Introduction

• A common failure in product development is making products that work but that are also very difficult to build.
• Difficulty in manufacturing makes a product expensive:
  – Hard to fabricate, takes extra time, and is unreliable.
  – Requested geometry can be hard to fabricate
  – Unnecessarily tight tolerances require extra care in production that is hard to maintain.
• DFM and DFA is the analysis and redesign of a product or concept to make it easier to produce.

DFA and DFM

• In this lecture, basic design guidelines that one can apply to simplify a design in assembly and in piece-part production will be presented.
• DFM and DFA and synthesis is, as with many design process methods, applicable during many phases of a product design process.
• These can be used in benchmarking analysis, in simplifying new concepts not yet built, and in enhancing fully embodied designs.

Why are DFM and DFA Important?

• DFM and DFA is important for design because of 3 beneficial impacts:
  – Reduced cost because design is easier to produce, fewer parts, less time required, hence cheaper.
  – Increased reliability because production process is simplified, therefore less variability and opportunity for outright errors.
  – Increased quality because it is easier to produce, less machine capability is required to achieve the same tolerances. Less things can go wrong.

The DFM Method

[Diagram: Description of DFM Method]
Simple input-output model of a manufacturing system

Elements of the manufacturing cost of a product

Appropriate economies of scale

Summary of DFM Guidelines
- DFM is aimed at reducing manufacturing costs while simultaneously improving (or at least not inappropriately compromising) product quality, development time, and development cost.
- DFM utilizes estimates of manufacturing cost to guide and prioritize cost reduction efforts. Cost estimation requires expertise with relevant production processes. Suppliers and manufacturing experts must be involved in this process.
- Since accurate cost estimation is very difficult, much DFM practice involves making informed decisions in the absence of detailed cost data.

Summary of DFM Guidelines (cont)
- Component costs are reduced by understanding what drives these costs. Solutions may involve novel component design concepts or incremental improvement of existing designs through simplification and standardization.
- DFM is an integrative method taking place throughout the development process and requiring inputs from across the development team.
- DFM decisions can affect production lead time, product development cost, and product quality. Tradeoffs will frequently be necessary between manufacturing cost and these important broader issues.

DFM Guidelines
- Assembly costs can be reduced by following well-established DFA guidelines. Components can be redesigned to simplify assembly operations, or components can be eliminated entirely by integrating their functions into other components.
- DFA general guidelines are adapted from many sources and from experience. If a concept is compatible with these guidelines, one can be reasonably assured that the design will fare well in the subsequent more detailed analysis.
DFA General Guidelines
1. Minimize part count by incorporating multiple functions into single parts.
2. Modularize multiple parts into single subassemblies.
3. Assemble in open space, not in confined spaces. Never bury important components.
4. Make parts to self-identify how to orient them for insertion.
5. Standardize to reduce part variety.
7. Design in geometric or weight polar properties if non-symmetric.

DFA General Guidelines (cont)
8. Eliminate tangly parts.
9. Colour code parts that are different but shaped similarly.
11. Provide orientating features on nonsymmetries.
12. Design the mating features for easy insertion.
13. Provide alignment features.
14. Insert new parts into an assembly from above.

DFA General Guidelines (cont)
15. Insert from the same direction or very few. Never require the assembly to be turned over.
17. Place fasteners away from obstructions.
18. Deep channels should be sufficiently wide to provide access to fastening tools. No channel is best.
19. Providing flats for uniform fastening and fastening ease.
20. Proper spacing ensures allowance for a fastening tool.

Categorized guidelines
1. System guidelines
2. Ease of handling guidelines
3. Attachment guidelines: insertion, joining
4. Injection molded part design guidelines
5. Sheet-formed design guidelines
6. Cast part design guidelines
7. Machined part design guidelines

See separate .pdf file (catguide.pdf) of the above guidelines in picture form.

Topic Summary
• DFM and DFA are cost effective methodologies to reduce product cost.
• The basic techniques to improve a design are mostly a collection of common-sense rules.
• Most important rule: modularize to minimize part count, design for top-down insertion with alignment features.
• Review thoroughly and simplify the fabrication challenges of each feature on every part.

Useful References
• The Thomas Register is useful for identifying suppliers of components, tooling, machinery, and other industrial products. Available on the internet or see:
• Most popular method of DFA is by Boothroyd and Dewhurst. Software is also available to aid in estimating costs for both manual and automatic assembly, as well as a wide range of component costs: