Elementary treatment of metal cutting theory

In an industry, metal components are made into different shapes and dimensions by using various

metal working processes.

-Removal of chips, from a raw material, is performed by a cutting tool that need a motion relative to raw material.

-This motion, named cutting motion, could be practically a rotation one or a translation one

Metal working processes are classified into two major groups. They are:

Non-cutting shaping or chips less or metal forming process - forging, rolling, pressing, etc.

Cutting shaping or metal cutting or chip forming process - turning, drilling, milling, etc.

- However, all such manufacturing processes can be broadly classified in four major groups as follows
- **Shaping or forming**
- Manufacturing a solid product of definite size and shape from a given material taken in three possible states:
- in liquid or semi-liquid state – e.g., casting, injection moulding etc.
- in solid state – e.g., forging rolling, extrusion, drawing etc.
- in powder form – e.g., powder metallurgical process.

- Joining process
- Welding, brazing, soldering etc.
- Removal or Cutting process
- Machining (Traditional or Non-traditional), Grinding etc.
- Regenerative manufacturing Process
- 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 Modeling)
- Out of the fore said 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.

- Material Removal Processes – Metal Cutting Process
- A family of shaping operations, the common feature of which is removal of material from a starting work part so the remaining part has the desired geometry
- Traditional Process (Machining) – Material removal by a sharp cutting tool, e.g., turning, milling, drilling
- Nontraditional processes - Various energy forms other than sharp cutting tool to remove material. e.g., Laser and Electron Beam machining
- Abrasive processes – Material removal by hard, abrasive particles, e.g., grinding

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.**
- **Variety of work materials can be machined**
- **Most frequently used to cut metals**
- **Variety of part shapes and special geometric features possible, such as:**
- **Screw threads**
- **Accurate round holes**
- **Very straight edges and surfaces**
- **Good dimensional accuracy and surface finish**

Machining in Manufacturing Sequence

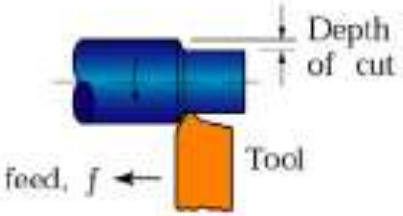
- Generally performed after other manufacturing processes, such as casting, forging, and bar drawing
- Other processes create the general shape of the starting work part Machining provides the final shape, dimensions, finish, and special geometric details that other processes cannot create
- Machining Operations
- Most important machining operations
- Turning

