

Chapter 1

Morphologic Process Model

Level

Textbook

Reference

Learning
Objectives

5

* *Manufacturing Processes for Engineering Materials*, 5th Ed., S. Kalpakjian and S. Schmid, Upper Saddle River, NJ: Prentice Hall (2008).

* *Manufacturing Engineering Processes*, L. Alting, Marcel-Dekker.

* *Manufacturing Engineering Processes* اختيار العمليات الهندسيه للتصنيع
By Dr Ali M Alsamhan and Prof Saied Darwish, Research center college of engineering, Project 50/426, June 2006.

To review and discuss the various manufacturing processes that are available and relate to their characteristics, cost and volume needs, and design requirements.

Chapter 1

Morphologic Process Model

Chapter 1: Morphological manufacturing process.

1.1 *Material flow system*

1.1.1 Types of material flow

1.1.2 State of material

1.1.3 Basic process

1.1.4 Illustrated examples

1.2 *Energy flow system.*

1.2.1 Energy flow for mechanical basic process

1.2.2 Energy flow in thermal basic processes

1.2.3 Energy flow for chemical basic processes

1.3 *Information flow system*

Morphological manufacturing process ??

➤ The term process in general can be defined as **a change in the properties** of an object, including geometry, hardness, state, information content. According to Alting morphological process model [1.1]



Fig. 1.1 Simplify morphological structure of manufacturing process [1.1].

Morphological manufacturing process ??

- The term process in general can be defined as **a change in the properties** of an object, including geometry, hardness, state, information content. According to Alting morphological process model [1.1].
- Any change in product properties requires three essential changes in **material, energy, and information**.

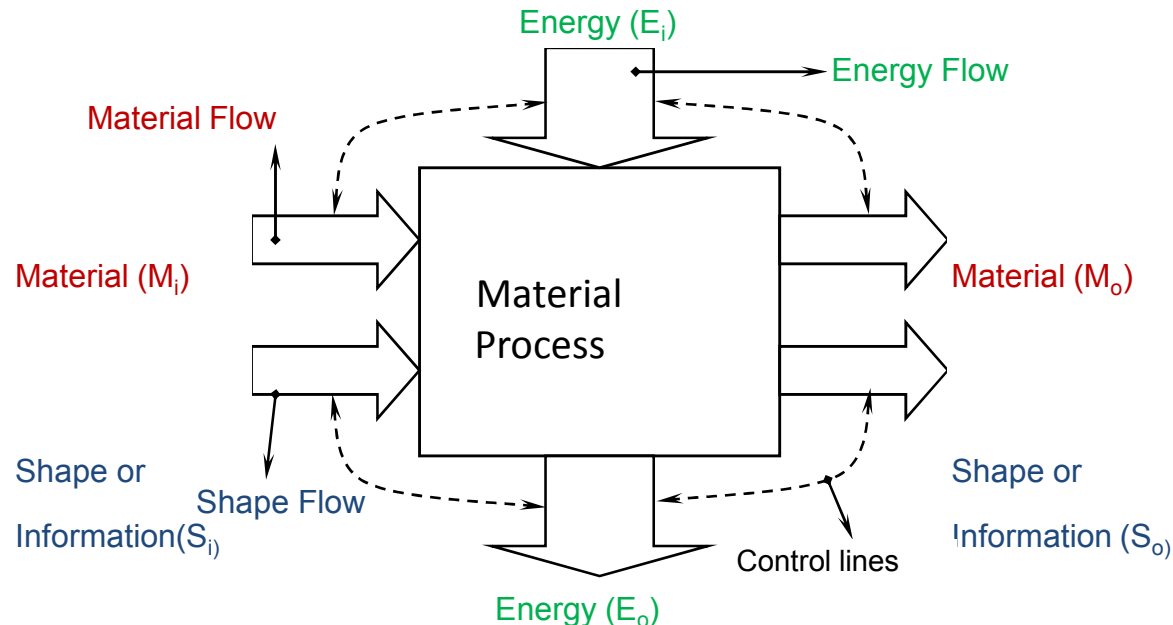
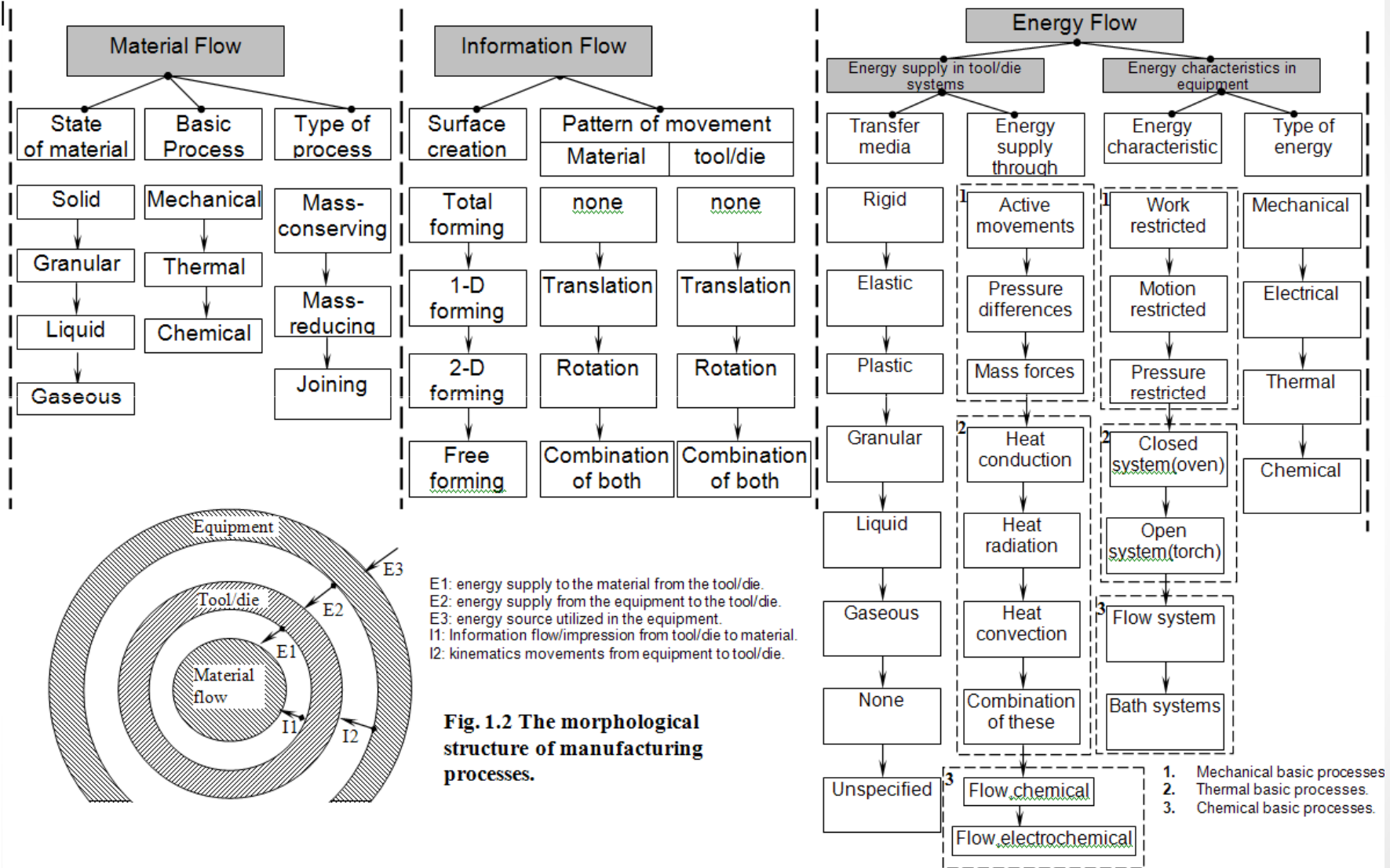


Fig. 1.1 Morphological structure of manufacturing process [1.1].

Morphological manufacturing process



1.1 Morphological manufacturing process

1.2 Material flow system

Types of material flow ??

