Module 1

Classification of Metal Removal Processes and Machine tools

Lesson 1

Introduction to Manufacturing and Machining

Instructional objectives

At the end of this lesson, the student would be able to :

(i) Identify the necessity of “manufacturing”
(ii) Define with examples the concept of “manufacturing”
(iii) List the main classifications of the manufacturing processes with examples
(iv) State the main purposes of “machining”
(v) Define with examples the concept of “machining”
(vi) State with example the principles of “machining”
(vii) State with examples the main requirements for “machining”
(viii) State with examples the main functions of “Machine tools”
(ix) Define the concept of “machine tools”

(i) Manufacturing – Need and concept

The progress and the prosperity of human civilization are governed and judged mainly by improvement and maintenance of standard of living through availability or production of ample and quality goods and services for men’s material welfare (MMW) in all respects covering housing, clothing, medicine, education, transport, communication and also entertainment. The successful creation of men’s material welfare (MMW) depends mainly on

- availability of natural resources (NR)
- exertion of human effort (HE); both physical and mental
- development and use of power tools and machines (Tools),

This can be depicted in a simple form,

$$MMW = NR(HE)^{TOOLS}$$

where, NR: refers to air, water, heat and light, plants and animals and solid and liquid minerals

TOOLS: refers to power plants, chemical plants, steel plants, machine tools etc. which magnify human capability.

This clearly indicates the important roles of the components; NR, HE and TOOLS on achieving MMW and progress of civilization.

Production or manufacturing can be simply defined as value addition processes by which raw materials of low utility and value due to its inadequate material properties and poor or irregular size, shape and finish are converted into high utility and valued products with definite dimensions, forms and finish imparting some functional ability. A typical example of manufacturing is schematically shown in Fig. 1.1.

A lump of mild steel of irregular shape, dimensions and surface, which had almost no use and value, has been converted into a useful and valuable product like bolt by a manufacturing process which imparted suitable features, dimensional accuracy and surface finish, required for fulfilling some functional requirements.

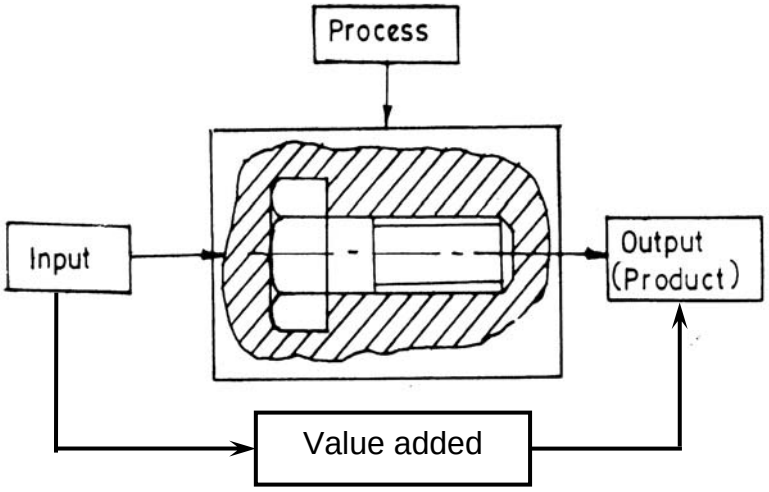


Fig. 1.1 *Value addition by manufacturing.*

Production Engineering covers two domains:

(a) Production or Manufacturing Processes
(b) Production Management

(a) Manufacturing Processes

This refers to science and technology of manufacturing products effectively, efficiently, economically and environment-friendly through

- Application of any existing manufacturing process and system
- Proper selection of input materials, tools, machines and environments.
- Improvement of the existing materials and processes
- Development of new materials, systems, processes and techniques

All such manufacturing processes, systems, techniques have to be

- Technologically acceptable
- Technically feasible
- Economically viable
- Eco-friendly

Manufacturing Science and technology are growing exponentially to meet the growing demands for;

(i) Increase and maintenance of productivity, quality and economy specially in respect of liberalisation and global competitiveness

(ii) Making micro and ultra precision components for the modern electronics, computers and medical applications
(iii) Processing exotic materials, coming up with rapid and vast advent of science and technology like aerospace and nuclear engineering.

