University of Baghdad
Al-Khwarizmi College of Engineering
Automated Manufacturing Engineering Department

Selection of Manufacturing Processes
Introduction to DFMA

Lecture 1

By " Hiba khalid "

Introduction to DFMA

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

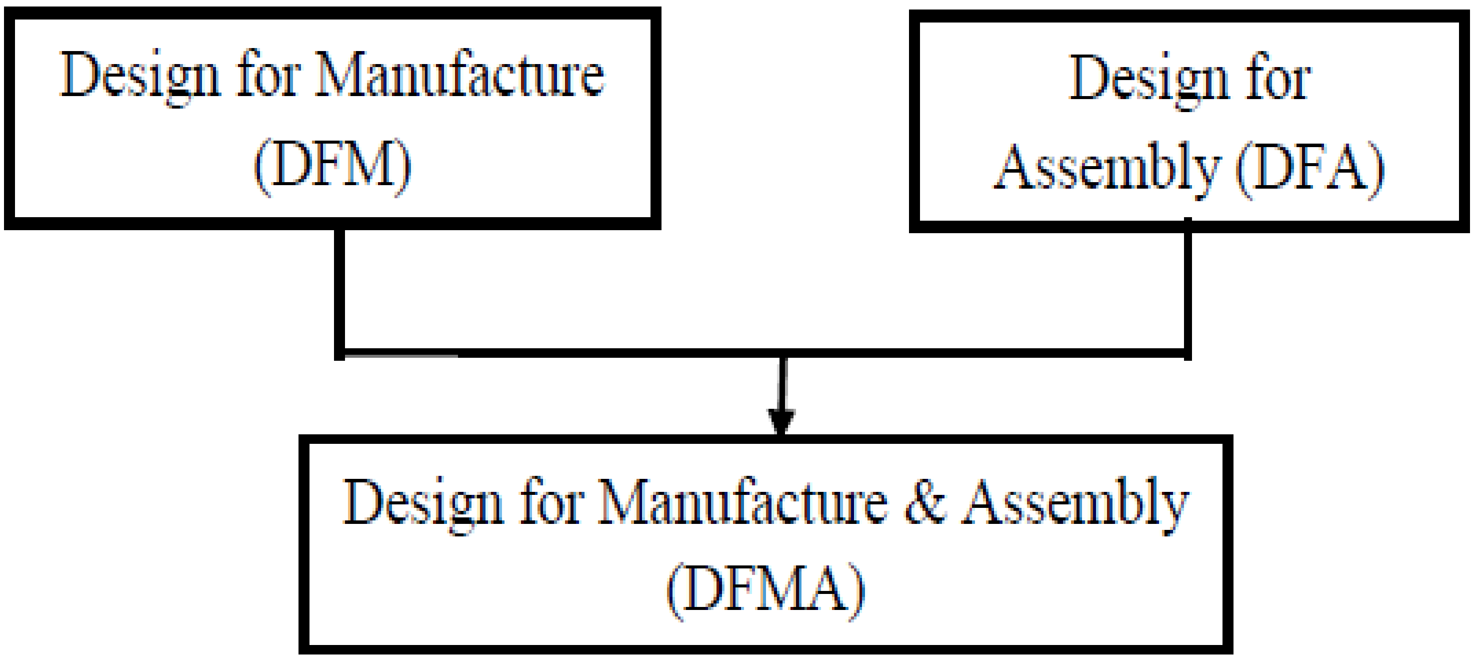

Figure M1.1.1: Definition of Design for Manufacture & Assembly (DFMA)

