design

1. Understand ‘Design for Manufacture and Assembly’

Design for Assembly - Determine the parts requirement

Reduce the number of unique parts, asking

- Must the part move relative to other parts already installed in the assembly? – It is only unique if movement is essential for product function
- Must the part be made of different material? - It is only unique if material type is essential for product fit, form or function
- Must the part be separate from other parts? – It is only unique if there is a separation requirement for in-service adjustment or replacement

1	Lower Arm Sub.
1.1	***Base Part*** **-** Lower Arm
1.2	Lower Arm cover
1.3	Rivet
2	Upper Arm Sub.
2.1	Upper Arm
2.2	Upper Arm cover
2.3	Rivet
3	Spring
4	Pivot

Parts List

1. Understand 'Design for Manufacture and Assembly'

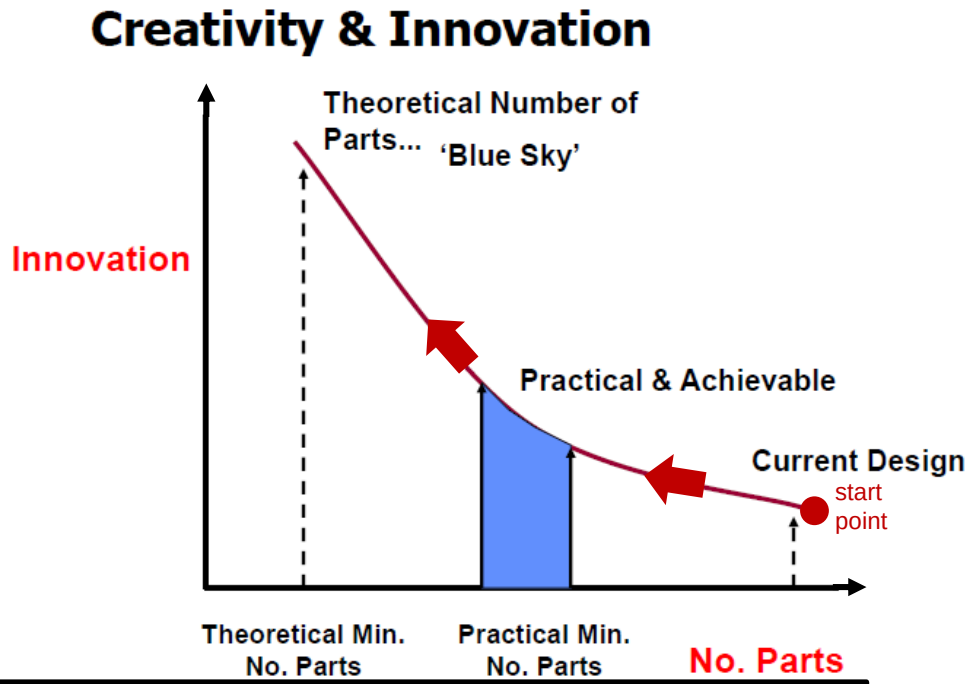
Design for Assembly - Determine parts standardisation & practical minimum number

Can the parts be standardised?

- Within the assembly station
- Within the full assembly
- Within the assembly plant
- Within the company

Determine the practical minimum number of parts

- Team assessment of practical changes
- Trade-offs between part cost and assembly cost
- Increasing creativity rate required towards theoretical min. no. of parts

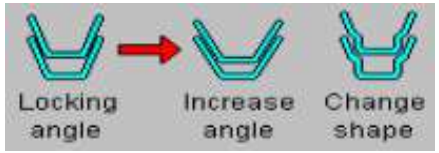


Cost focus: Minimising number of parts and extra sizes reduces both inventory and confusion during assembly

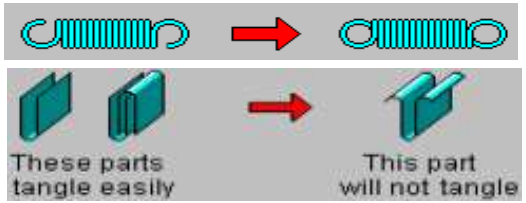
1. Understand 'Design for Manufacture and Assembly'