1- Mass conserving process ($dm=0$);

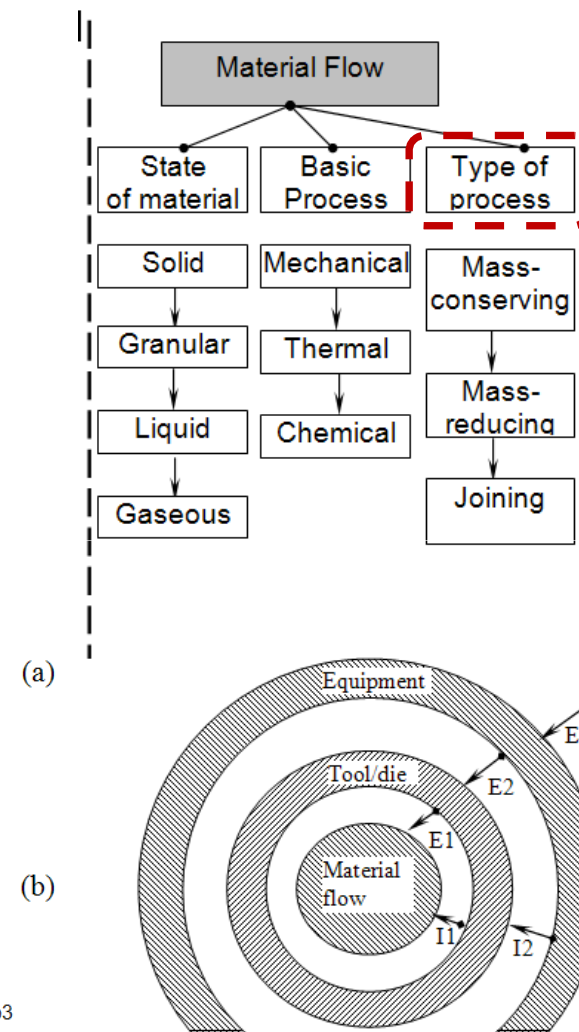
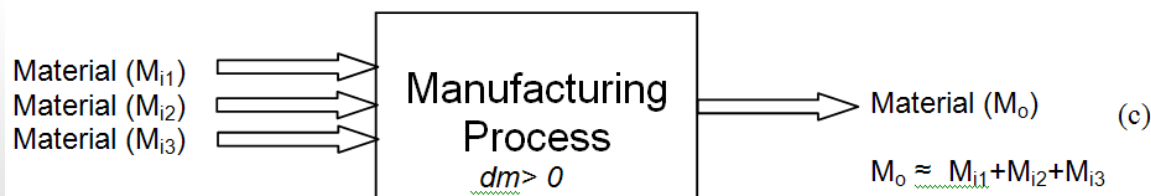
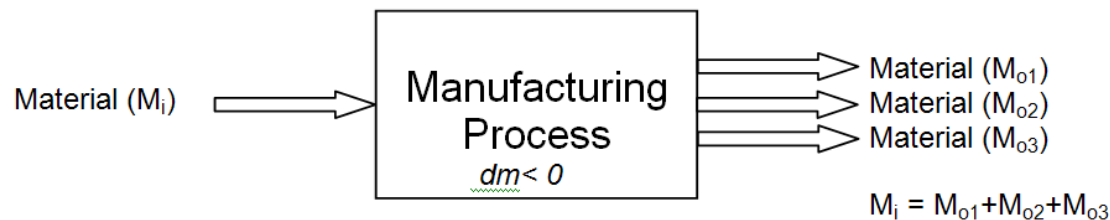
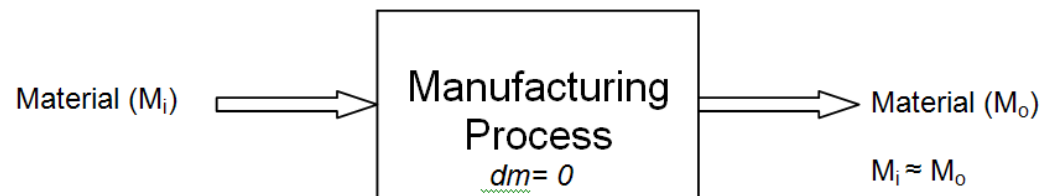
Metal forming processes (IE252)

2- Mass reducing process ($dm<0$);

Metal cutting processes (IE352)

3- Assembly or joining processes ($dm>0$);

Welding process (IE252)



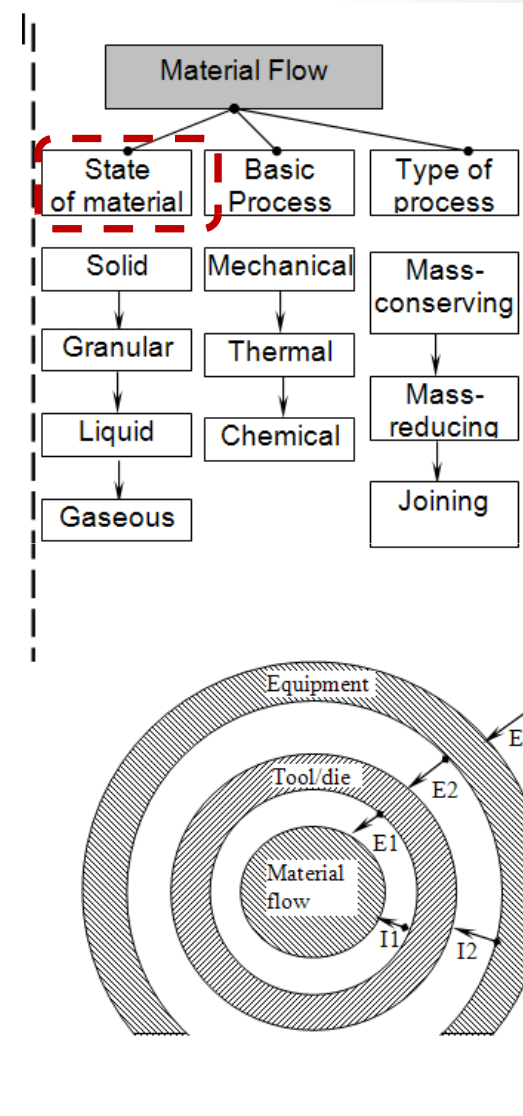
1.1 Morphological manufacturing process

1.2 Material flow system

State of material ??

State of processed material can be :

- Solid,
- Fluid,
- Gaseous or
- Granular 'homogeneous e.g. pure metal and heterogeneous e.g. mechanical mixture'

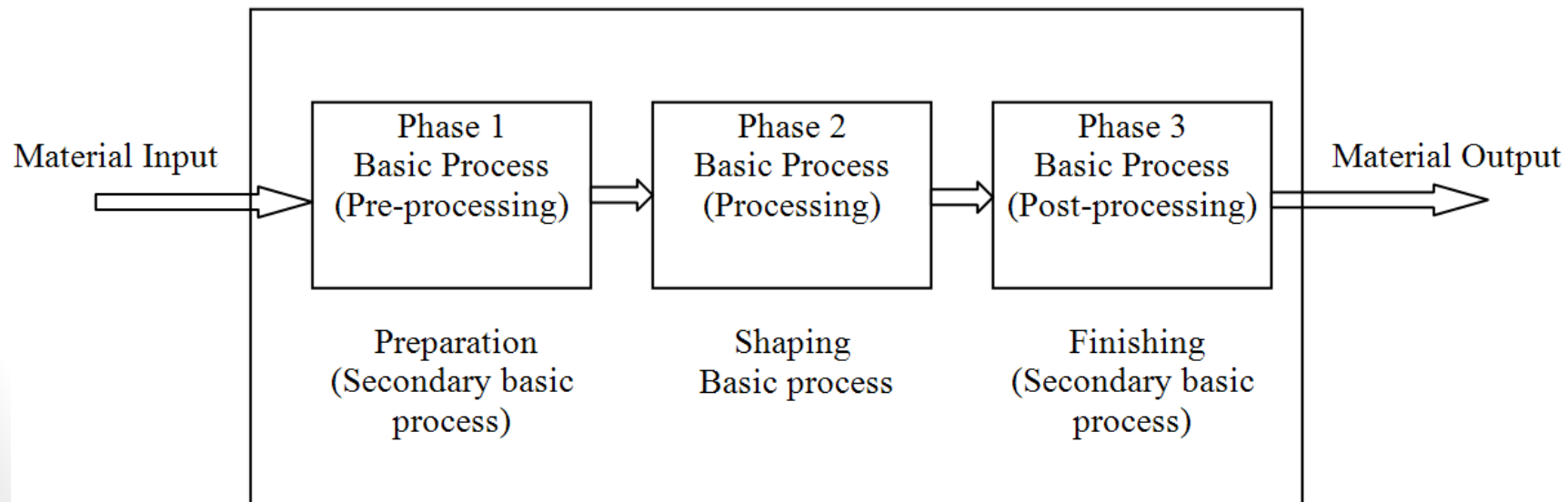
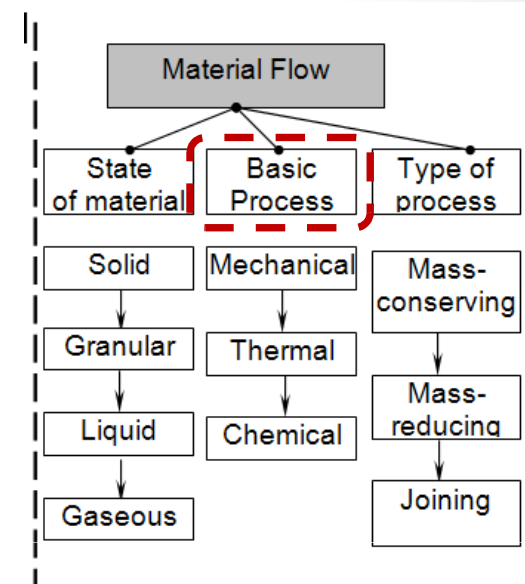


1.1 Morphological manufacturing process

1.2 Material flow system

Basic process ??