Steps for applying DFMA during product design

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

- DFA analysis lading 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

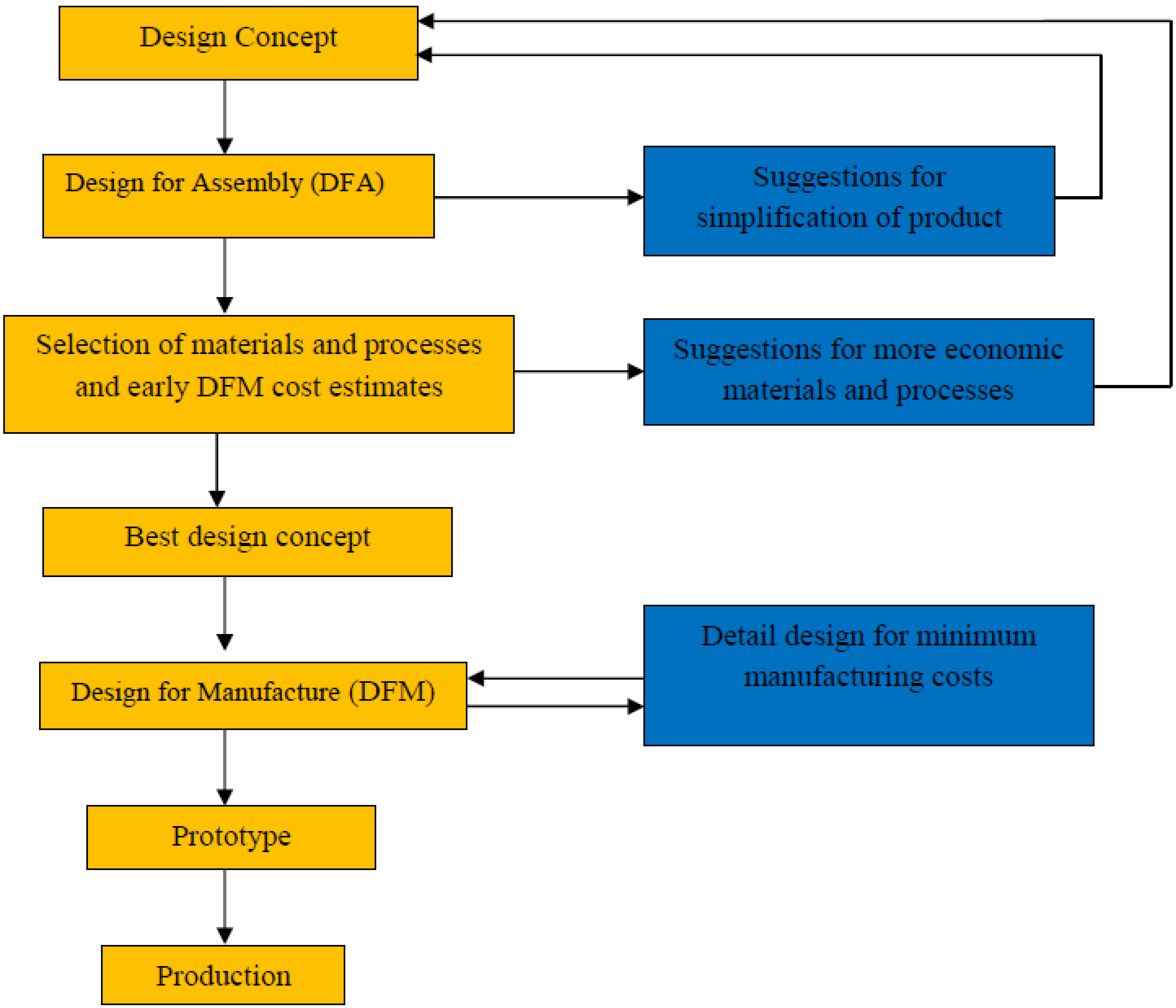

Figure M1.1.2: Common steps taken in a DFMA study *(Source: G. Boothroyd, P. Dewhurst and W. Knight Product Design for Manufacture and Assembly, 2nd edition)*

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.