Design for Assembly - Determine parts presentation for ease of assembly

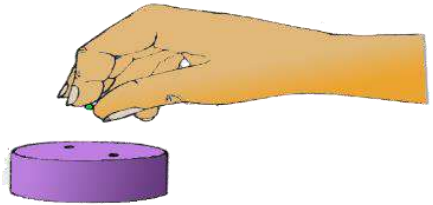
- Design out jamming and tangling



Avoid nesting & tangling

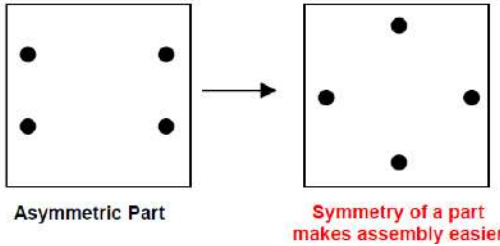


- Avoid too small or too large



Avoid small items requiring precision placement

- Design for part symmetry



Symmetry eliminates reorientation

1. Understand ‘Design for Manufacture and Assembly’

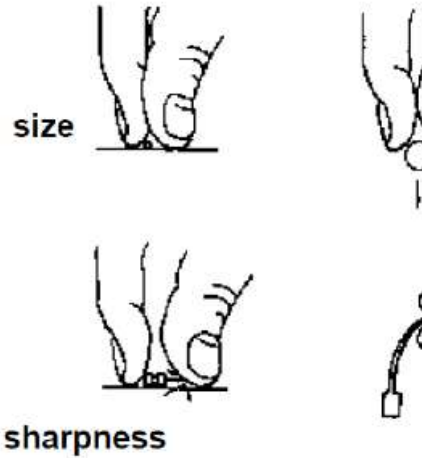
Design for Assembly - Determine parts handling requirements

Considering the current handling techniques: based on assembly process and complexity of parts

- How many hands are required?
- Is any grasping assistance needed?
- What is the effect of part symmetry on assembly?
- Is the part easy to align/position?

Part handling considerations

- Size
- Thickness
- Nesting
- Weight
- Tangles
- Fragile
- Slippery
- Sharpness
- Stickiness
- Requires two hands
- Requires grasping tool
- Requires magnification to be seen
- Requires mechanical assistance



1. Understand ‘Design for Manufacture and Assembly’

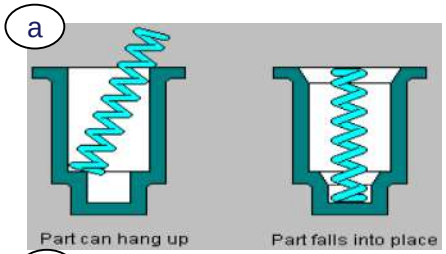
Design for Assembly - Determine parts insertion requirements

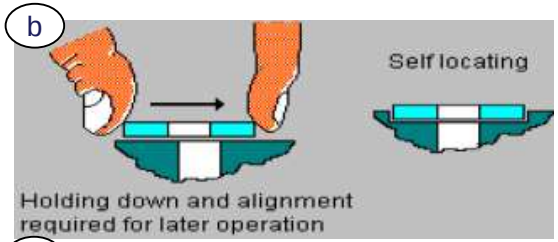
Considering the current insertion (locate & secure) techniques: based on difficulty required for each component insertion

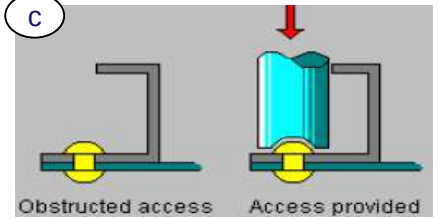
- Is the part secured immediately upon insertion?
- Is it necessary to hold down part to maintain location?
- Is the part easy to align/position?

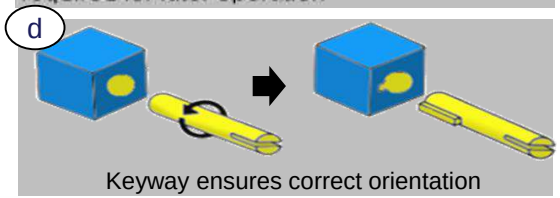
Part insertion considerations

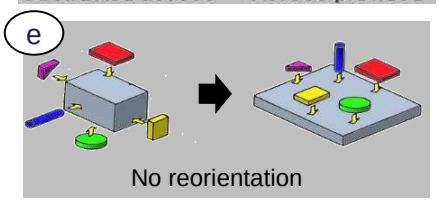
a) Self-aligning parts
b) Self locating parts
c) Adequate access and visibility
d) One way orientation
e) Avoid reorientation during assembly









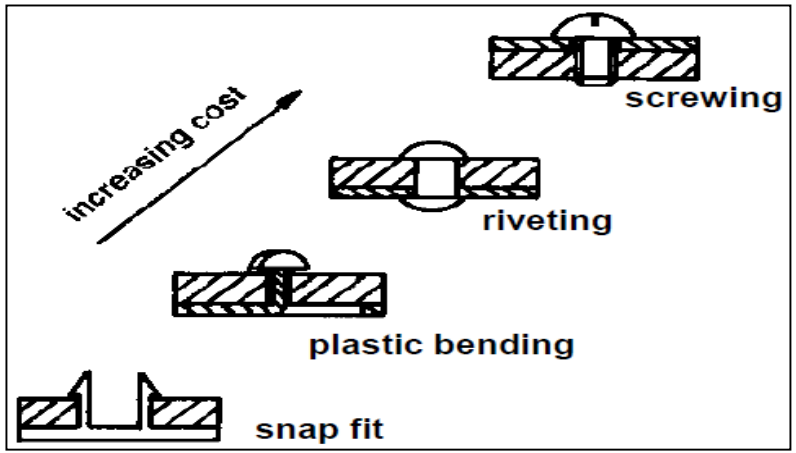


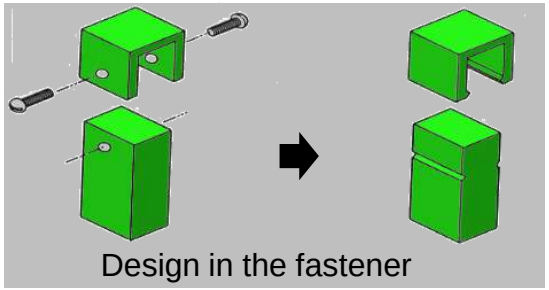
1. Understand ‘Design for Manufacture and Assembly’

