

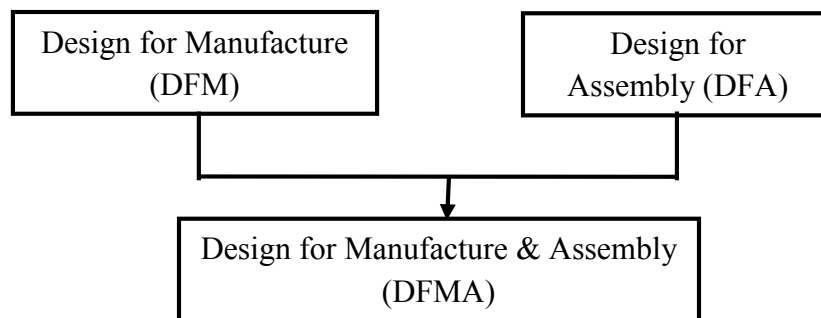
# Introduction to DFMA

## Objectives of this course

1. To introduce the concept and application for design for manufacturing and assembly to practicing designers and manufacturing engineers as well as design students
2. To discuss various fundamentals of assembly and design recommendations for product development

## What is “DFMA”?

The concept of DFM (Design for Manufacture) is not new, it dates back as early as 1788 when LeBlanc, a Frenchman, devised the concept of inter-changeable parts in the manufacture of muskets which previously were individually handmade. DFM is the practice of designing products keeping manufacturing in mind. “Design for manufacture” means the design for ease of manufacture for the collection of parts that will form the product after assembly. Similarly DFA is called Design for Assembly. DFA is the practice of designing product with assembly in mind. “Design for assembly” means the design of the product for ease of assembly. So design for Manufacture and assembly is the combination of DFM and DFA as shown in Figure M1.1.1



**Figure M1.1.1:** Definition of Design for Manufacture & Assembly (DFMA)

## History of DFMA

1. Eli Whitney is an inventor from America used some DFM techniques in earlier times before the term DFM came in to existence. Whitney incorporated the concept of interchangeable parts for manufacturing musket for U.S. government. Prior to this innovation, each craftsman was responsible to manufacture the complete product by using saw and files to shape each part and fit them together.
2. Henry Ford an American industrialist was renowned for his advanced and extensive use of assembly lines. The manual assembly operation was broken down into small chunks of repetitive work that could be carried out at high efficiency. Ford in his book “My Life and Work” described about the successful model T car that includes simplicity in operation, absolute reliability and high quality in materials that used in that model. The concept used at that time by Ford is now referred as DFM.
3. General Electric used value analysis techniques in the late 1940s. With the help of value analysis techniques, it is possible to find the cost of a product and obtaining the design alternatives for the product at the lowest cost. The philosophical approach of value analysis is through questioning and comparing the value and cost of each features and each element of a product design.
4. The book “Metal Engineering Processes” edited by Roger W. Boltz is one of the books from a series of handbook published by ASME in 1941. This book provides a series of guidelines to designer in enhancing the manufacturability of metal components made with a number of manufacturing processes such as casting, forging, extrusion, machining, joining, finishing etc. Though Boltz used the word DFM, he is the first person arrange and plan DFM methodology.
5. In the year 1960, people started to use the terms producibility and manufacturability and about 1985, design for manufacturability and its short form DFM were widely used.
6. Geoffrey Boothroyd and A.H. Redford studied automatic assembly and provided various design guidelines to make the assembly process easier.
7. In the recent years various trade association and vendors of parts are issuing booklets to the product designers providing a series of guidelines and tolerance and materials