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Need Identification and Problem Definition

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Instructional objectives

The primary objective of this lecture module is to outline how to identify the need and define the problem so as to begin with the activities and steps involved in *design for manufacturing* process

Steps involved in Engineering Design process

Figure 1.1.1 **schematically outlines the typical steps involved in an engineering design process**

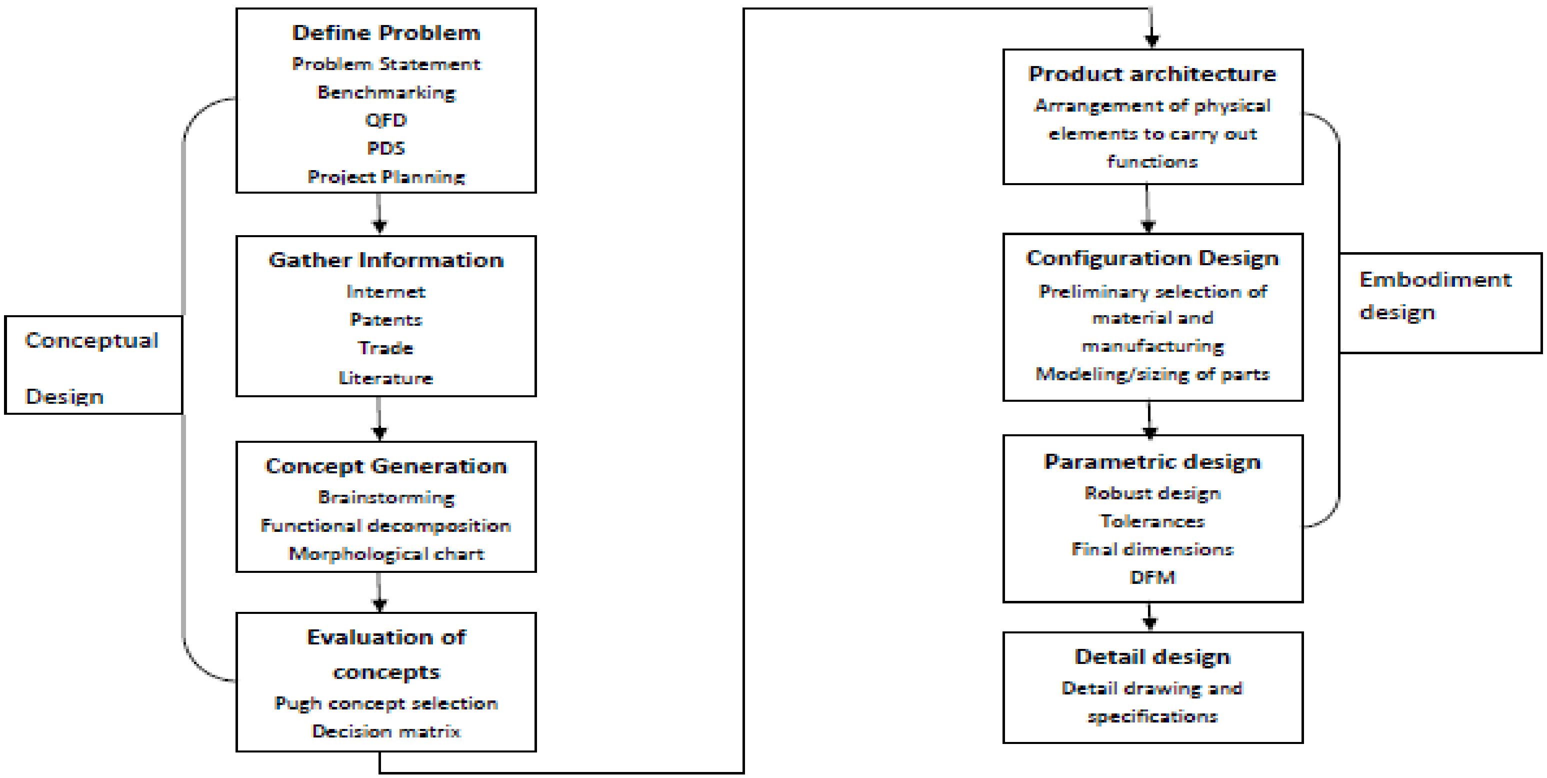


Figure 1.1.1 Discrete steps involved in engineering design process. It also mentions the important techniques used in each steps.