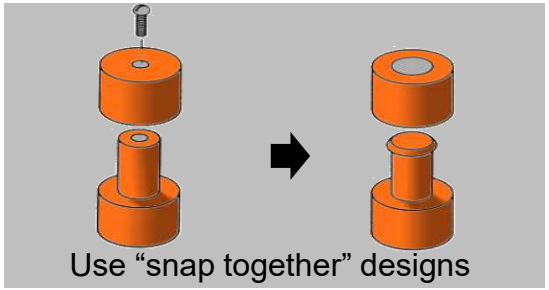
Design for Assembly - Determine parts insertion requirements

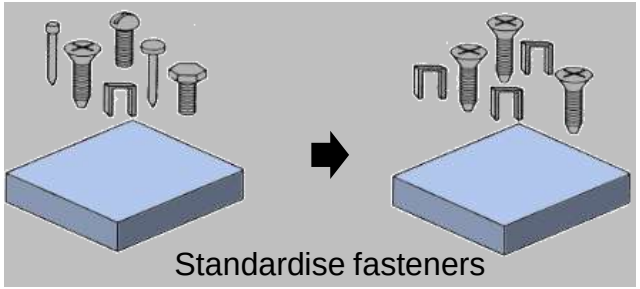
When using mechanical fasteners, attempt to use the lowest cost method:

- Snap fitting
- Plastic flexing
- Riveting
- Screwing




Design in the fastener


Use “snap together” designs


Standardise fasteners

1. Understand ‘Design for Manufacture and Assembly’

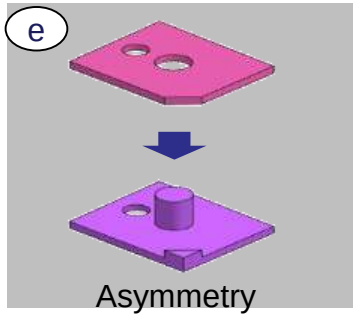
Design for Assembly - Design for mistake proof assembly

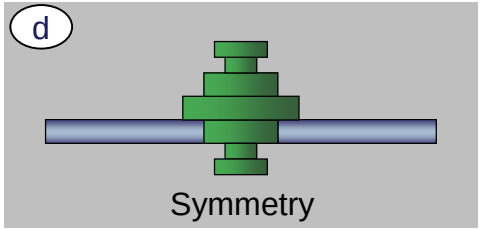
Design in mistake-proofing in to assembly to prevent

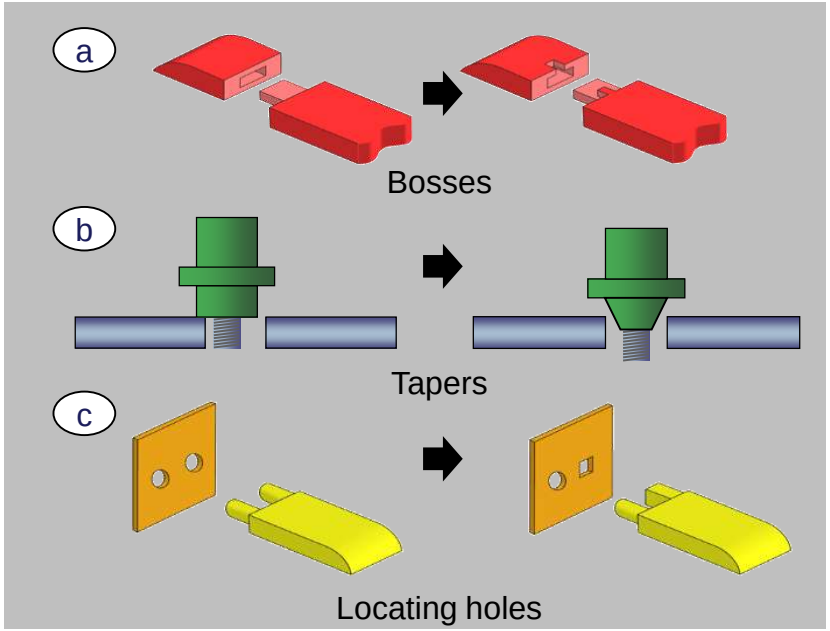
- wrong parts being assembled
- parts being omitted
- assembling parts in the wrong orientation