- Basic process is the process that creates changes in geometry and/or properties of material.
- Manufacturing processes consist of a series of basic processes, which in general can be divided into three phases; pre-processing, processing, then post processing).



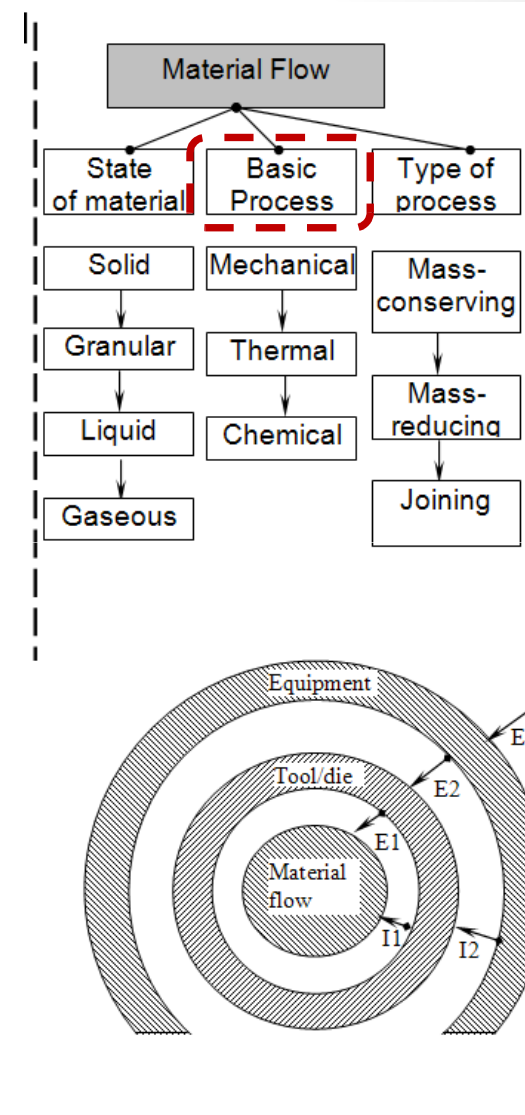
1.1 Morphological manufacturing process

1.2 Material flow system

Basic process ??

➤ Categories of basic process:

1. **Mechanical type**, which covers:
 - Plastic/elastic deformation.
 - Fracture (brittle or ductile type).
 - Flow/mixing process.
2. **Thermal type**, which covers:
 - Heating.
 - Cooling.
 - Melting.
 - Solidification.
 - Evaporation.
3. **Chemical**, which covers;
 - Solution/dissolution.
 - Combustion.
 - Hardening.
 - Phase transformation, diffusion.

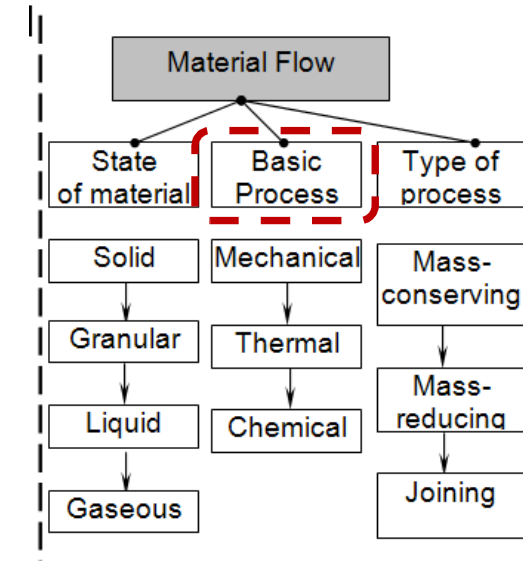


1.1 Morphological manufacturing process

1.2 Material flow system

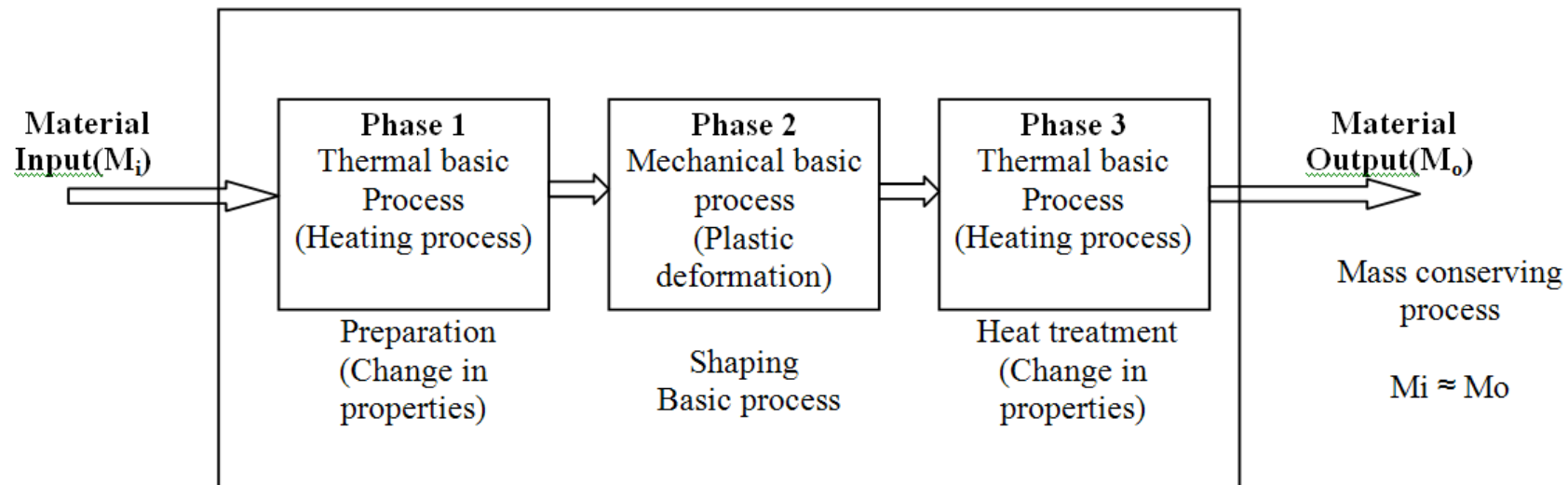
Basic process ??

➤ Illustrated examples:



1. Morphological model for hot forging processes (for example hot rolling process):

The basic processes involved are; Heating and Mechanical basic processes and shown in the following block diagram:

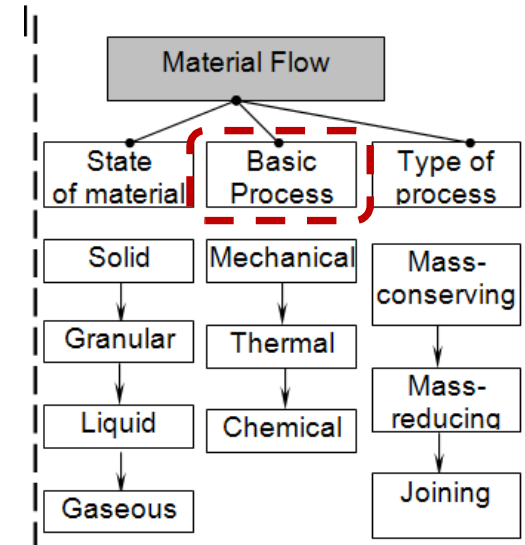


1.1 Morphological manufacturing process

1.2 Material flow system

Basic process ??