Conceptual Design

It is a process in which we initiate the design and come up with a number of design concepts and then narrow down to the single best concept. This involved the following steps.

(1)Identification of customer needs: The mail objective of this is to completely understand the customers' needs and to communicate them to the design team

(2)Problem definition: The mail goal of this activity is to create a statement that describes what all needs to be accomplished to meet the needs of the customers' requirements.

(3)Gathering Information: In this step, we collect all the information that can be helpful for developing and translating the customers' needs into engineering design.

(4)Conceptualization: In this step, broad sets of concepts are generated that can potentially satisfy the problem statement

(5)Concept selection: The main objective of this step is to evaluate the various design concepts, modifying and evolving into a single preferred concept.

Embodiment Design

It is a process where the structured development of the design concepts takes place. It is in this phase that decisions are made on strength, material selection, size shape and spatial compatibility. Embodiment design is concerned with three major tasks – product architecture, configuration design, and parametric design.

(1)Product architecture: It is concerned with dividing the overall design system into small subsystems and modules. It is in this step we decide how the physical components of the design are to be arranged in order to combine them to carry out the functional duties of the design.

(2)Configuration design: In this process we determine what all features are required in the various parts / components and how these features are to be arranged in space relative to each other.

(3)Parametric design: It starts with information from the configuration design process and aims to establish the exact dimensions and tolerances of the product. Also, final decisions on the material and manufacturing processes are done if it has not been fixed in the previous process. One of the important aspects of parametric designs is to examine if the design is robust or not.

Product Life cycle

Every product goes through a cycle from birth, followed by an initial growth stage, a relatively stable matured period, and finally into a declining stage that eventually ends in the death of the product as shown schematically in *Figure .1.1.2*

(1)Introduction stage: In this stage the product is new and the customer acceptance is low and hence the sales are low.

(2)Growth stage: Knowledge of the product and its capabilities reaches to a growing number of customers.

(3)Maturity stage: The product is widely acceptable and sales are now stable, and it grows with the same rate as the economy as a whole grows.

(4)Decline stage: At some point of time the product enters the decline stage. Its sales start decreasing because of a new and a better product has entered the market to fulfill the same customer requirements.

