Design for Manufacturing

Product Development Process

Planning → Concept Development → System-Level Design → Detail Design → Testing and Refinement → Production Ramp-Up
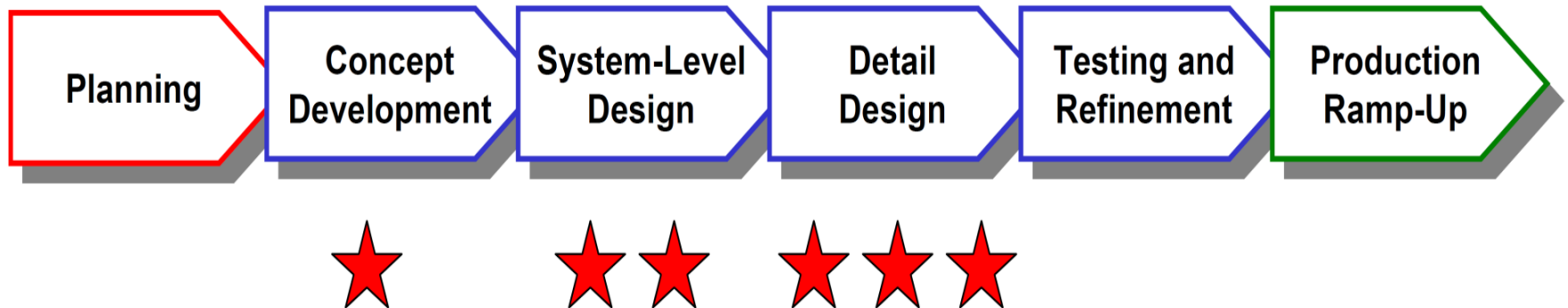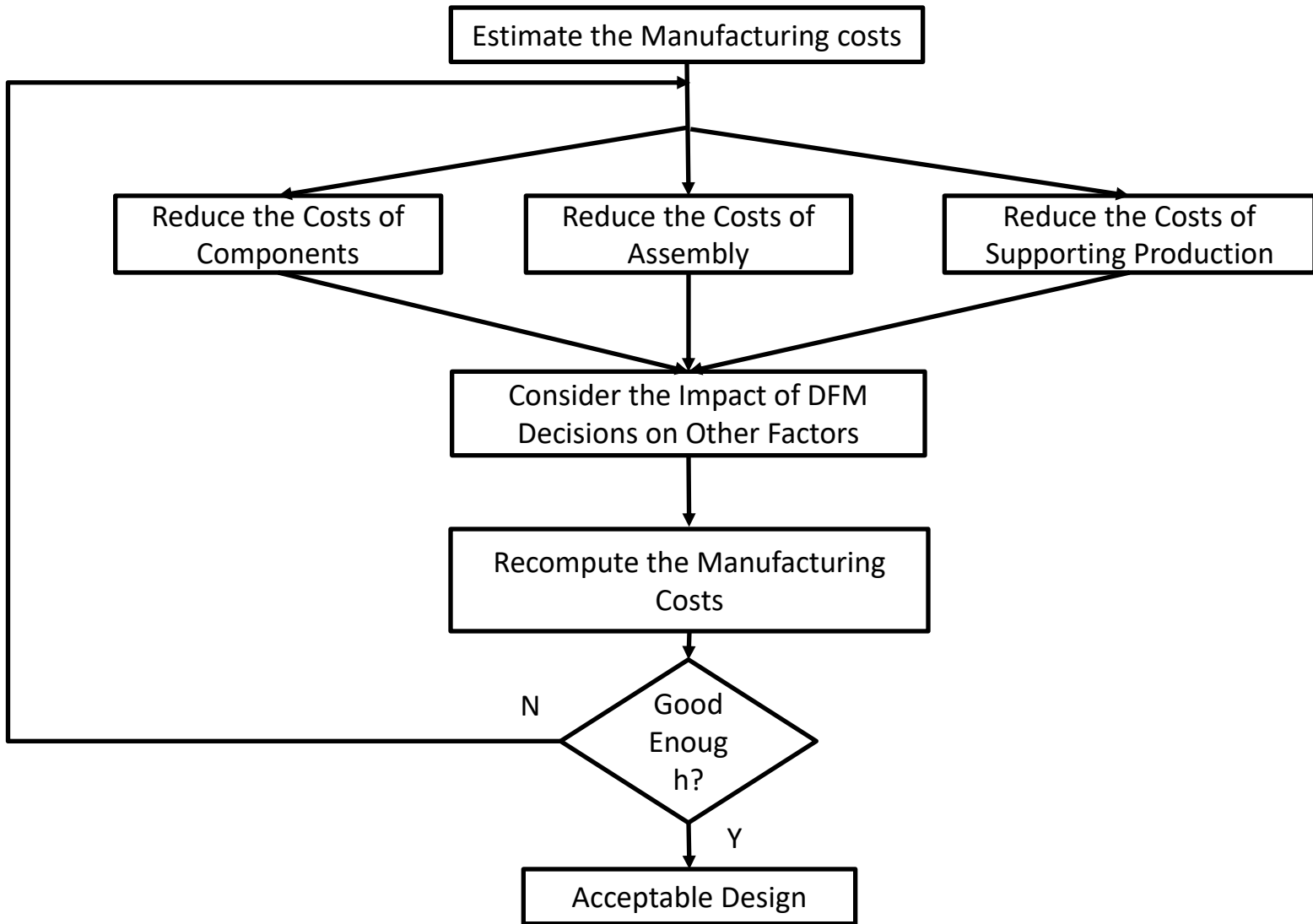
How can we emphasize manufacturing issues throughout the development process?