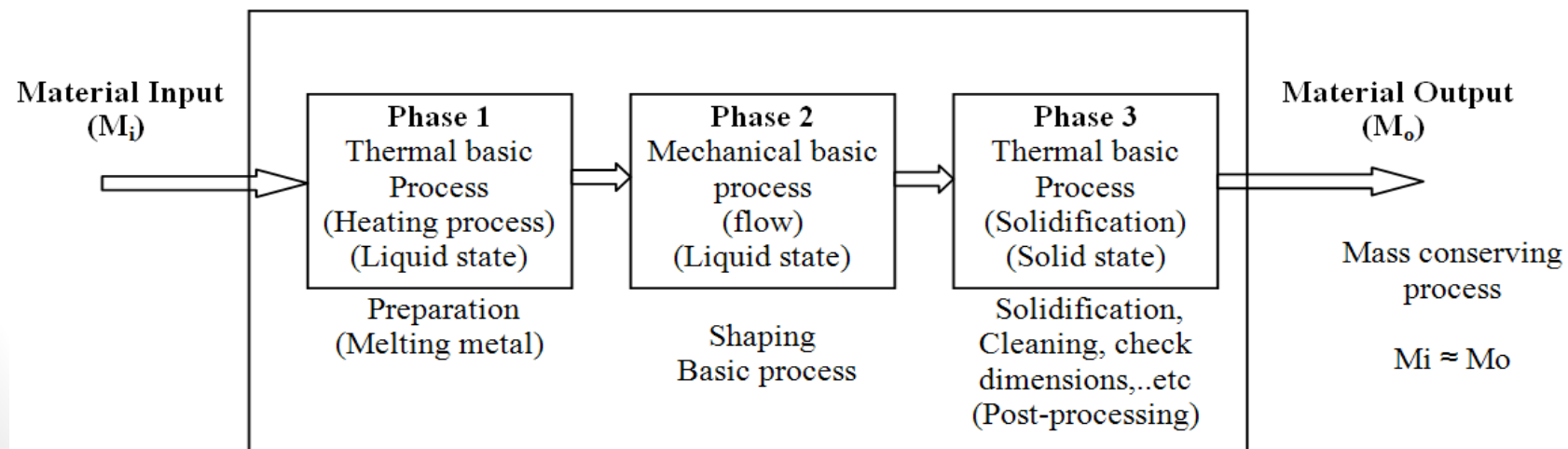
➤ Illustrated examples:



2. Morphological model for sand casing process:

The basic processes involved are:

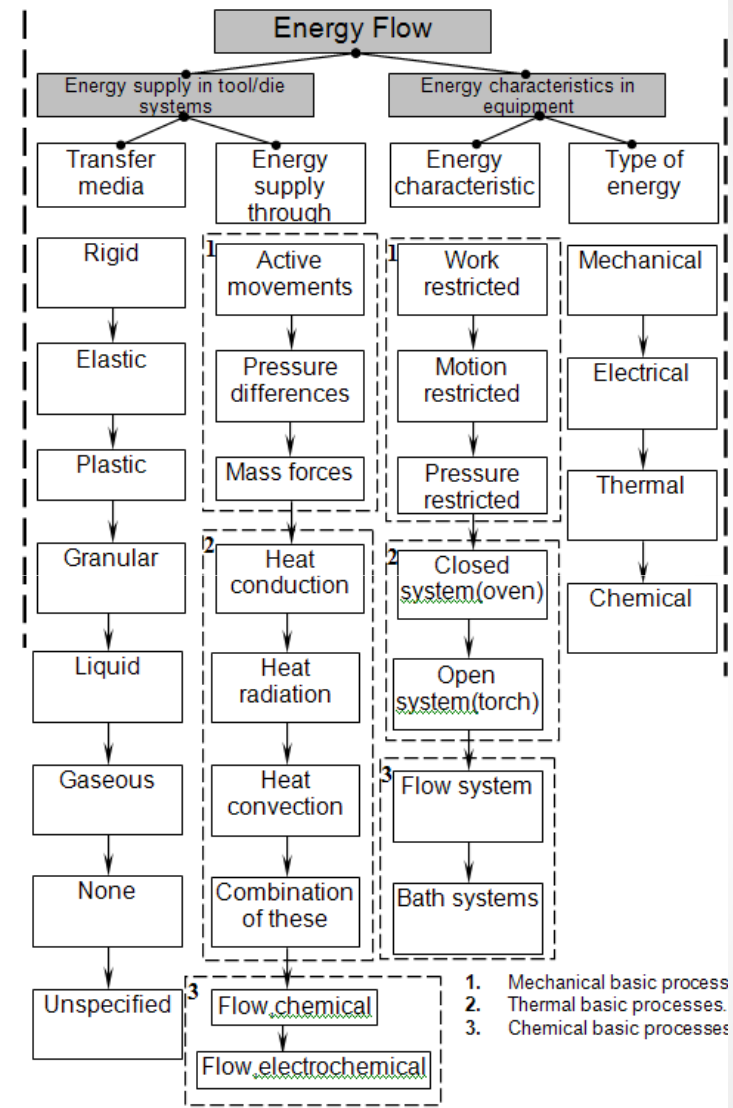
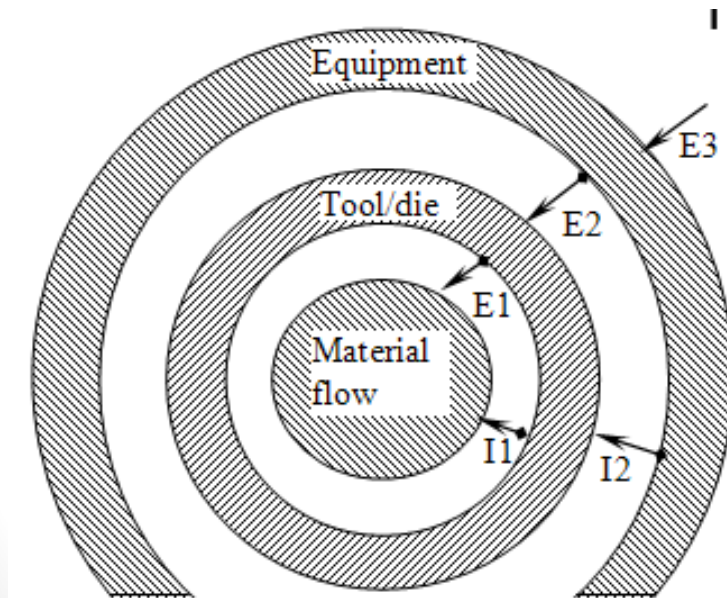
- Heating (thermal basic process); which covers melting the metal,
- Shaping or metal flow (mechanical basic process): covers pouring molten metal in mold cavity.
- Cleaning (mechanical basic process); cleaning and checking final dimensions.