(b) Production Management

This is also equally important and essential in the manufacturing world. It mainly refers to planning, coordination and control of the entire manufacturing in most profitable way with maximum satisfaction to the customers by best utilization of the available resources like man, machine, materials and money. It may be possible to manufacture a product of given material and desired configuration by several processes or routes as schematically indicated in Fig. 1.2.

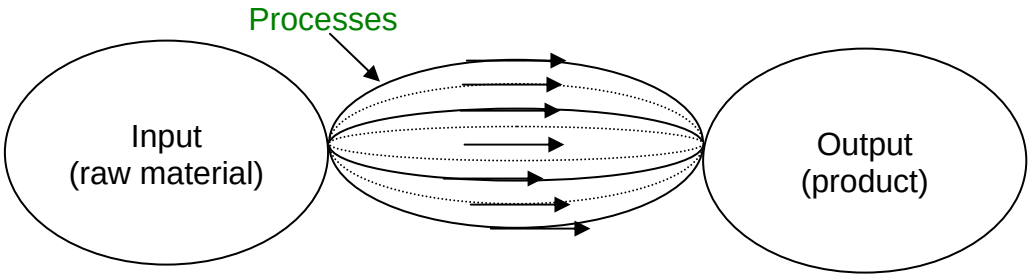


Fig. 1.2 *Possibility of manufacturing in number of routes.*

The various process routes may be different in respect of principle, technique, quality of products and time requirement and cost of manufacture. The best one is to be selected based on some criteria. Achieving the goal in manufacturing requires fulfillment of one or more of the following objectives:

- reduction of manufacturing time
- increase of productivity
- reduction of manufacturing cost
- increase in profit or profit rate

The most significant and ultimate objective, i.e., "Increase in Profit, P_r", can be attained by

(i) reducing the overall manufacturing cost, C_m
(ii) increase in revenue, R by increasing quality and reliability of the products
(iii) enhancement of saleable production

As has been indicated in Fig. 1.3

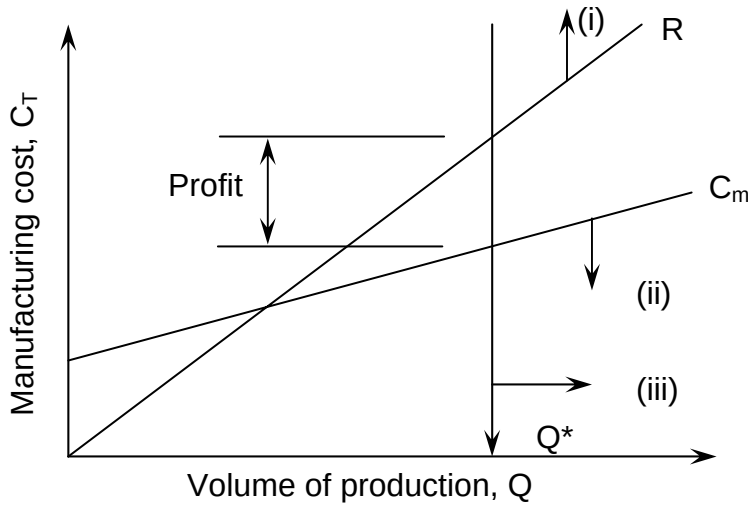


Fig. 1.3 *Strategies of increasing profit.*

Production management integrates and accomplishes all such essential activities leading to maximum benefits by best utilization of the resources and strategies.

(ii) Broad classification of Engineering Manufacturing Processes.