Importance of DFM

- Detailed design decisions have substantial impact on product quality and cost

- Development teams face multiple, and often conflicting goals

- It is important to have metrics with which to compare alternative designs

- Dramatic improvements require substantial creative efforts early in the process

- A well defined process assist the decision- making process

Definition

- <u>Design for manufacturing</u> (DFM) is a development practice emphasizing manufacturing issues throughout the product development process.

- Successful DFM results in lower production cost without sacrificing product quality.

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                    Estimate the Manufacturing costs

    Reduce the Costs of      Reduce the Costs of      Reduce the Costs of
        Components               Assembly           Supporting Production

                    Consider the Impact of DFM
                     Decisions on Other Factors

                     Recompute the Manufacturing
                                Costs

                                  Good
                 N               Enoug
                                   h?

                                   Y

                          Acceptable Design
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The Design for Manufacturing Method

Understanding Manufacturing Costs
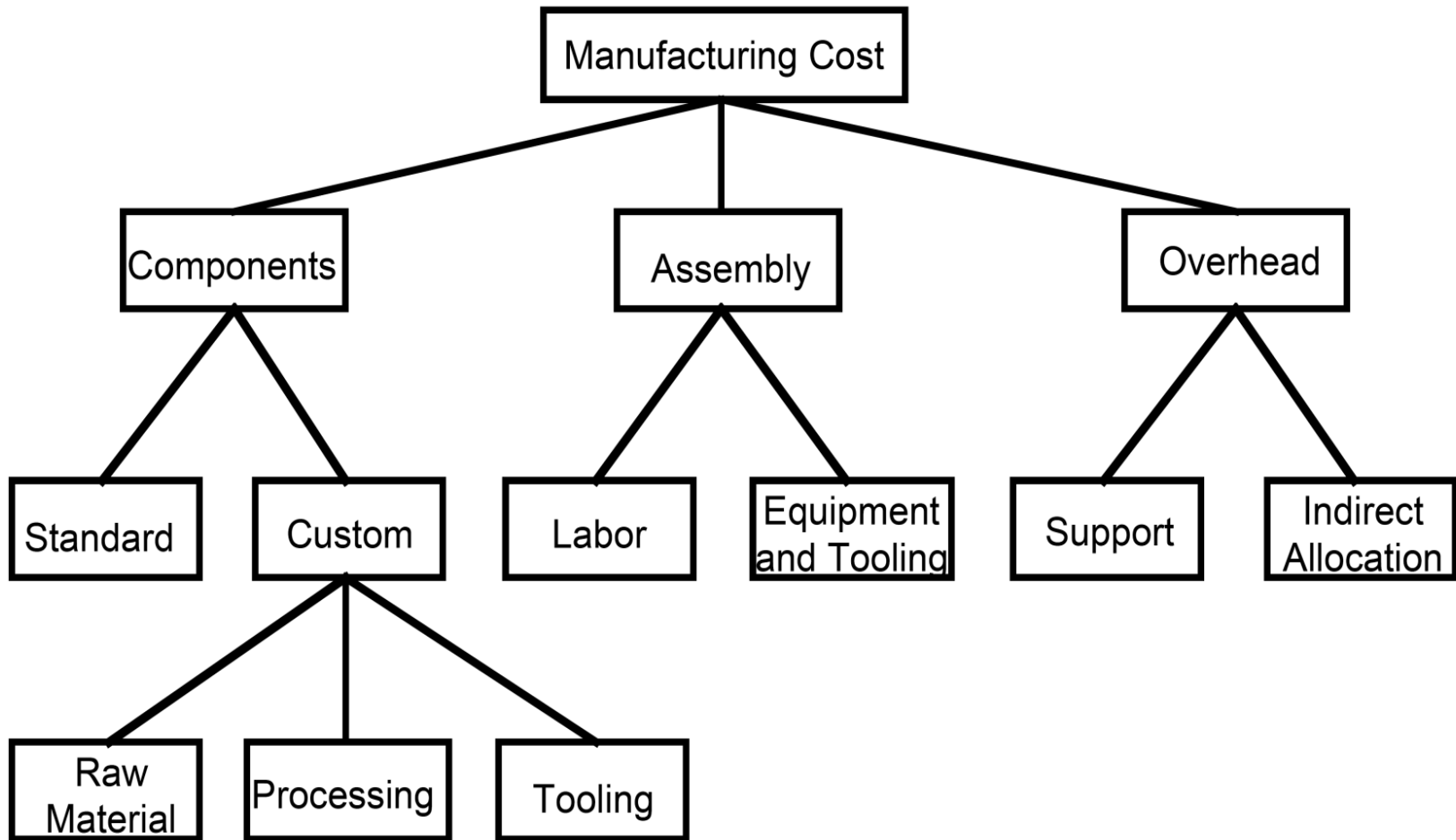
Estimate the Manufacturing Cost
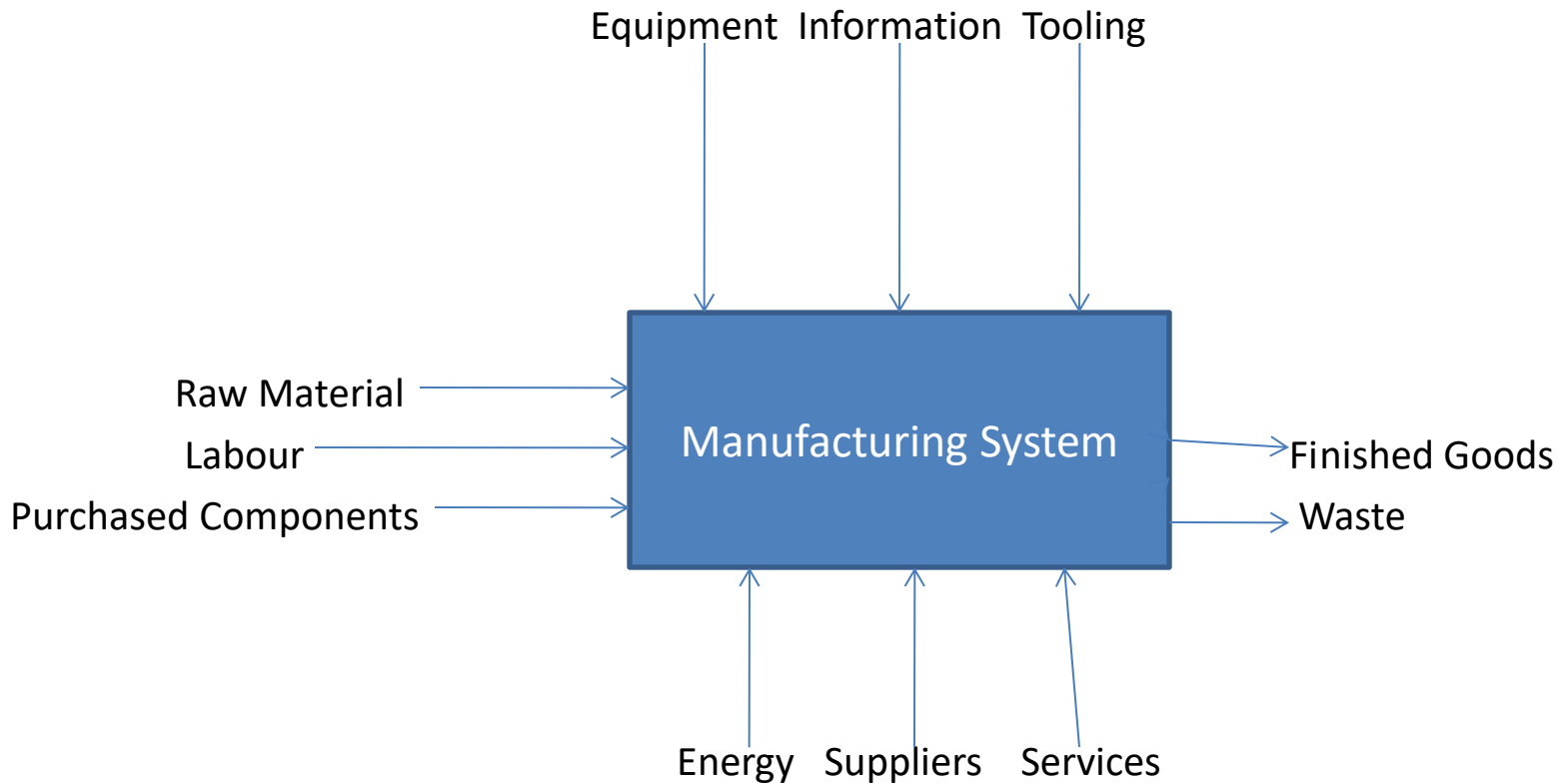
Estimate the Manufacturing Cost