1.1 Morphological manufacturing process

1.3 Energy flow system

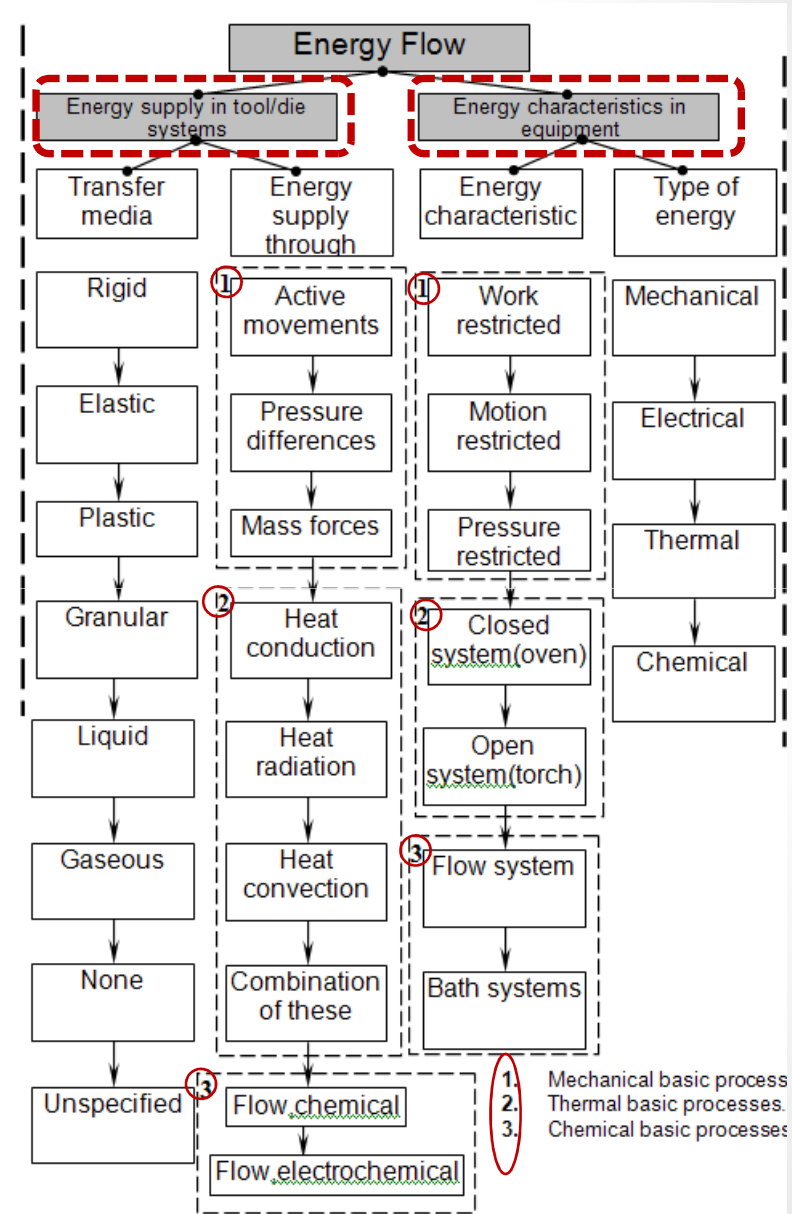
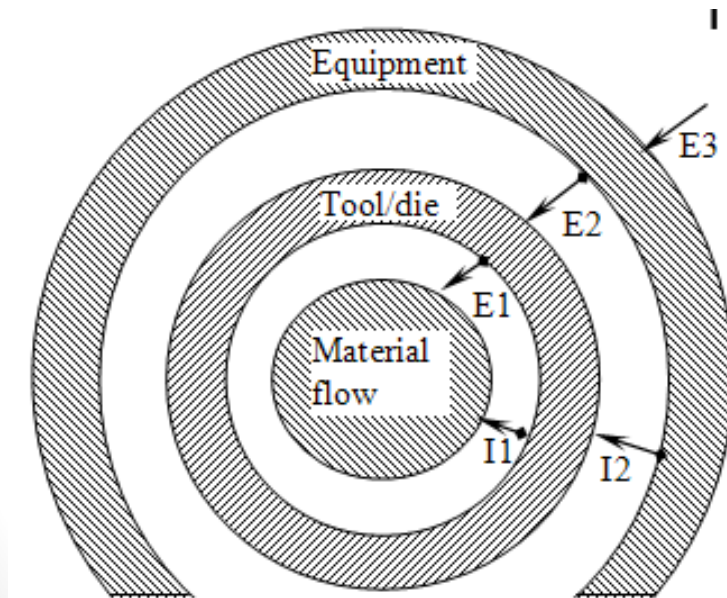
- E1: energy supply to the material from the tool/die.
 E2: energy supply from the equipment to the tool/die.
 E3: energy source utilized in the equipment.
 I1: Information flow/impression from tool/die to material.
 I2: kinematics movements from equipment to tool/die.



1.1 Morphological manufacturing process

1.3 Energy flow system

- To carry out the basic process required, the provided energy must be transmitted to the work material via different media.
- This covers two sub-systems: **energy supply in tool/die systems** and **energy equipment characteristics**

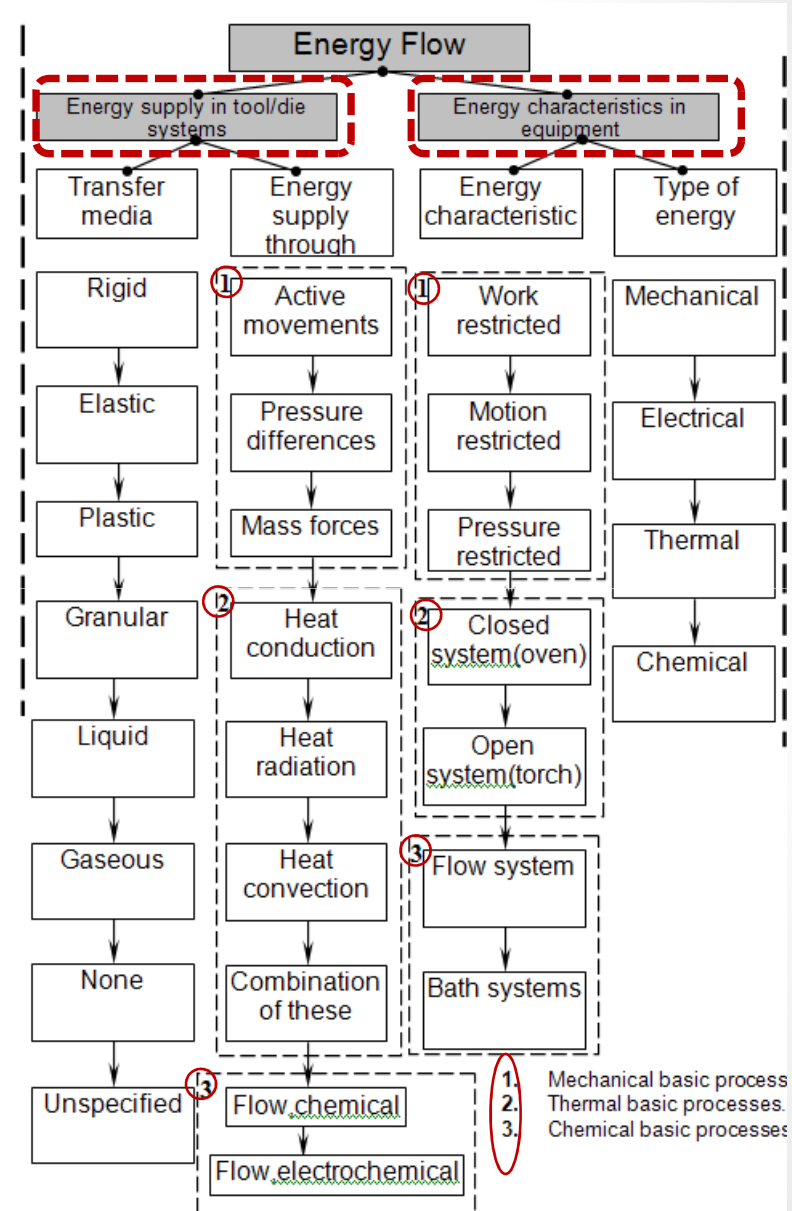
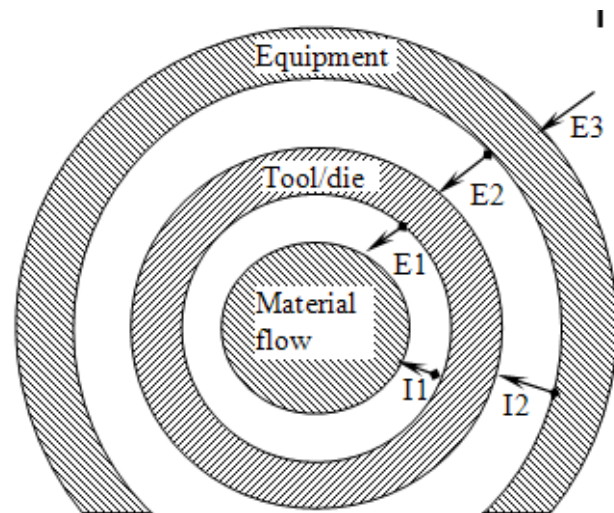


1.1 Morphological manufacturing process

1.3 Energy flow system

➤ **In tool/die systems** it describes how energy is supplied to material and to the transfer media used in manufacturing process.

➤ **The equipment system** describes the characteristics of the energy supplied from the equipment and type of energy used in manufacturing processes.