It is extremely difficult to tell the exact number of various manufacturing processes existing and are being practiced presently because a spectacularly large number of processes have been developed till now and the number is still increasing exponentially with the growing demands and rapid progress in science and technology. However, all such manufacturing processes can be broadly classified in four major groups as follows:

(a) Shaping or **forming**
Manufacturing a solid product of definite size and shape from a given material taken in three possible states:

- in solid state – e.g., forging rolling, extrusion, drawing etc.
- in liquid or semi-liquid state – e.g., casting, injection moulding etc.
- in powder form – e.g., powder metallurgical process.

(b) Joining process
Welding, brazing, soldering etc.

(c) Removal process
Machining (Traditional or Non-traditional), Grinding etc.

(d) Regenerative manufacturing

Production of solid products in layer by layer from raw materials in different form:

- liquid – e.g., stereo lithography
- powder – e.g., selective sintering
- sheet – e.g., LOM (laminated object manufacturing)
- wire – e.g., FDM. (Fused Deposition Modelling)

Out of the aforesaid groups, Regenerative Manufacturing is the latest one which is generally accomplished very rapidly and quite accurately using CAD and CAM for Rapid Prototyping and Tooling.

(iii) Machining – Purpose, Principle and Definition

(a) Purpose of Machining

Most of the engineering components such as gears, bearings, clutches, tools, screws and nuts etc. need dimensional and form accuracy and good surface finish for serving their purposes. Preforming like casting, forging etc. generally cannot provide the desired accuracy and finish. For that such preformed parts, called blanks, need semi-finishing and finishing and it is done by machining and grinding. Grinding is also basically a machining process.

Machining to high accuracy and finish essentially enables a product

- fulfill its functional requirements
- improve its performance
- prolong its service

(b) Principle of Machining

The basic principle of machining is typically illustrated in Fig. 1.4.

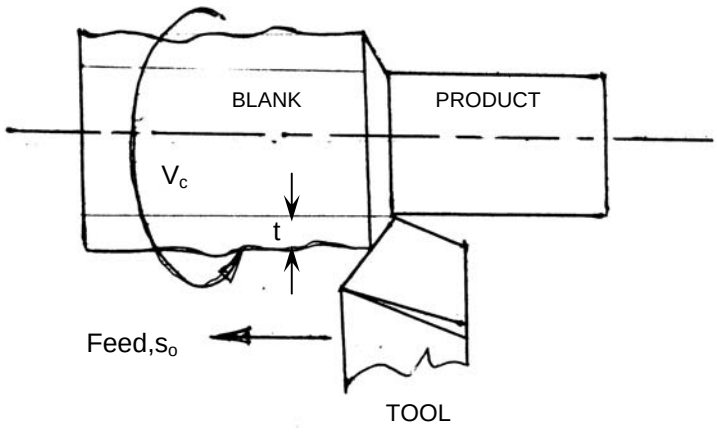


Fig. 1.4 *Principle of machining (turning)*

A metal rod of irregular shape, size and surface is converted into a finished rod of desired dimension and surface by machining by proper relative motions of the tool-work pair.

(c) Definition of Machining: Machining is an essential process of finishing by which jobs are produced to the desired dimensions and surface finish by gradually removing the excess material from the preformed blank in the form of chips with the help of cutting tool(s) moved past the work surface(s).

(iv) Machining requirements

The essential basic requirements for machining work are schematically illustrated in Fig. 1.5