  Drilling
- Milling

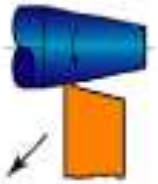
Other machining operations

- Shaping and planning
- Broaching
- Sawing

(a) Straight turning

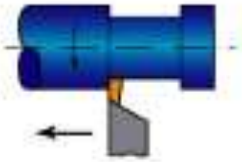


(b) Taper turning

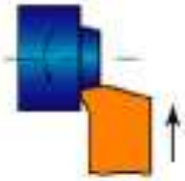


(c) Profiling

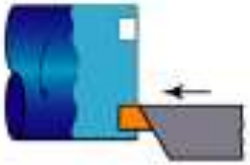
(d) Turning and external grooving



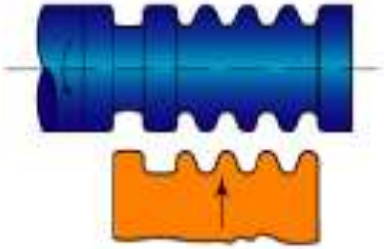
(e) Facing



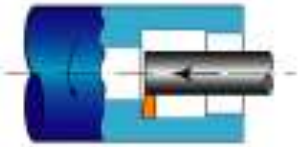
(f) Face grooving



(g) Cutting with a form tool

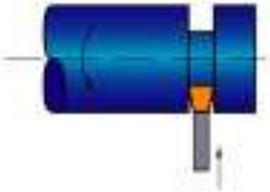


(h) Boring and internal grooving

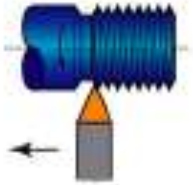


(i) Drilling

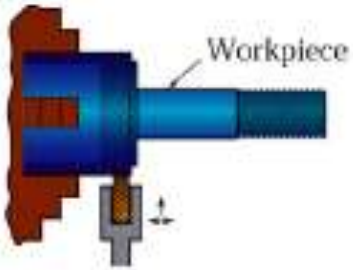
(j) Cutting off

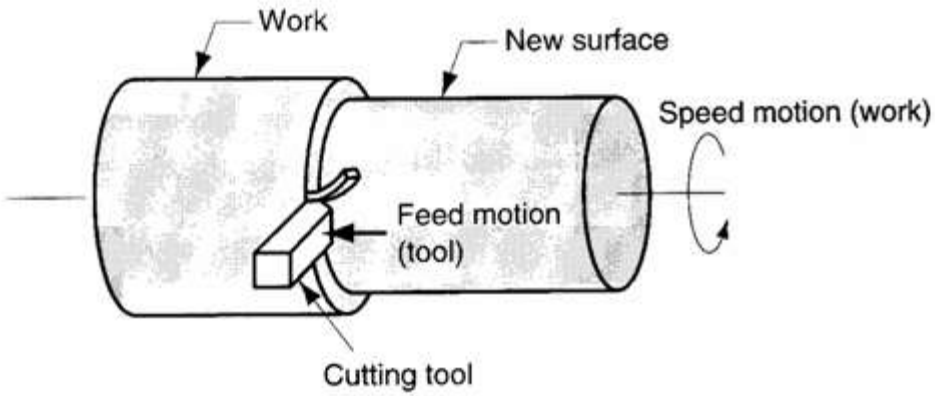


(k) Threading

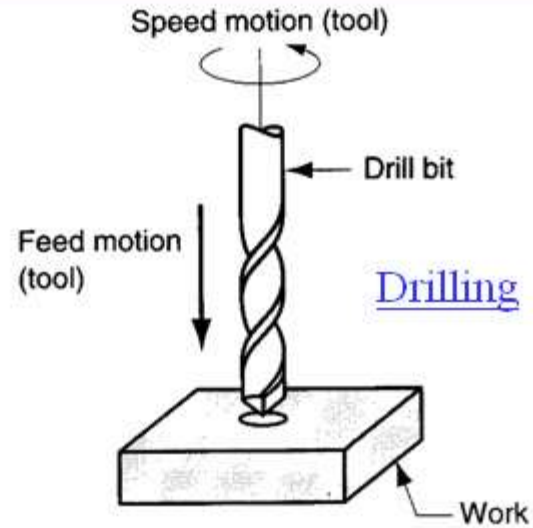


(l) Knurling

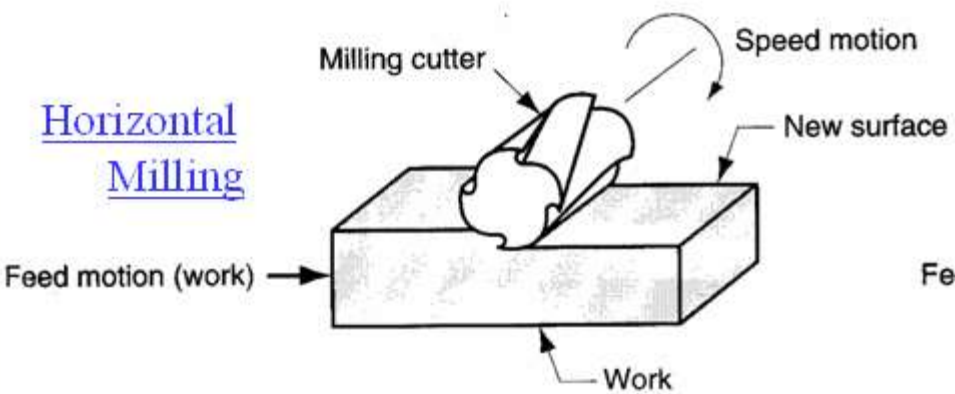



Turning
Work
New surface
Speed motion (work)
Feed motion
(tool)
Cutting tool

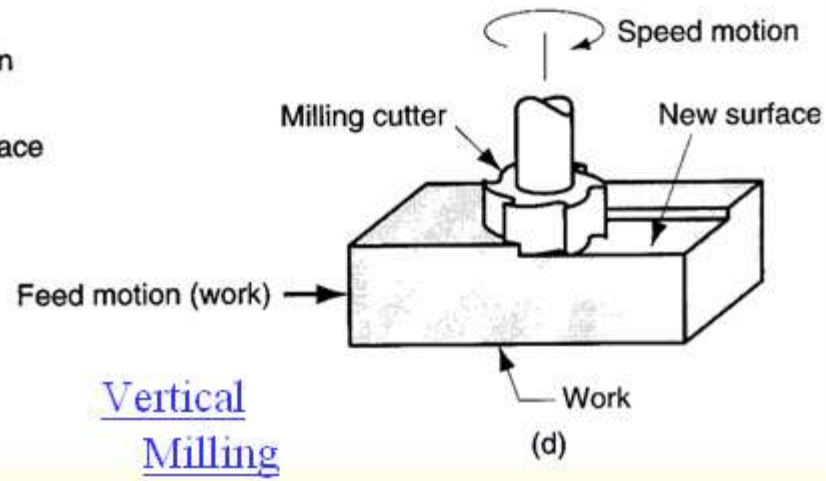
(a)


Speed motion (tool)
Drill bit
Feed motion
(tool)
Drilling
Work

(b)