1.1 Morphological manufacturing process

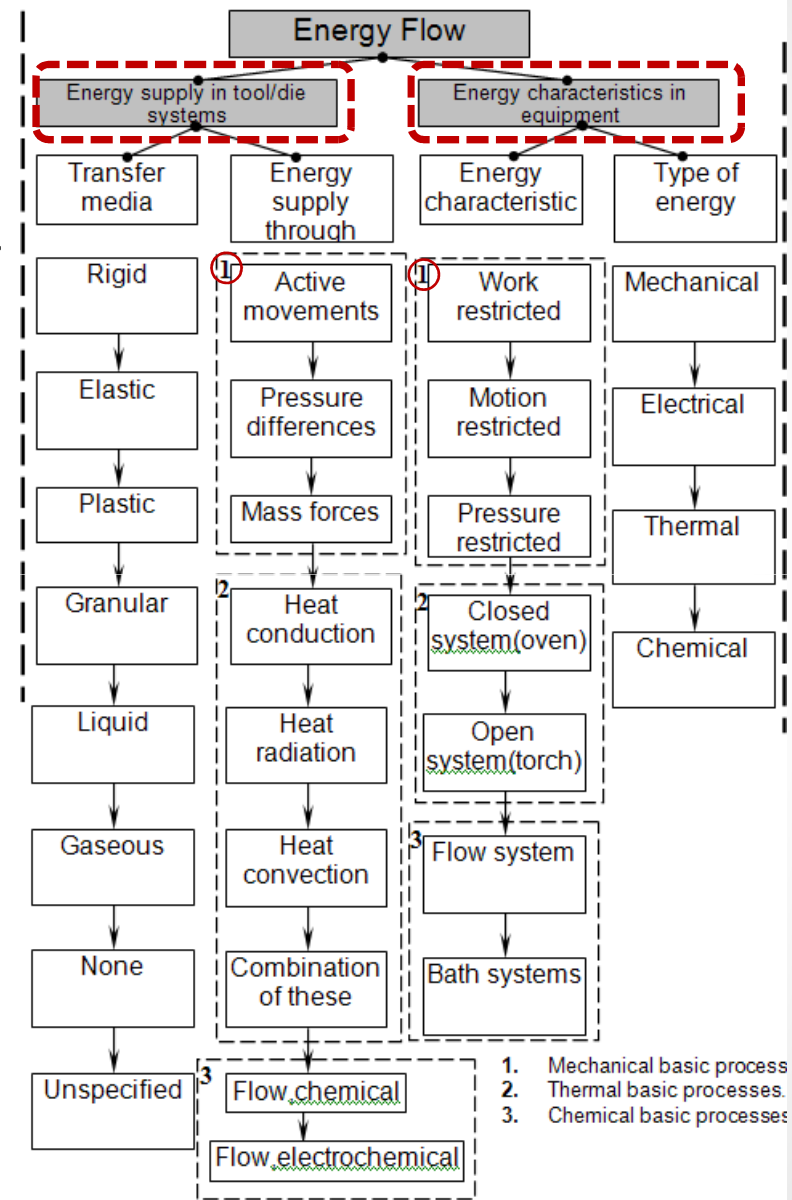
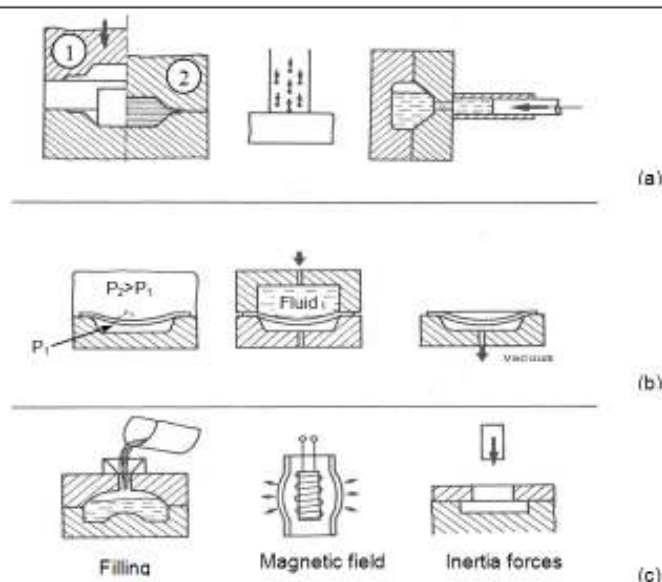
1.3 Energy flow system

Energy flow for mechanical basic process

Primary basic process are: plastic and/or elastic deformations, brittle or ductile fracture, and flow

Methods of energy supply, see Fig. 1.5:

- Relative motions between a transfer medium and the work material.
- Pressure differences across the work material.
- Mass forces generated in the work material.



1.1 Morphological manufacturing process

1.3 Energy flow system

Energy flow for mechanical basic process

Mechanical energy sources:

- Mechanical energy (Translation – Rotation – Combinations of these).
- Potential energy (Gravity – Elastic).
- Pressure in a medium (Kinetic energy in molecules). Vacuum.

Electrical energy sources:

- Discharge between two electrodes.
- Electromagnetic fields.
- Magnetostrictive effects. (Change in dimensions of metals due to magnetic field).
- Piezoelectric effects. (Discharge generation of some crystals under compression or tension load).

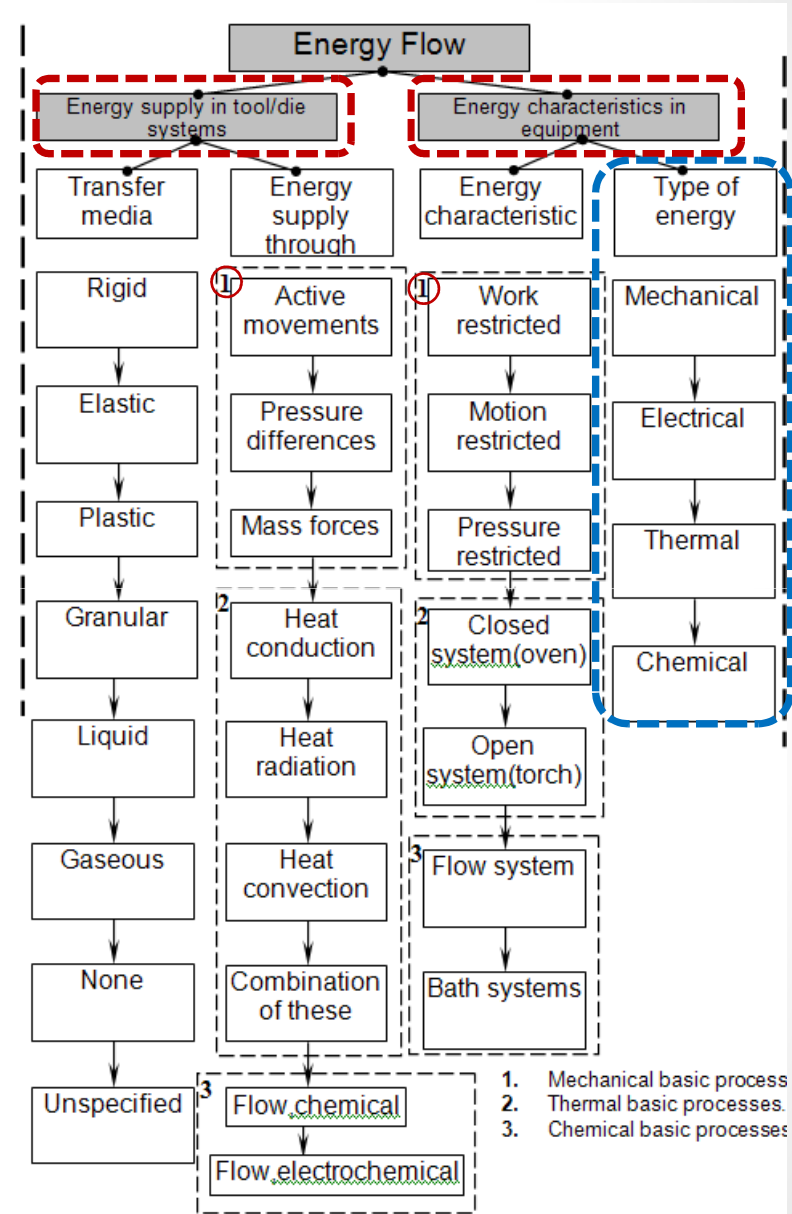
Chemical energy sources:

Here chemical energy is used and converted to mechanical energy by different ways, like

- Combustion.
- Combustion and pressure increased which result in motion (e.g. internal combustion engine).
- Explosive. (Explosive forming process, welding, and compaction).

Thermal energy sources:

Here the thermal energy used to generate mechanical energy through utilizing the thermal expansion of material to provide relative motions or pressure in working media.