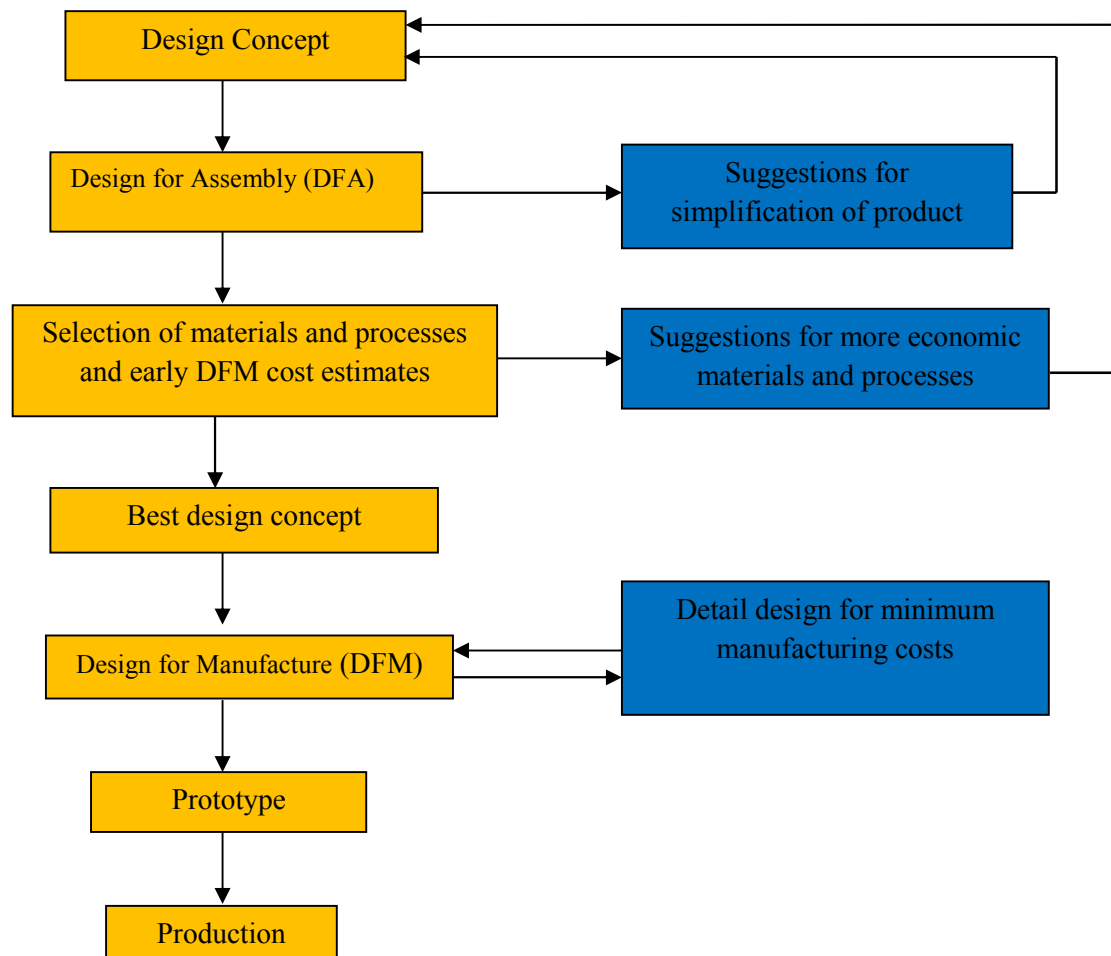
recommendations for parts. These kinds of publications have provided valuable and authoritative assistance to product designers.

## Steps for applying DFMA during product design

The following steps are followed when DFMA used in the design process.

- DFA analysis leading to simplification of the product structure
- Early cost estimation of parts for both original design and modified design
- Selecting best material and process to be used
- After final selection of material and process carry out a thorough analysis of DFM

Figure M1.1.2 depicts the flow diagram of various steps undertaken in a DFMA study using DFMA software.



**Figure M1.1.2:** Common steps taken in a DFMA study (Source: G. Boothroyd, P. Dewhurst and W. Knight *Product Design for Manufacture and Assembly*, 2nd edition)

## **Advantages of applying DFMA during product Design**

Today products are

- Tending to becoming more complex
- Made/required in increasingly large number
- Intended to satisfy a wide variation in user population
- Required to compete aggressively with similar products
- Required to consistently high quality

Through DFMA it is possible to produce competitively priced, high performance product at a minimal cost. The advantages of applying DFMA during product design are as follows:

- DFMA not only reduces the manufacturing cost of the product but it helps to reduce the time to market and quality of the product.
- DFMA provides a systematic procedure for analyzing a proposed design from the point of view of assembly and manufacture.
- Any reduction in the number of parts reduces the cost as well as the inventory.
- DFMA tools encouraged the dialogue between the designer and manufacturing engineer during the early stages of design.

## **Reasons for not implementing DFMA**

1. No time: Designers are constrained to minimize their “design to manufacture time” for a new product.
2. Not invented here: Very often designers provide enough resistance to adopt new techniques.
3. The ugly baby syndrome: Designer ego crashes if there is some suggestion for design change.
4. Low assembly cost: Since assembly cost of a particular product is less as compared to the total material and manufacturing cost, DFA analysis is not required.
5. Low volume: Often it is expressed that DFMA is applicable for large quantity production.
6. Database doesn't apply to our product: Since DFMA is applied at the early stages of design before the detail design has taken place; there is a need for a generalized database.

7. We have been doing it for years: Sometimes industry uses the design for producibility concept to fine-tune the design. There is a misconception that they are doing the similar practice of DFMA.
8. It is only value analysis: The objective of DFMA and value analysis are same, however DFMA is used at the early stages of design and can be used in every stages of design.
9. DFMA is only one among many techniques.
10. DFMA leads to products that are more difficult to service.
11. Prefer design rules: Sometimes design rules guide the designer in the wrong direction.
12. Refuse to use DFMA: Individual doesn't have the incentive to adopt the new technology and use the tools available.

## **Course Overview**

In this course, the following topics shall be covered through different modules.

- Various types of materials, its classification, suitable materials for product design and various methods of material selection, various mechanical properties of material (Module I).
- Various casting design, machining design, designing of formed components (Module II, Module III, and Module IV).
- Various design recommendations for cleaning, design for polishing, plating and coating, and Heat treatment and various design recommendations (Module V).
- Various design recommendation for permanent joining such as welding, soldering and brazing (Module VI).
- Various design recommendation for riveting, screw fastening etc. (Module VII).
- Lastly, the course is completed with an introduction to CAD, various types of geometric model, different types of features, procedure for feature extraction from part and assembly model (Module VIII).