Examples include using

a) Bosses
b) Tapers
c) Locating holes
d) Part symmetry
e) Part asymmetry





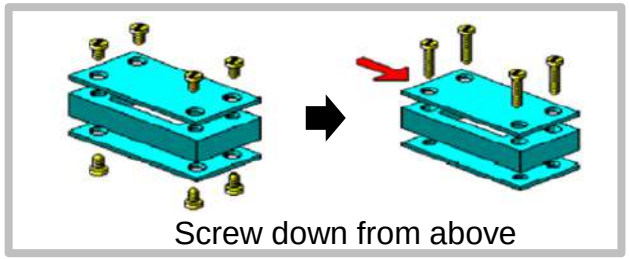


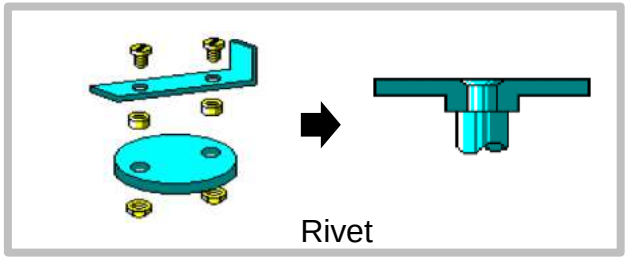
1. Understand ‘Design for Manufacture and Assembly’

Design for Assembly - Secondary operations and other considerations

Eliminate secondary operations

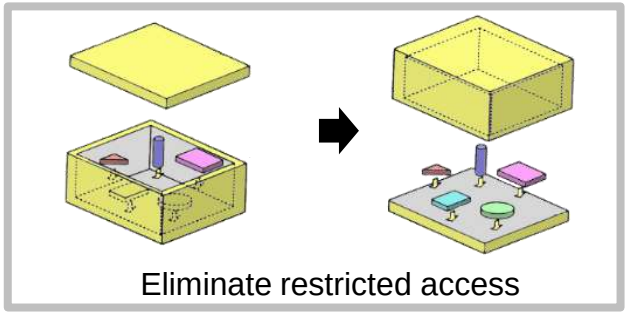
- Assemble in single axis (from above) - screw, twist, rivet, bend, crimp
- Eliminate operations - weld, solder, glue, paint, lubricate, test, measure, adjust


Screw down from above


Rivet

Other considerations

- Avoid connections
- Eliminate restricted access for operations
- Avoid adjustments
- Minimise part variation


Eliminate restricted access

1. Understand ‘Design for Manufacture and Assembly’

Design for Manufacture - Considerations for ease of Manufacture

When selecting the manufacturing methods:

- Is hard tooling required?
- Have we selected the best technology or process to fabricate parts?
- Have we selected the best material needed for function and cost?
- Have we looked at all the new technology that is available?
- Are the parts shaped for the implementation of automation?
- Is the supplier capable of meeting the specifications?

Other considerations

- Parts reduction strategy
  - reducing manufacturing costs through less purchases, inventory, handling, processing time, development time, equipment, engineering time, inspection, testing, etc.
- Raw material choices
  - Lowest cost choices can drive up the number of materials. Choosing a material with better machining characteristics might result in lower processing costs offsetting higher material cost.

1. Understand 'Design for Manufacture and Assembly'

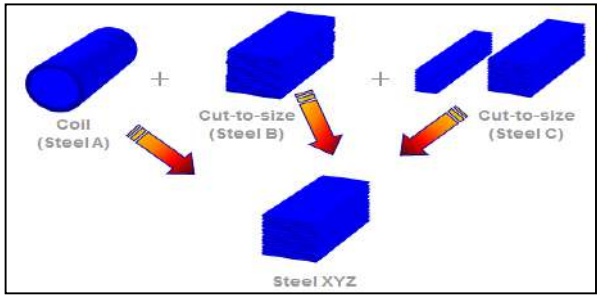
Design for Manufacture - Standardising Materials

Standard stock sizes

- Develop a common set

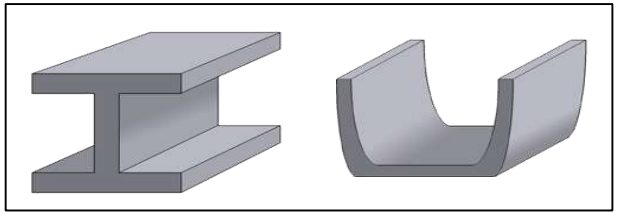
Standard material types and properties

- Develop a common set



Pre-shaping

- Develop forming requirements & work with suppliers



1. Understand ‘Design for Manufacture and Assembly’

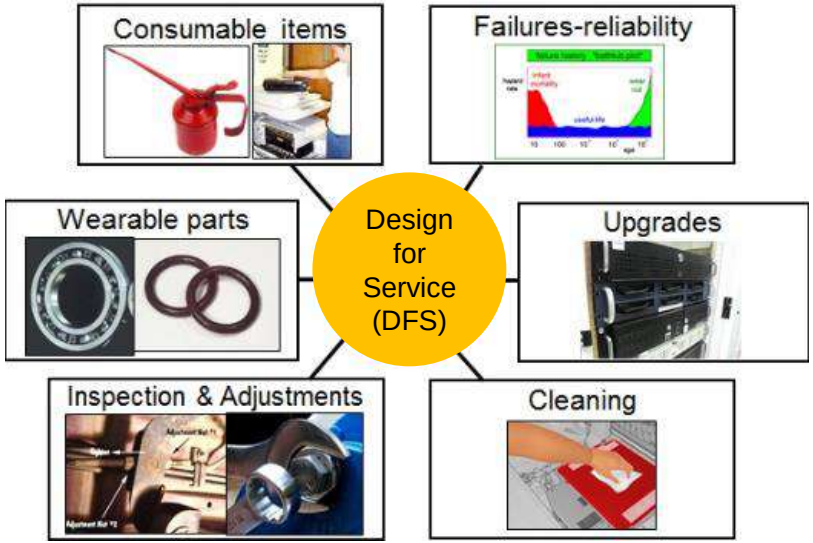
Design for Excellence

‘Design for’ (DFX) is not limited to ‘assembly’ (DFA) or ‘manufacture’ (DFM), there are other types for example

Design for

- Performance
- Testability
- Serviceability
- Reliability
- Yield
- Six Sigma

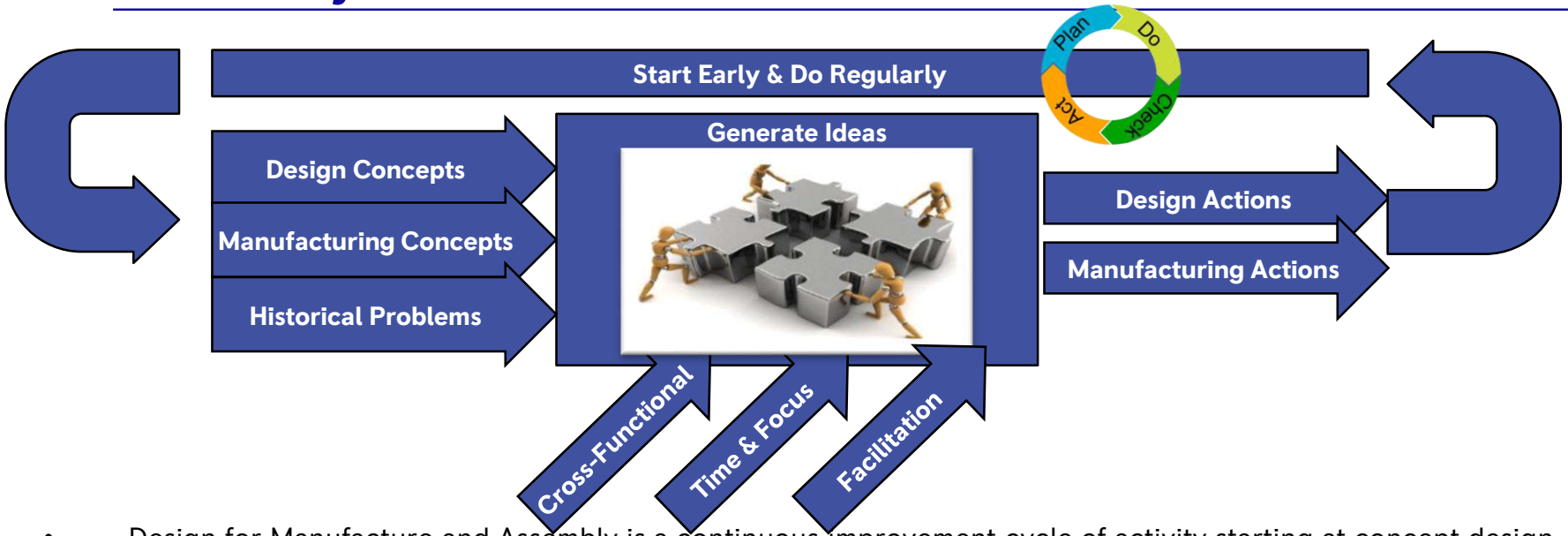
Collectively known as DFX



Gate checklist 1: Understand ‘Design for Manufacture and Assembly’

- ☑ A better understanding gained of Design for Assembly (DFA) and benefits for ease of assembly operations
- ☑ A better understanding gained of Design for Manufacture (DFM) and benefits for ease of manufacturing operations
- ☑ Awareness of other ‘Design for’ activity available through DFX