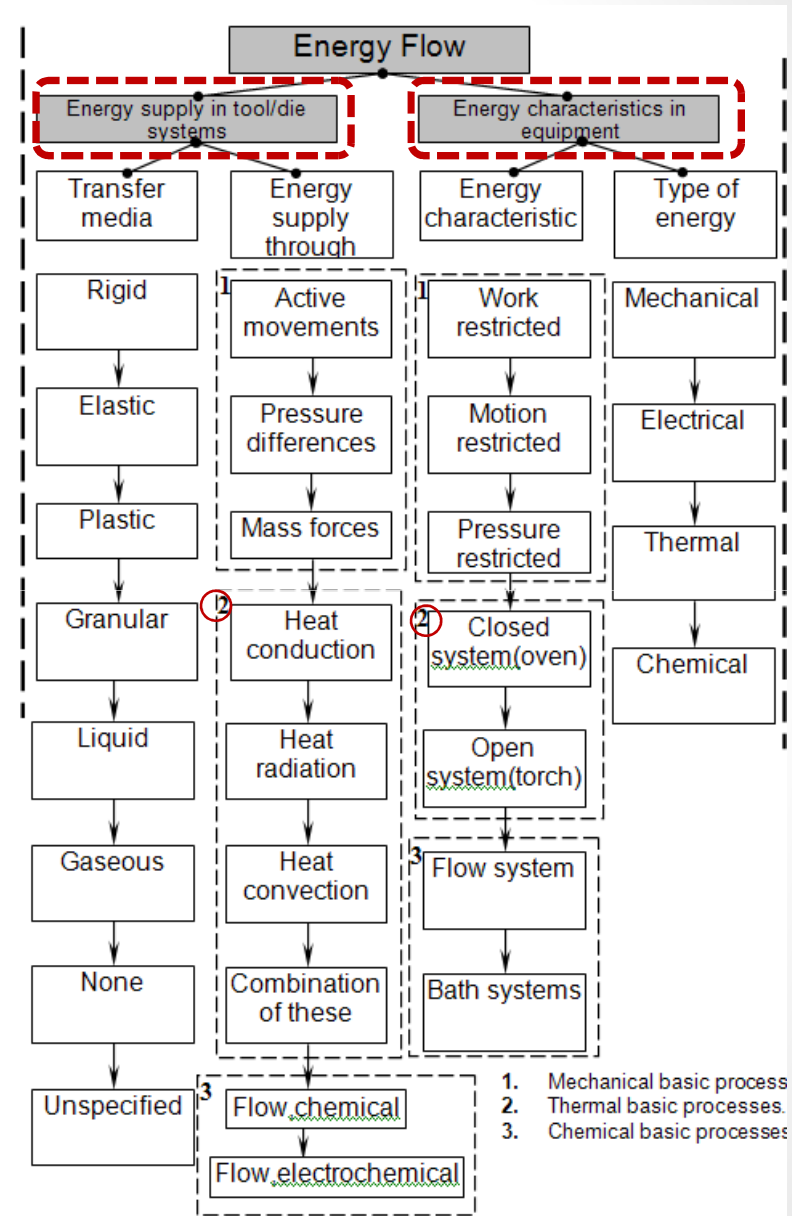


1.1 Morphological manufacturing process

1.3 Energy flow system

Energy flow in thermal basic processes

- Heating energy is used as primary basic thermal process. Melting or evaporation is used to generate heat energy.
- The electric, mechanical, or chemical energy used is converted into heat energy to be utilized in the selected manufacturing process.



1.1 Morphological manufacturing process

1.3 Energy flow system

Energy flow in thermal basic processes

Heat transfer:

Conduction, radiation, convection and mass transfer carry out heat transfer in these processes.

Heating sources:

• Heating source based on electric energy:

1. Electrical conduction (resistance).
2. Induction.
3. Dielectric loss.
4. Arcing (discharge between electrodes).
5. Sparking.
6. Electronic beams.
7. Lasers.

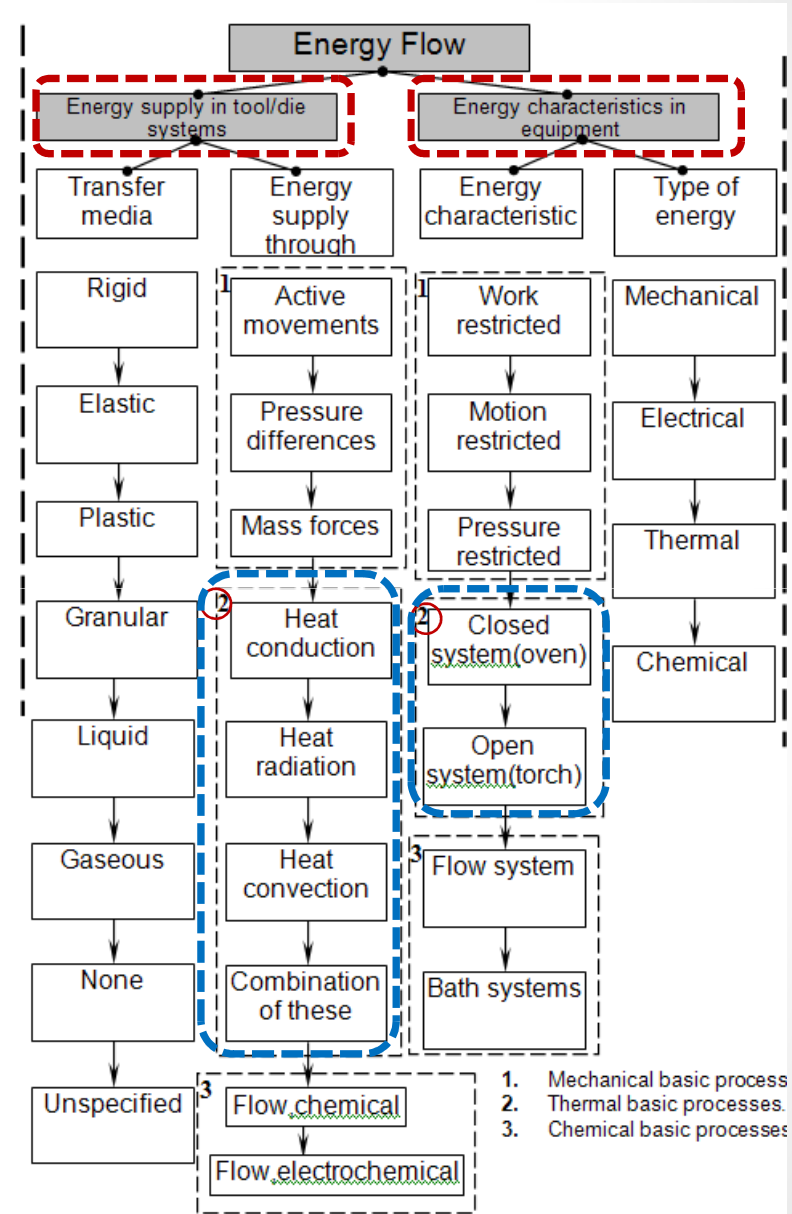
• Heat source based on chemical energy

1. Combustions.
2. Exothermic chemical reactions (e.g. Fe_3O_4 reaction with AL plus helium or argon gas to generate arc-plasma torches).

• Heat source based on mechanical energy

1. Heat generation by friction (e.g. friction welding process).
2. Heat generation by internal hysteresis losses (e.g. ultra-sonic welding process of plastic materials).

• Heat source based on thermal energy



1.1 Morphological manufacturing process

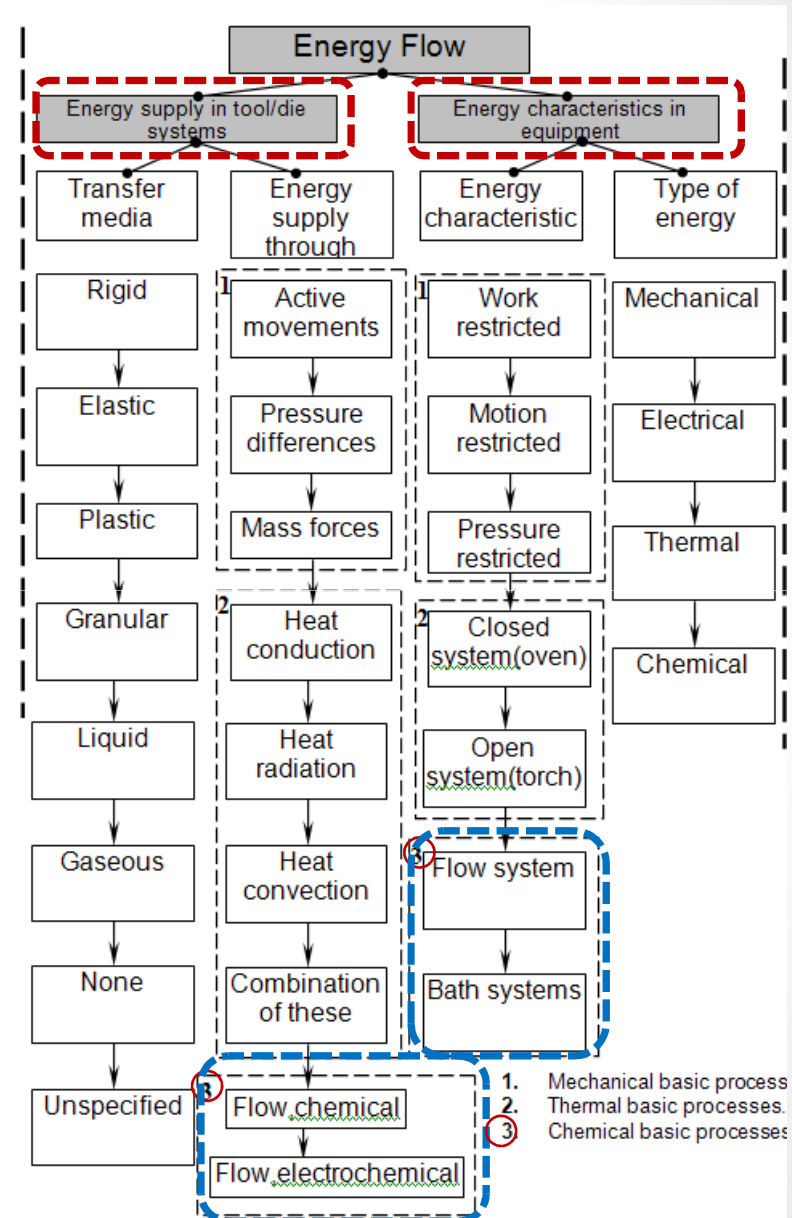
1.3 Energy flow system

Energy flow for chemical basic processes

This covers chemical basic processes like solution/dissolution, deposition, diffusion, phase transformation.

