DFM and DFA

In order to link 'customer needs' and 'product specifications' in the context of specific design issues, many teams practice 'design for X' (DFX) methodologies, where X may correspond to a number of quality criteria such as:

- Reliability
- Robustness
- Serviceability
- Environment Impact
- Manufacturability

The most common of these methodologies is design for manufacturing (DFM) because it directly addresses manufacturing costs.

Effective DFM practice leads to low manufacturing costs without sacrificing product quality.

- <u>DFM requires a cross-functional team</u>

DFM is one of the most integrative practices involved in product development. DFM utilizes information of several types, including;

1. Sketches, drawings, product specifications, and design alternatives.
2. A detailed understanding of production and assembly processes.
3. Estimates of manufacturing costs, product volumes, and ramp-up timing.

DFM efforts draw upon expertise from manufacturing engineers, cost accountants and product personnel, in addition to product designers.

<u>DFM is applied throughout the development process</u>

DFM begins during the concept development phase, when product's functions and specifications are being determined. Although cost estimates at the concept development phase are highly subjective and approximate, Trade-offs between costs and desired performance characteristics are made when product specifications are finalized (example : weight reduction may increase manufacturing costs). At this point, the team may have an approximate bill of materials along with cost estimates.

During the system level design phase, decisions are made on how to break the product into individual components.

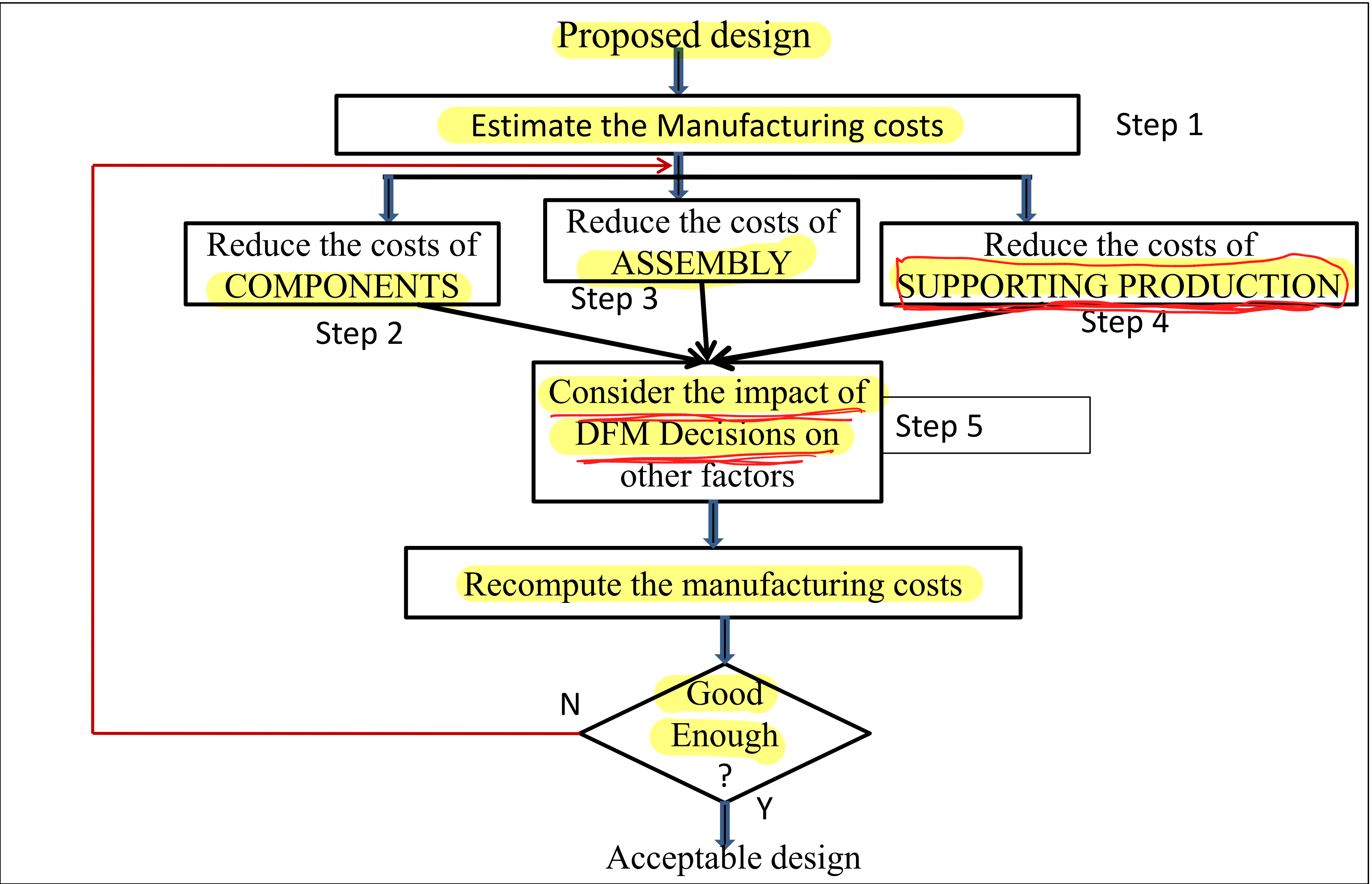
Accurate cost estimates finally become available during the detail design phase.

