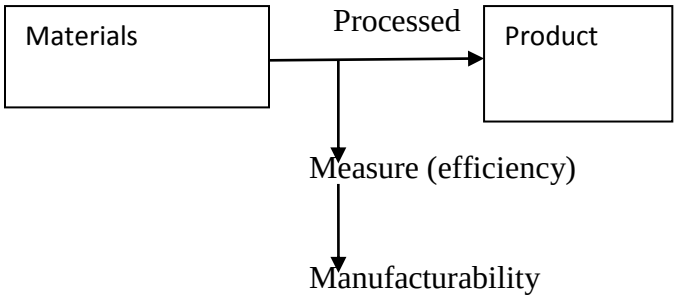
Design for manufacturability

INTRODUCTION

Manufacturability

1. It is a measure of efficiency with which materials can be processed in order to create a product.



2. It implies that all aspects of product planning which are used to create a product.
Comparison of manufacturability

Guide lines for better manufacturability

1. Reduce no. of product parts.
2. Use modular parts wherever possible.
3. Use standard parts.
4. Strive for z-axis assembly.
5. Reduce no. of Threaded fastener's in design.
6. Use symmetrical part's to simplify the assembly.
7. Use human assemblers (hand).
i.e. human hand is an ideal assembly tool.
8. Simplify part designs (quick, economical).
i.e Design for ease in fabrication.
9. Design part's that are impossible to assemble incorrectly.
10. Automate assembly systems.

MANUFACTURABILITY & ITS REQUIREMENTS

1. Design for manufacturability /Design for assembly/Design for automation/Design for robotization/Design for production.
Production → product
2. Manufacturing engineering must be an integral part of the design process. With production & design engineers.
3. Production engineers should participate in design development & design engineers should participate in production planning to ensure design compatibility with production.

Production/manufacturing engineer's assist the design engineer in the producibility analysis by identifying the following:

1. Processes, materials, components & Vendors.
2. Standard's, capabilities & limitations.
3. Design criteria for fabrication & assembly methods.
4. Production, test, integration & repair procedures.

5. Risks.

Manufacturing engineers perform
1. Process studies (capabilities).
2. Design analysis (simplification).
3. Value analysis & engineering.
4. Tolerance analysis to identify problem areas.
5. Manufacturing testing of alternative design approaches.
6. Manufacturing Documentation.

Note:
1. Design's remember engg. Drawing, procedures& report's foundation for developing manufacturing & requirement's.
2. Review of design documentation will avoid many of the problems.

Better Producibility in manufacturing organization:
1. Corporate Policy =a + b:
a. Strategies, plan's, procedures & standard's.
b. Multi-disciplined engineering design process.
2. Proven Design practices:
a. Simplification by customer option's (part reduction & functional analysis).
b. Standardization (standard part's tolerances & part families, component selection with preferred parts.
c. Testability & Repairability (built-in test, modularity, test points &maintainability).
d. Developmental Testing (quality improvement, part qualification & Environmental stress screening).

Manufacturing Process Analysis (For better productivity)
1. Use of high quality, low cost, low-risk manufacturing methods & processes.
2. Process Capability Analysis.
3. Use prototypes for verification.
4. Vendor qualification & ctrl.

Specific Design Criteria (For selected manufacturing process)
a. Type of process.
b. Manual/automated.
Its aim to obtain required quality in product at minimum cost.

Considerations Include
1. Product & Process Design.
2. Selection of manufacturing processes.

Product & Process Design:
1. Designer's concerned with material processing because they are right/wrong ways of designing them.
2. Each process has design considerations.

Ex: Part consists of considerations.
a. Avoid deep narrow groves, long thin less & under cuts.
b. Avoid sharp corners, bevels & chamfers.
c. Avoid abrupt changing cross section.

1. Provide fillets & rounds.
2. Uniform cross section possible.
3. Dimensional ctrl.
4. Symmetric design for hallow Area.
5. Rib stiffness to reduce twisting.

Design Factors

1. Improve quality, strength & economics of extruded pasts.
2. Casting provides fillets, rounds & eliminates undercuts.

Casting Processes (cp)

1. Sand.
2. Pressure die (cp).
3. Injection Moulding (cp).

Holes generated & designer's must have through knowledge of each & must specify according to functional behavior of products. Knowledgeable Designer examines differ types of machine processes characteristics & Designs for them.