2. Apply ‘Design for Manufacture and Assembly’

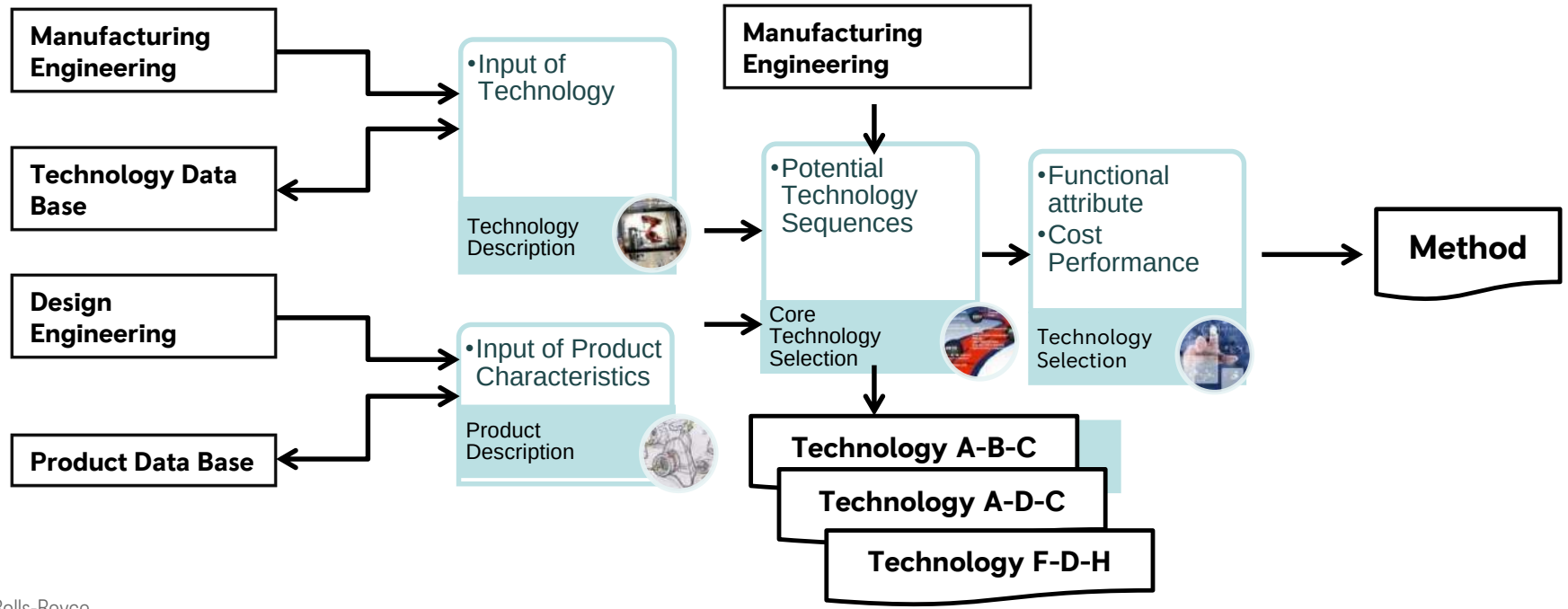


- Design for Manufacture and Assembly is a continuous improvement cycle of activity starting at concept design through to final definition
- It requires a cross-functional input for effective idea generation and action
- The activity needs time & focus, benefiting from facilitation
- It is a data-driven activity using existing knowledge and experience
- Benefits are only gained through robust action taking and close-out

2. Apply 'Design for Manufacture and Assembly'

Manufacturing Technology Planning

Define Potential Technologies – Design for Manufacture starts with a good understanding of product functionality and the functional features and the capabilities of manufacturing technology options.



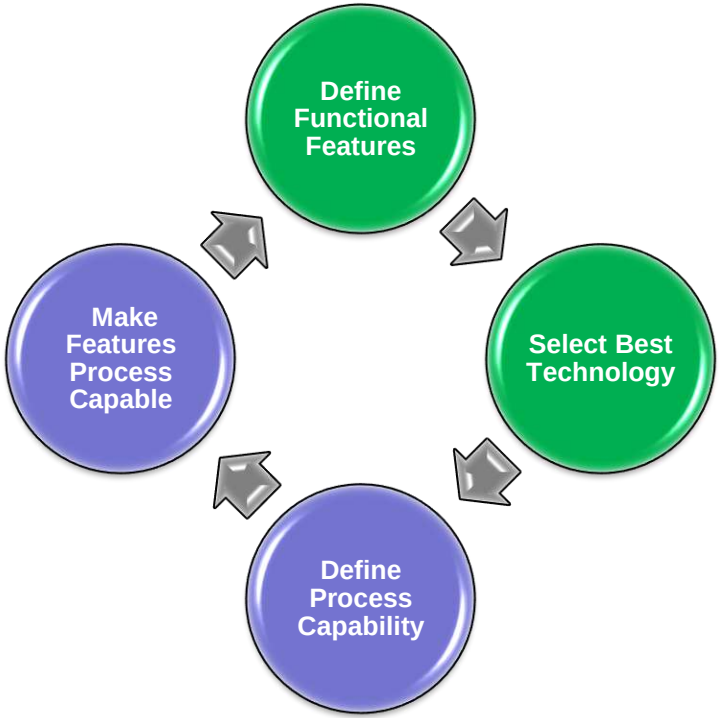
2. Apply 'Design for Manufacture and Assembly'

Match Manufacturing Process to Product Features

Match manufacturing process to product functional features

Conduct Design for Manufacture & Assembly

- Identify product functional features
- Select Technologies based upon their capability to produce the products functional features.
- In selecting the technologies:
    1. Consider the capability of the proposed technologies
    2. If a technology is not currently capable can it be developed to become capable?
    3. Can product design change to match current technology capability and still meet the functional requirement?



