CHAPTER 1- INTRODUCTION TO MACHINING

LEARNING OBJECTIVES

- Introduction to Manufacturing, Manufacturing processes
- Broad classification of Manufacturing processes
- Kinematics elements involved in metal cutting
- Machining – purpose, principle and definition
- Definition of Machine tool

The progress and the prosperity of any country is 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 in all respects covering housing, clothing, medicine, education, transport, communication and also entertainment. The successful creation of men’s material welfare depends mainly on:

- availability of natural resources
- availability of human resources
- exertion of human effort -both physical and mental
- development and use of power tools and machines

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 in Figure 1.0

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.

Figure 1 Value addition by manufacturing processes

Complied by: Jagadeesha T, Assistant Professor, MED, National Institute of Technology, Calicut
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

BROAD CLASSIFICATION OF ENGINEERING MANUFACTURING PROCESSES.

Manufacturing processes can be broadly classified in four major groups as follows:

1. **Subtractive Processes**
   - Machining: Turning, milling, boring, grinding
   - Non-traditional machining: EDM, chemical milling, waterjet, etc.
   - Micro-electronics processes: Primarily etching type processes using either masks or beam, chemical mechanical polishing

2. **Additive Processes**
   - Rapid Prototyping - Very flexible to part shape; usually limited in material choices; slow rates; fully automated
   - Advanced Composites Processes - Combination of additive and net shape processes
   - Microelectronics Processes - Physical and chemical vapor deposition processes and coating methods
   - Joining & Assembly - Broad category includes welding, adhesives, and mechanical assembly

3. **Continuous Processes**
   - Pultrusion of composites
   - Metal Extrusion - Net shape process
   - Plastic Extrusion
   - Czochralski Crystal Growth
   - Continuous Casting

4. **Net Shape (& near net shape)**
   - Solids: Metal Forming, Powders, Others
   - Liquids: Casting, Injection Molding, Others
   - Mixtures: Infiltration, Viscoelastics, Others Characteristics
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

KINEMATIC ELEMENTS INVOLVED IN METAL CUTTING ACTION

The principle used in all machine tool is one of the generating the surface by providing suitable relative motion between tool and work piece.

For example: Cylindrical surface can be generated by rotating the workpiece and feeding the tool parallel to the axis of the workpiece rotation. Thus, in general, two kinds of relative motion must be provided by metal cutting machine tools. These motions are called **Primary motion and Feed motion**.

The primary motion is the main motion provided by the machine tool or manually to cause the relative motion between the tool and workpiece so that the face of the tool approaches the workpiece material. **Usually the primary motion absorbs most of the total power required to perform a machining operation.**

The feed motion is a motion that may be provided to the tool or workpiece by a machine tool which, when added to the primary motion leads to repeated or continuous chip removal and the creation of a machined surface with the desired geometric characteristics, This motion may proceed by steps or continuously: in either case it **usually absorbs a small proportion of the total power required to perform a machining operation.**

Few examples are shown below for some common machine tools.

**Example 1: Engine Lathe.**

![Engine Lathe Diagram](image)
In Engine lathe, Primary motion is provided by the movement of series of gears driving the main spindle, the gears being driven by the electric motor mounted at the rear of the machine (or below the head stock).

The feed motion of the tool is given carriage (which holds the tool in the tool holder). The carriage is driven along the bed by a lead screw (for screw cutting) or a rack and pinion gear and feed rod (for turning) both the lead screw and feed rods are connected to the main spindle through a train of gears.

**Example 2: Drilling Machine**

Drilling machine is used to generate internal cylindrical surface.

In drilling, workpiece remains stationary during the machining process. On many drill presses, the tool is fed by the manual operation of a lever to the right of the head. Both the worktable and head can be raised and lowered to accommodate workpieces of different heights.

Primary motion is given to drill and feed motion to tool (either manually or through set of gears). The tool has two cutting edges, each of which is expected to remove its share of work material.

**Example 3: Shaping machine (Shaper)**

Shapers are most commonly used to produce flat surfaces on small components and are only suitable for low batch quantities.

Primary motion is linear and it is given to the tool. Ram is made to move forward or backward either by a mechanical system or by hydraulic piston and cylinder.

The feed motion is imparted to workpiece in increments at the end of return stroke of the ram by ratchet and pawl mechanism driving the lead screw in cross rail.

Shaper uses single point cutting tool.
Example 4: Planing machine (Planer)

The planer is used for generating flat surfaces on very large parts which cannot be machined using shaper.

Primary motion is linear and it is given to the workpiece. Primary motion is normally accomplished by a rack and pinion drive using variable speed motor.

The feed motion is imparted to tool. Tool is fed at right angles to workpiece. Feed is intermittent.

Planer uses single point cutting tool

Example 5: Vertical Milling Machine (Vertical miller)

A wide variety of operations involving the machining of horizontal, vertical, and inclined surfaces can be performed on a vertical milling machine.

Primary motion is given to tool. Feed motion is given to the workpiece. The workpiece can be fed either

- Along the vertical axis(Z) by raising or lowering the knee
- Along the horizontal axis(Y) by moving saddle along the knee
- Along a horizontal axis (X) by moving the table across the saddle.

Milling cutter is a multi point cutting tool.
MACHINING – PURPOSE, PRINCIPLE AND DEFINITION

Purpose: Most of the machine tool elements such as gears, bearings, clutches, tools, screws and nuts etc. need dimensional and form accuracy and good surface finish for serving their purposes. Other processes like casting, forging etc. generally cannot provide the desired accuracy and finish. Therefore machining is used. In machine tool majority of material removal is done by conventional machines like Lathes, Planers, shapers etc and parts are finished by Grinding process.

Machining to high accuracy and finish essentially enables a product
• fulfill its functional requirements
• improve its performance
• prolong its service

Principle: The principle used in all machine tool is one of generating the surface required by providing suitable relative motion between the tool and the workpiece. The cutting edges on the cutting tool remove a layer of work. These relative motions are called primary motion and feed motion.

For example: Cylindrical surface can be generated by rotating the workpiece and feeding the tool parallel to the axis of the workpiece rotation.

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).

Machine Tool - 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).