Selection of manufacturing processes

Factors affect selection of a manufacturing method for a particular product.
1. Shape
2. Property (Mechanical and Physical)
3. Service
4. Manufacturing
5. Cost (Consideration's above)

Shape considerations

1. Shape complexity.
2. How many Dimensions.
3. Precise Dimensions.
4. Components interactions?
5. Surface characterizes (smooth/hard finished)
6. Dimensional change by wear of corrosion.
7. Change in shape improve suitability of part (↑ strength, Reliability, fracture, resistance e.t.c).

Property Considerations

Mechanical Properties:

1. Component overload may fracture or fail.
2. Loading impacts, type & magnitude.
3. Cyclic loading, type, magnitude frequency.
4. Resistance needed (how much, deep)
5. Temperature range.
6. Material Deflect, Stretch/compress & function property.

Physical Properties

1. Magnetic properties desired. 2. Thermal properties desired.
3. Optical requirements? 4. Weight factor significance.
5. Appearance. 6. Thermal conductivity.

Service Consideration

Service environment of the product throughout its life cycle.
1. Component operating temperature (high, low, normal) is likely to change.
2. Desired properties in temperature range.
3. Life time of product desired service.
4. Liability of product fail?
5. Product recycling in mind.

Manufacturing Considerations

1. Standard component's & sizes.
2. Design requirements, ease of manufacture, mach inability, weld ability, form ability, harden ability, cast ability.
3. How many components, rate.
4. Quality level desired similar to market.
5. Quality ctrl anticipated.
6. Assembly concerns.

Cost Consideration

Design stage – manufacturing & Assembly problems.
Design phase – 70%
Actual production – 20%
Product functional needs meet.

Design for assembly

1. Optimize number of parts.
2. Assembly method
3. Ease of handling & construction

Material selection

1. Bulk. 2. Coating.

Design for part manufacture

a. Process selection. B. Design for processing. C. Tooling design.
Quality & reliability, Standardization & variety reduction.

Small components for powder metallurgy methods considerations

1. Machining
2. Casting
3. Powder metallurgy
4. Fastening & joining
5. Forging

Design for machining

1. Avoid machining operations
2. Surface finish & dimensional tolerances
3. Part easy fixturing & secure holding during machining operations.
4. Avoid sharp corners & points in tools.
    1. Use dimensions.
    2. Suit location & clamping
    3. Use cutting tool
    4. Reduce tool deflection
    5. Reduce cost
    6. Avoid interrupted cuts
    7. Part design using clamping & machining without distortion
    8. Avoid tapara & contours
    9. Reduce no. of size of shoulders
    10. Avoid under cut
    11. Avoid hardened machine materials
    12. Provide room cutler's bushing & fixture elements.
    13. Avoid draft surfaces as clamping (or) locating surfaces
    14. Avoid projections

Design for casting considerations

1. Moulding methods
2. Flow ctrl & behavior of metals during casting process.
3. Assist fitting
4. Location & shape of joint surfaces
5. Draw angles & re-entrant shapes
6. Location of bosses
7. Thickness of sections & ribs, bosses
8. Design of cores & core supports
9. Prevention of stresses & fracture during cooling
10. Location of runner's & risers
11. Ease of removal of finished component from die
12. Extend life & reduce wear
13. Filet & corner radii
14. Inserts
15. Accuracy

Design for powder metallurgy

1. Behaviour of powder during compacting
2. Ejection of compact from the die
3. Simplified die set & its extended life
4. Design for Accuracy of parts produced.

Design for Fastening & joining

Fastening methods:

Screw threads, fasteners, pins, rivets & differ joining methods are soldering, welding & bonding by adhesives.

1. Permanency required
2. Sizes & shapes of the pieces to be joined
3. Strength of assembly
4. Materials properties involve – composition, mechanical, physical
5. Heat effect on environment factors
6. Ease of separation of component
7. Appearance of Appearance of product

Design for forging

1. Development of uniform & fine grains
2. Development of directional strength
3. Minimizing the number of operations & dies

Die forging considerations

1. Behaviour of work piece material during forging.
2. Separation of forging from dies.
3. Die manufacture & their extended life.
4. Design of forged product.

INTEGRATED MANUFACTURING SYSTEM

Introduction:

1. Computer's ---------- controlling machines } both do operation's in their field's
   Robots ---------- performing processes } efficiently then human's.
2. Degree (Automation)

   Aid of computer & robot to small batches

   Mass production

Production line → Automation → Emerging market's requirements