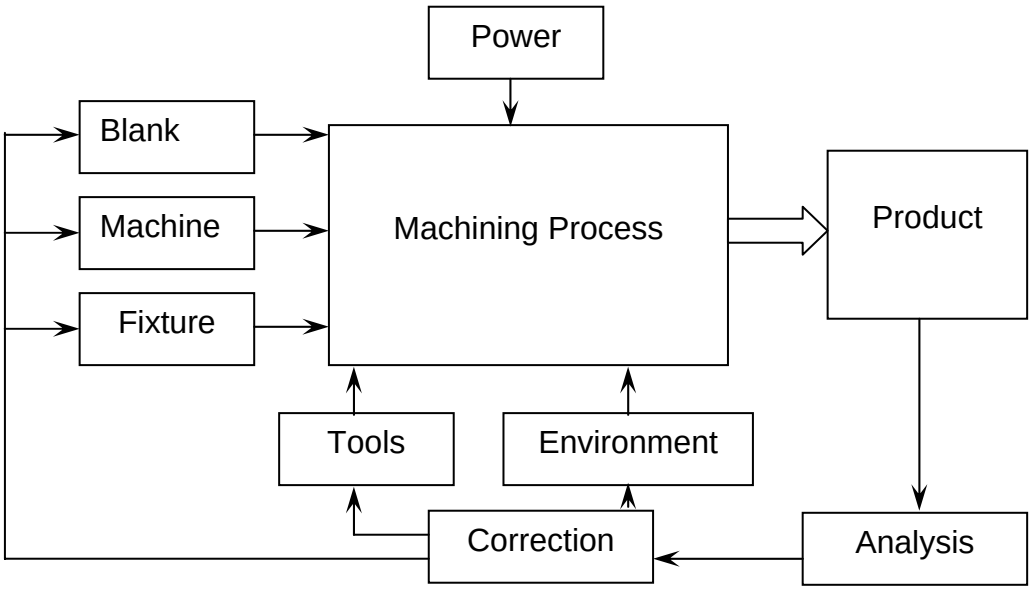


***Fig. 1.5** Requirements for machining*

The blank and the cutting tool are properly mounted (in fixtures) and moved in a powerful device called machine tool enabling gradual removal of layer of material from the work surface resulting in its desired dimensions and surface finish. Additionally some environment called cutting fluid is generally used to ease machining by cooling and lubrication.

(v) Basic functions of Machine Tools

Machine Tools basically produce geometrical surfaces like flat, cylindrical or any contour on the preformed blanks by machining work with the help of cutting tools. The physical functions of a Machine Tool in machining are:

- firmly holding the blank and the tool
- transmit motions to the tool and the blank

- provide power to the tool-work pair for the machining action.
- control of the machining parameters, i.e., speed, feed and depth of cut.

(vi) Machine Tool - definition

A machine tool is a non-portable power operated and reasonably valued device or system of devices in which energy is expended to produce jobs of desired size, shape and surface finish by removing excess material from the preformed blanks in the form of chips with the help of cutting tools moved past the work surface(s).

A. Quiz Test:

Select the correct answer from the given four possible answers: -

1. Machining is a
   (a) shaping process
   (b) removal process
   (c) regenerative process
   (d) joining process.

2. An object is machined to
   (a) fulfill its functional requirement
   (b) provide desirably good performance
   (c) render longer service life
   (d) all of the above.

3. Feed rate is expressed in turning operation by
   (a) mm/revolution
   (b) mm/stroke
   (c) mm per min
   (d) none of the above.

4. Rapid prototyping is a
   (a) joining process
   (b) removal process
   (c) regenerative manufacturing process
   (d) finishing process.

B. Exercises:

1. What should be the aims and objectives in manufacturing of any product?

2. Justify “Machining is a value addition process”.

3. Why even a battery operated pencil sharpener cannot be accepted as a machine tool?

4. Why is making profit must for any industry ?

Answers of the given questions.

A. 1. – (b)
2. – (d)
3. – (a)
4. – (c)

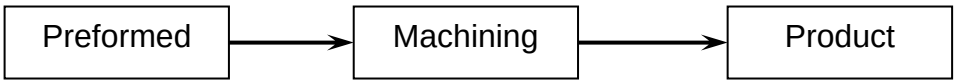
B.

Ans. 1 Aim – enhance profit rate and job opportunity

Objectives –

- reduce manufacturing time
- increase rate of production
- reduce cost of manufacturing
- raise profit and profit rate

Ans.2



- Poor quality
- Less utility
- Less value

- Dimensional accuracy
- Good finish

- High quality
- High utility
- High value

Ans. 3 Inspite of having all other major features of machine tools, the sharpener is of low value.

Ans. 4 For

- Maintenance, repair & replacement
- Modernisation
- Increase salary / incentive
- Expansion