2. Apply ‘Design for Manufacture and Assembly’

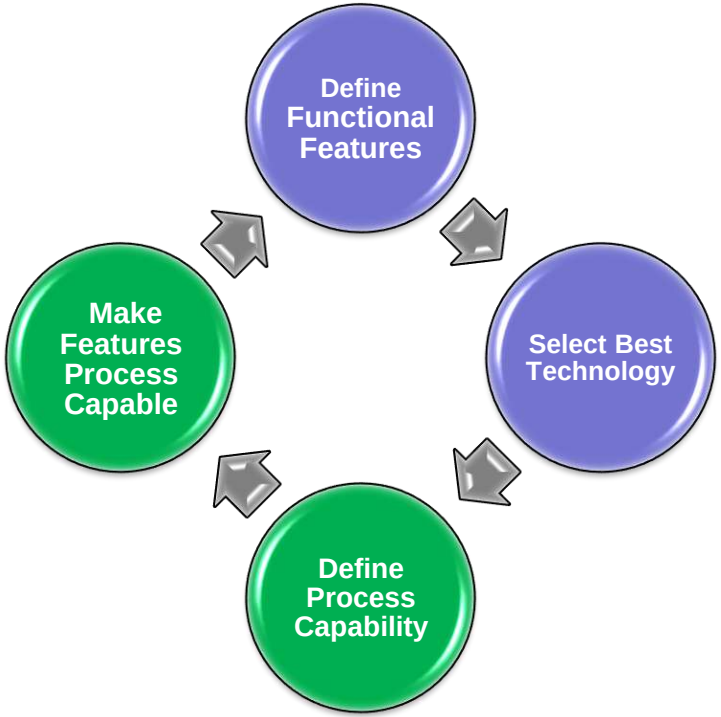
Match Product Design to Process Capability

Design for Manufacture - Match non-functional product attributes to process capability

Conduct Design for Manufacture & Assembly

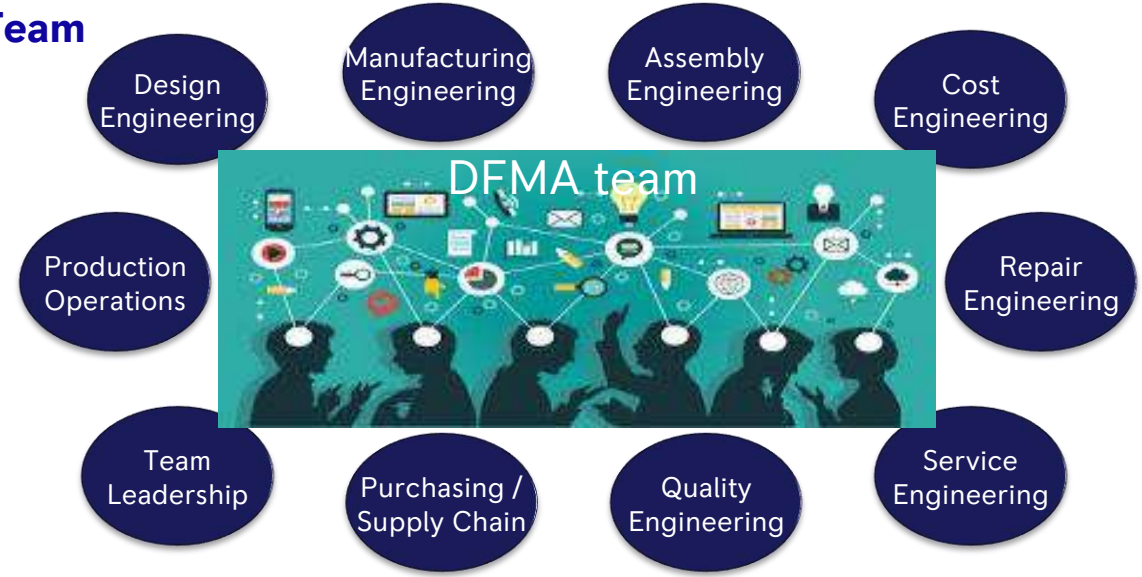
- Confirm the technologies to manufacture the product functional features.
- The design of product non functional features needs to be changed to make their manufacture process capable.

These actions will ensure the product design intent is achieved in manufacture and production.