➤ Chemical solution (dissolution), e.g. etching and polishing processes of metals.

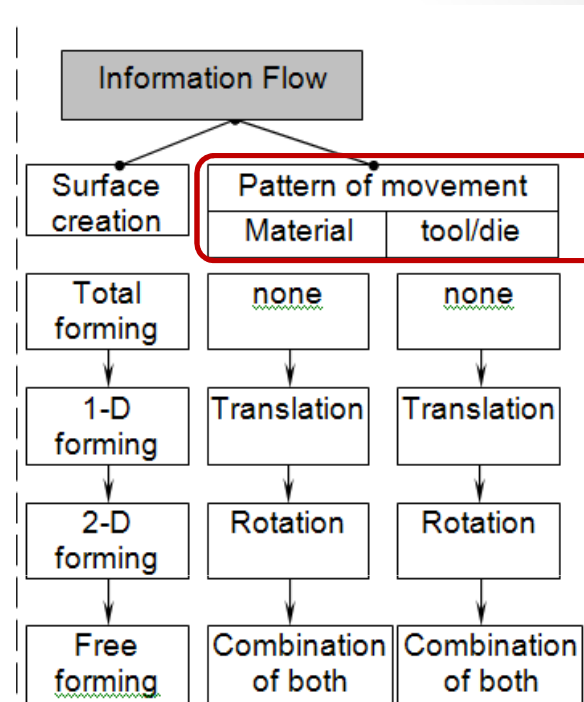
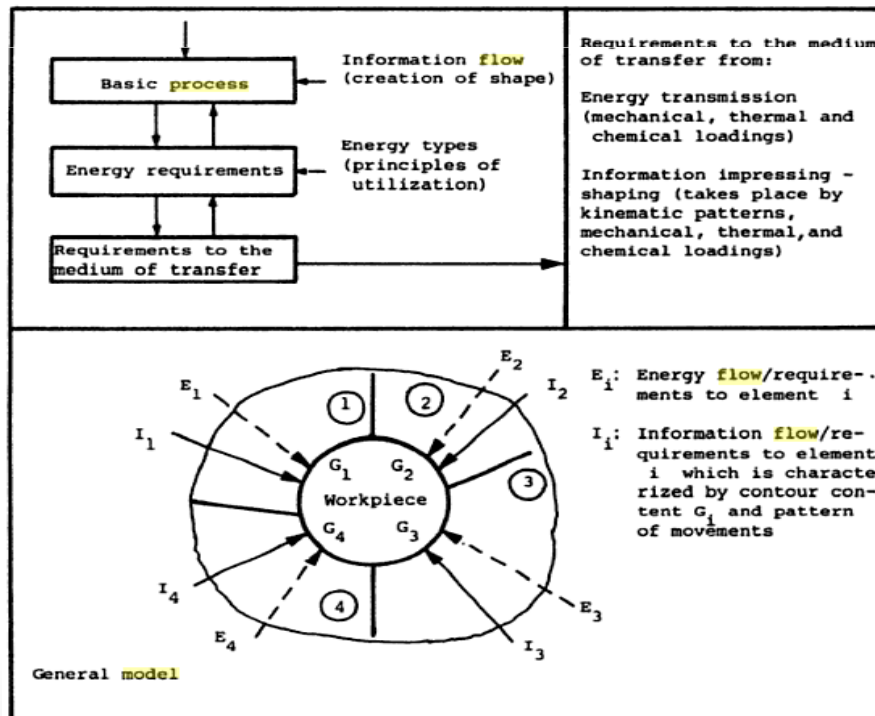
➤ Phase transformation and diffusion is important process in which heat treatment of metals are used in industries.



1.1 Morphological manufacturing process

1.4 Information flow system

The creation of the desired geometry takes place for a given basic process by the interaction between the medium of transfer together with the contour of the desired geometry G_i and the pattern of motions for the medium of transfer (G_1, \dots, G_i) and the work material (A).

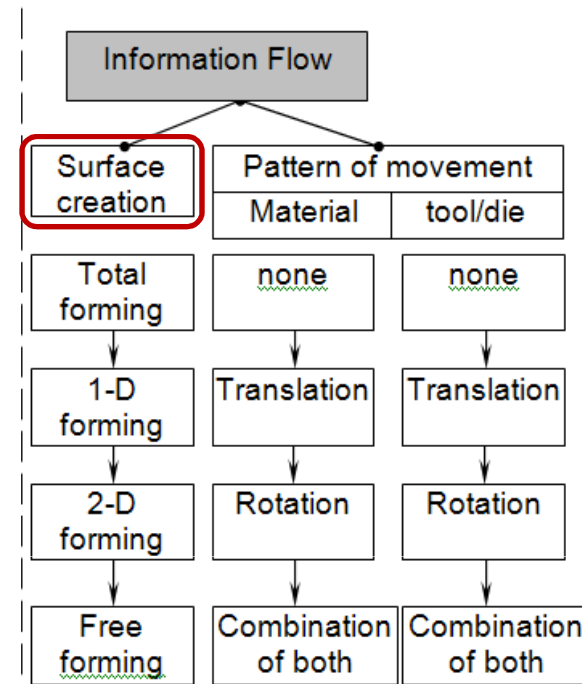


1.1 Morphological manufacturing process

1.4 Information flow system

Surface creation carried out by the four methods, is given as follows:

- Free forming:** Here the medium of transfer does not contain the desired geometry (i.e. the surface/geometry is generated by stress fields, like **torsion process**).
- Two-dimension forming:** Here the medium of transfer contains a point or a surface element of the desired geometry (two relative motions are required to generate the surface, e.g. **turning process**).
- One-dimension forming:** Here the medium of transfer contains a producer or equipment (a line or surface area along the line) required to create the product or required surface. This requires one relative motion to generate the required surface (**strip rolling process** is one dimension forming which is mainly forming along the rolling direction).
- Total forming:** Here the medium of transfer contains the whole surface of the desired geometry. No relative motion is required in this case, like **forging process**.

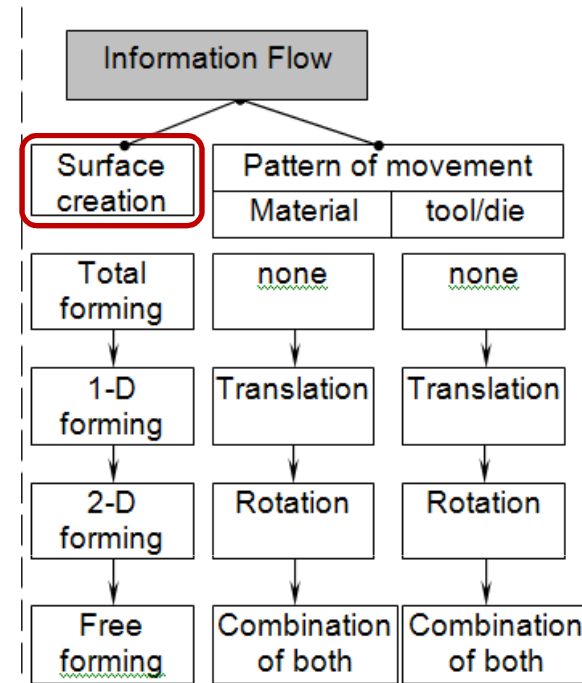


1.1 Morphological manufacturing process

1.4 Information flow system

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End Of Chapter 1:

Morphological manufacturing process