- What are the boundaries of manufacturing operations? Should field service operations be included?

- How do we charge the product for the use of expensive general purpose equipment that last many years?

- How are costs allocated among more than one product line?

Estimate the Manufacturing Cost

- Fixed costs V/S Variable costs
- The bill of material
- Estimating the cost of standard components
  - Comparing each part to a substantially similar part the firm is already purchasing/ producing in comparable volumes
  - Soliciting price quotes from vendors
- Estimating the cost of custom components
  - Raw material + Processing + Tooling + Assembly

Cost of operator + Cost of using equipments

Design and fabrication of cutters, dies, moulds, fixtures etc required to use certain machinery to fabricate a part

Estimate the Manufacturing Cost

- Estimating the cost of assembly
  - Labour time + Fixed cost of tooling

  Work study or published data can provide information

- Estimating the overhead costs
  - Cost of purchase parts
  - Cost of assembly labour
  - Number of hours of equipment time product consumes

Reduce the Component Cost

- Understand the process constraint and cost drive
  - Suggest a corner in casting involving EDM operation
  - Keeping un necessary high tolerances
- Redesigning components to eliminate processing steps (net shape manufacturing)
- Choose the appropriate economic scale of the part
- Standardised components
- Adhere to 'Black Box'

Reduce the Assembly Cost

- Keeping score

DFA index = $\dfrac{\text{(theoretical min no of parts)} \times \text{(3 seconds)}}{\text{Estimated total assembly time}}$

- Integrate parts
  – Integrated parts do not have to be assembled
  – Often less expensive
  – The dimensions can be more closely controlled

Though this may make the part too complex

- Consider customer assembly

- Maximise ease of assembly

DFA Guidelines- System Guidelines

1. Minimise parts count by incorporating multiple functions into single part

2. Modularise multiple parts into single subassemblies

3. Assemble in open space, not in confined space. Never bury important parts

4. Make parts to identify how to orient them for insertions

5. Standardise to reduce part variety

DFA Guidelines- Handling Guidelines

1. Maximise part symmetry

2. Design in geometric or weight polar properties if non symmetry

3. Eliminate tangly parts

4. Colour code parts that are different but shaped similarly

5. Prevent nesting of parts

6. Provide orientation features on non symmetry

DFA Guidelines- Insertion Guidelines

- Design for mating features for easy insertion
- Provide alignment features
- Insert new parts in an assembly from above
- Insert from the same direction. Never require assembly to turn over
- Eliminate fasteners
- Place fasteners away from obstructions
- Deep channels should be sufficiently wide to provide access to fastening tools. No channel is best
- Provide flats fro uniform fastening and ease
- Proper spacing ensures allowances for a fastening tool.

Minimise Support Cost

- Minimise system complexities
- Error proofing

Consider the Impact of DFM Decision on Other factors

- The impact of DFM on development time
- The impact of DFM on development cost
- The impact of DFM on quality
- The impact of DFM on external factors
  - Component reuse
  - Life-cycle cost

Design for Assembly Rules

Example set of DFA guidelines from a computer manufacturer

1. Minimize parts count.

2. Encourage modular assembly.

3. Stack assemblies.

4. Eliminate adjustments.

5. Eliminate cables.

6. Use self-fastening parts.

7. Use self-locating parts.

8. Eliminate reorientation.

9. Facilitate parts handling.

10. Specify standard parts.

Design for Assembly

- Key ideas for DFA:
  - Minimize parts count
  - Maximize the ease of handling parts
  - Maximize the ease of inserting parts
- Benefits of DFA
  - Lower labor costs
  - Other indirect benefits
- Popular software developed by Boothroyd and Dewhurst.
  - http://www.dfma.com

Method for Part Integration

- Ask of each part in a candidate design:
    1. Does the part need to move relative to the rest of the device?
    2. Does it need to be of a different material because of fundamental physical properties?
    3. Does it need to be separated from the rest of the device to allow for assembly, access, or repair?
- If not, combine the part with another part in the device.