2. Apply ‘Design for Manufacture and Assembly’

Form a DFMA Team

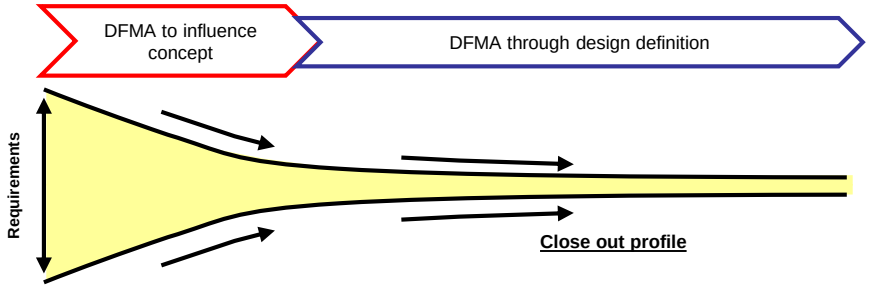


- DFMA team members should have relevant knowledge and experience covering multiple disciplines, through Design Engineering to Production Operations
- A core team will maintain consistency through the development period, possibly bringing in other disciplines as required

2. Apply 'Design for Manufacture and Assembly'

Review product, manufacturing and assembly requirements

- The team should review appropriate product, manufacturing and assembly requirements at different stages of the lifecycle
- It can be helpful, particularly at the early stages to nominate an independent facilitator to run the DFMA reviews. This helps maintain team focus and help achieve a balanced output



- The majority of issues should be reviewed in the Concept Stage:
  - This is where most problems can be solved
  - As the project matures the requirements for resolution should reduce

- Useful review aids to make issues easier to understand include:
  - 2D printed drawings marked up with identified issues
  - Projected 3D models
  - Prototypes in easily produced materials
  - 3D Printed and/or Stereolithography models
  - Virtual Manufacturing

2. Apply ‘Design for Manufacture and Assembly’

Engaging with suppliers- why do it?

Engaging with suppliers in DFMA:

- Is crucial for influencing and optimising the concept
- Helps to develop the manufacturing requirements and identifies potential risks later on in the production phase

Benefits include:

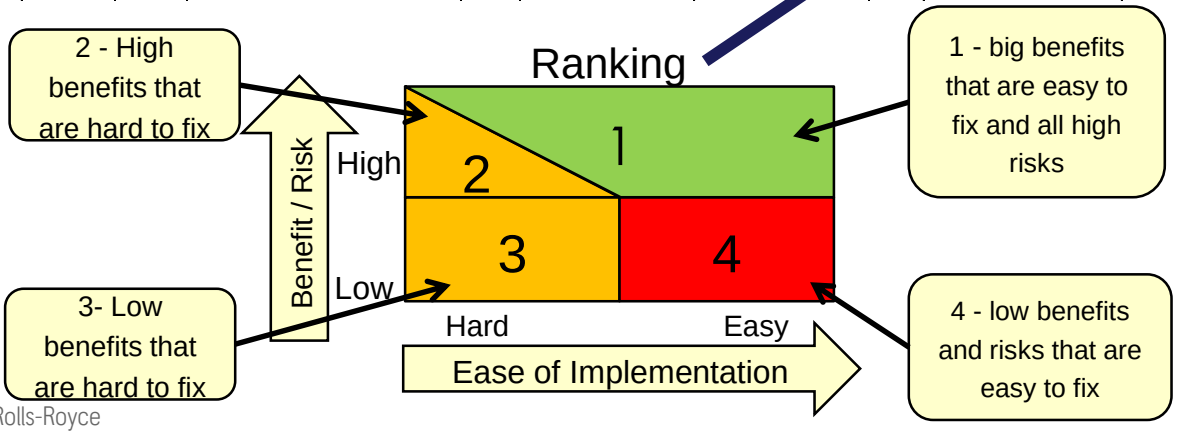
- Forming strategic alliances in development of advanced product / process solutions
- Supply chain mutual competitive advantage, best use of supplier capabilities and capacities
- Cross-functional engagement on capability assessments
- Faster technology development and deployment
- Global collaboration partnerships delivering technology solutions to market
- Leveraging supplier knowledge to achieve cost effective solutions and intelligence

2. Apply 'Design for Manufacture and Assembly'

DFMA Action Tracking

- DfMA activity generates output in the form of ideas and issues
- Each idea for improvement or issue to resolve should be ranked and an action to address it

DfMA Tracker													Actions	
#	Date Raised	Raised By	Description	Type	Advantages	Disadvantages	Rank	Action	Action Owner	Action Status	Result Status	Result	Open	Closed
1	Dec 12th 2013	Joe Bloggs	Opportunitiy to standaridse hole sizes on 5 and 5.5mm holes in casing PCD	Idea	Cost reduction on tooling and will prevent mistakes by having one drill size.	None	1	Update drawing	CDG	Open			1	2



- Ranking provides a means of prioritising actions to be taken
- High benefit/risk and easy to implement actions should be pursued for completion first
- All high risks must be addressed

Gate checklist 2: Apply ‘Design for Manufacture and Assembly’

BACK Map

- ☑ Understanding gained on the application process for DFMA
- ☑ Understanding of design to process capability match and technologies required
- ☑ DFMA team formed with knowledge experience across required disciplines
- ☑ Product requirements understood and regular review methods in place
- ☑ Early supplier engagement considered
- ☑ DFMA action capture, ranking and closure tracking in place