OVERVIEW OF THE DFM PROCESS

The methods consists of five steps

1. Estimates the manufacturing costs.
2. Reduce the costs of components.
3. Reduce the costs of assembly.
4. Reduce the costs of supporting production.
5. Consider the impact of DFM decisions on other factors.

The ‘Design for manufacturing (DFM)’ method



Element of the manufacturing cost of a product

Step-1) Estimate the → manufacturing Cost (Step-1 of DFM)

- Components (parts)
  - Standard
  - Custom (supplier/in-house)
    - Raw Material
    - Processing (Machine + Labour)
    - Tooling
- Assembly (LTE)
  - Labour
  - Tooling
  - Equipment
- Overhead
  - Support Costs (Associated With
    - Material handling
    - Q.A.
    - Purchasing
    - Shipping
    - Receiving
    - Facilities
    - Maintenance

    etc.
  - Indirect Allocation (Not relevant to DFM; Not Specifically linked to the design of the product)

Step 3: Reduce the cost of Assembly

Design for Assembly (DFA) is a subset of DFM which involves minimising the cost of assembly. Often as a result of emphasis on DFA, the overall parts count, manufacturing complexity and support costs are all reduced along with the assembly cost.

DFA Index

Boothroyd and Dewhurst (1989) advocate maintaining an ongoing cost of assembly. They propose the concept of assembly efficiency. This concept is useful in developing an intuition for what drives the cost of assembly. The expression for the DFA index is

$$\text{DFA index} = \frac{(Theoretical\ minimum\ number\ of\ parts) * (3\ seconds)}{Estimated\ total\ assembly\ time}$$

To determine the theoretical minimum number of parts, the following questions regarding each part must be raised. Only parts satisfying one or more of these conditions must "theoretically" be separate.

1. Does the part need to move relative to the rest of the assembly?
2. Must the part be made of a different material from the rest of the assembly for fundamental physical reasons?
3. Does the part have to be separated from the assembly for assembly access, replacement or repair?

The “3 seconds” in the numerator reflects the theoretical minimum time required to handle and insert a part that is perfectly suited for assembly. – Average time required to assemble a small part that is easy to grasp, requires no particular orientation, and demands no special insertion effort. (Example : Placing a ball into a circular hole with adequate clearance)

<u>Intergrate Parts</u>

If a part does not qualify as one of those theoretically necessary, then it is a candidate for physical integration with one or more other parts.

Maximize Ease of Assembly → straw

example → pushpa

- Part is inserted from the top of the assembly (Z-axis assembly and not inverted)
- Part is self-aligning (provide chamfer)
- Part does not need to be oriented (Example: Sphere Vs Cylinder)
- Part requires only one hand for assembly (takes less time than using both hands)
- Parts require no tools
- Part is assembled in a single linear motion (Pushing a pin Vs driving a screw)
- Part is secured immediately upon insertion (without a subsequent securing option such as tightening or the addition of extra part etc.)

Consider Customer Assembly

Customers may tolerate completing source of the product assembly themselves, especially if doing so provides other benefits, such as making the purchase and handling of the packaged product easier.