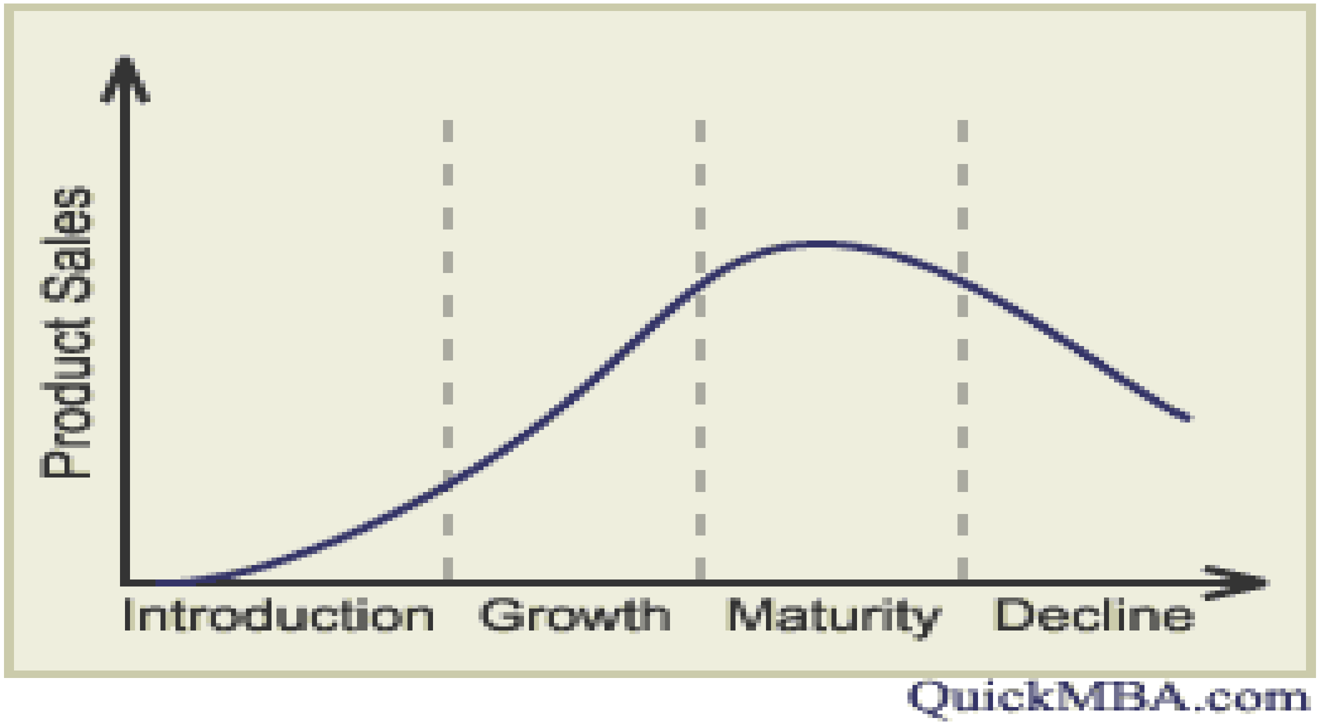
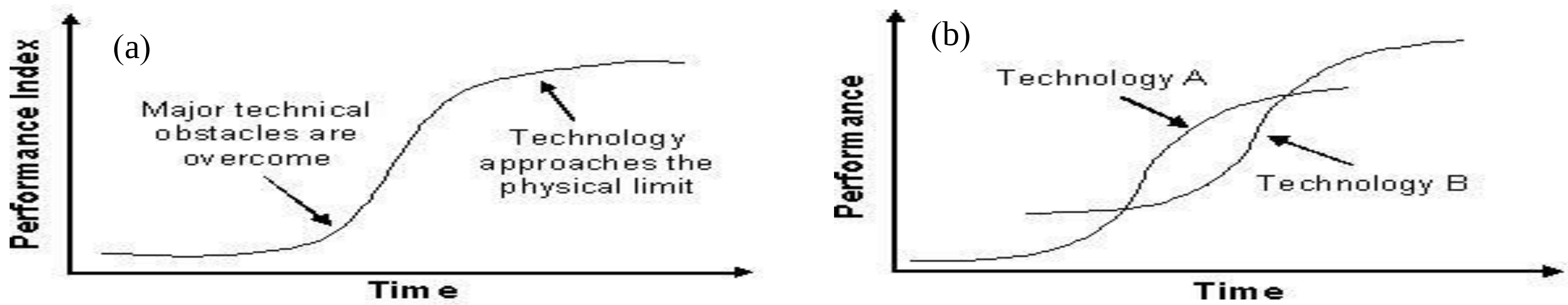


Figure 1.1.2 Schematic outline of a product life cycle

Technology development cycle

The development of a new technology follows a typical S-shaped curve [*Figure 1.1.3*(*a*)]. In its early stage, the progress is limited by the lack of ideas. A single good idea can make several other god ideas possible, and the rate of progress is exponential. Gradually the growth becomes linear when the fundamental ideas are in place and the progress is concerned with filling the gaps between, the key ideas. It is during this time when the commercial exploitation flourishes. But with time the technology begins to run dry and increased improvements come with greater difficulty. This matured technology grows slowly and approaches a limit asymptotically. The success of a technology based company lies in its capabilities of recognizing when the core technology on which the company's products are based begin to mature and through an active R&D program, transfer to another technology growth curve [*Figure 1.1.3*(b)] which offers greater possibilities.



Schematic outline of (a) technology development curve, (b) improved program to develop new technology **1.1.3Figure**
.before the complete extinct of existing technology