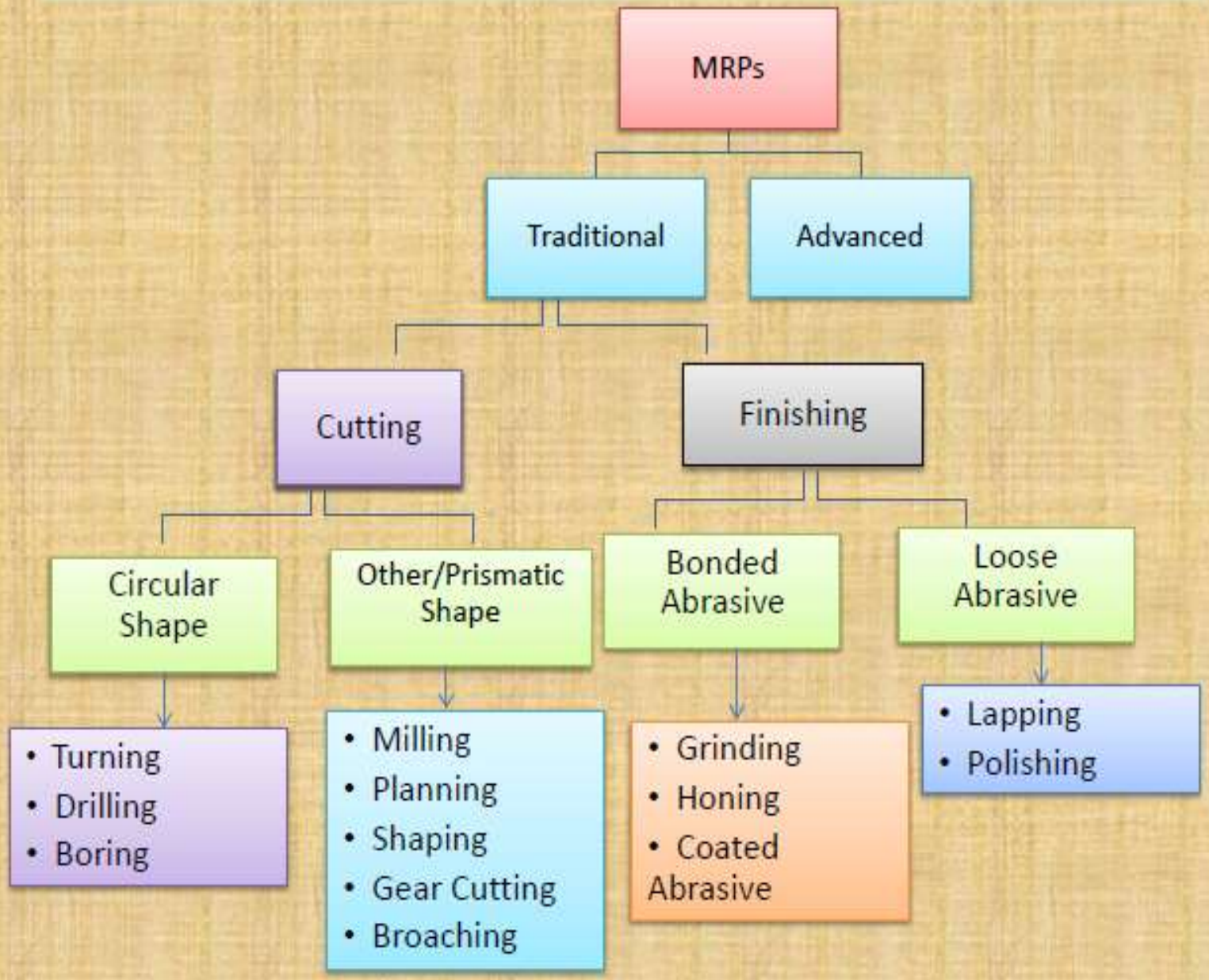

Milling cutter
Speed motion
New surface
Horizontal
Milling
Feed motion (work)
Work

(c)

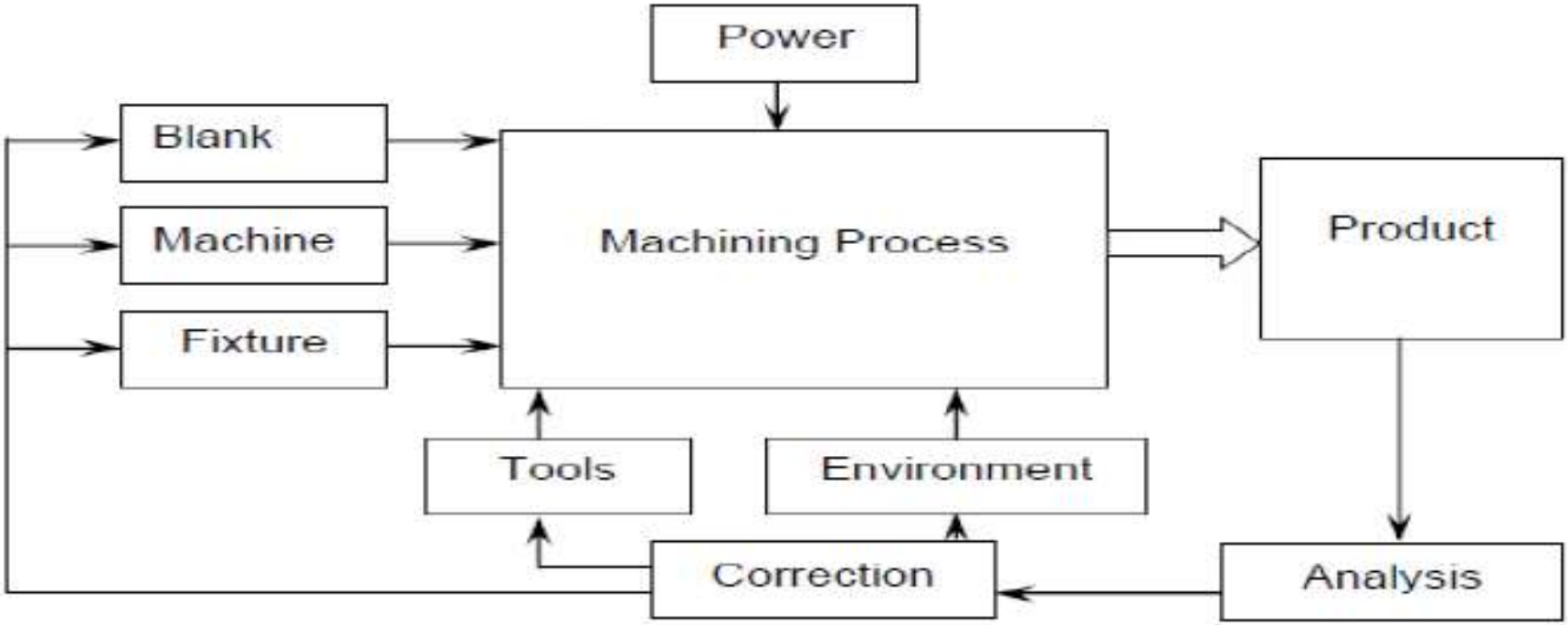

Speed motion
Milling cutter
New surface
Feed motion (work)
Work
Vertical
Milling

(d)

MATERIAL REMOVAL PROCESSES



Machining requirements



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, (speed, feed and depth of cut).**

- 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.
- 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.

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.