TA 202 : Introduction to Manufacturing processes

2016-17 (II Semester)

Instructor-in-Charge:

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Information About the Course

TA202A: Introduction to Manufacturing Processes

TA: Technical Arts.

Manufacturing: something made from raw materials by hand or by machinery.

Process: a series of actions that you take in order to achieve a result.

Goal: The course aims to impart the basic knowledge about the fundamental manufacturing techniques employed to convert a raw material into final product.

About the Course

- **Theory (50%)**
- **Lecture : Tuesday**: 8 to 9 am in L-7 (Total 12 classes)
- **Lab (50%)**
- **Monday to Friday : 14:00 to 17:00**
- **TA 202 ME Lab (near to Gate – 4)**
- **Departments : AE, BSBE, CHM, CHE, CSE, EE, ME, MATH, MSE & PHY**

Course Weightage

- **Theory – 50% (50 marks):**
  - ❑ **Mid Sem. – 40% (20 marks);**
  - ❑ **End Sem. – 60% (30 marks)**

- **Lab – 50 % (50 marks):**
  - ❑ **Project 60% (30 marks)**
    - ➢ **20 marks for Final Evaluation**
    - ➢ **10 marks for Mid Evaluation (3 marks for Drawings and 7 marks for Project Progress)**
  - ❑ **Quiz (Theory + Lab) – 20% (10 marks)**
  - ❑ **Log/Load Sheet – 5% (2.5 marks)**
  - ❑ **Lab Exercise (Lab Report + Exercises) – 5% (2.5 marks)**
  - ❑ **Individual Evaluation – 10% (5 marks)**

- Quiz will be based on theory as well as lab exercises.
- Attendance in class and lab will be considered during final grading.

Instructions for the Lab

- ***You are required to bring your lab manual for every exercise lab turn.***
- ***Log sheet is to be prepared on the same day (Template is provided in the manual).***
- **Project group – 8 members; *Size of the project should not exceed 1.5 ft (max) in overall dimensions or 450*450*450 mm.***

From SECOND turn onwards, you should follow the schedule given below for the project (Parallel with your Lab Exercise):

- **Turn 2 –Discuss your project idea with the Technical Personal allotted to your project group in the lab. Come prepared with minimum 3 ideas for discussion**

Simple working idea is appreciated more than complex incomplete project.

- **Turn 3 – Finalizing rough drawing. Sketches of parts and subassembly/assembly should be made on A4 size papers using pencil.**
- **Turn 4 -Make individual component drawing**
- **Turn 5 –Submit hard copy of ALL part drawings**
- **Turn 6 –Start working on project**

Instructions for the Lab

Project involves

- Conceptual design
- Rough Detailed design
- Manufacturing drawing
- Fabrication

Project grading

- Innovative idea - 30%
- Working of the project - 50%
- Finishing - 10%
- Final report - 10%

Course Content

- **Introduction to manufacturing: materials mechanical properties in manufacturing, manufacturing processes, manufacturing systems**
- **Metal machining: theory of chip formations, generation of surfaces, force and power relationships, cutting tool material and its geometry and tool wear, fundamentals of machine tools, types of machining operations**
- **Un-conventional machining – Introduction, mechanical energy processes, thermal energy processes, electro chemical machining**
- **Computer control machining - Basic of numerical controlled machines, programming for NC machines, Motion and co-ordinate system, structure of a NC part program, examples of part programming**
- **Metrology - Dimensions, tolerances, surfaces, structure and properties, surface texture and roughness, engineering metrology and instrumentation**
- **Microfabrication – Silicon processing, lithography and micro and nanofabrication processes**
- **Layered manufacturing – fundamentals of rapid prototyping, rapid prototyping technologies, design modeling for rapid prototyping**

Reference books

Available in the Reference Section of the Central Library

- **Mikell P. Groover** - ***Fundamentals of Modern Manufacturing (PRENTICE HALL), 24 copies***
- **Kalpakijan Serope** - ***Manufacturing Processes for Engineering Materials (ADDISON-WESLEY PUBLISHING COMPANY), Second Edition, 12 copies***
- **G.K.Lal & S.K.Choudhury** - ***Fundamentals of Manufacturing Processes(Narosa) 20 copies***
- **A. Ghosh and A.K. Mallik** - **Manufacturing Science: (East-West Press) 20 copies.**

Manufacturing

- What is Manufacturing?
  - Making goods & articles
  - Shaping & treating materials to perform desirable functions
- Manufacturing Processes
  - Casting
  - Powder Processing
  - Forming
  - Machining
  - Surface Processing
  - Joining
- To make goods, a sequence of processes is chosen based on shape, material, tolerance & cost
- Before manufacturing goods, decide to either make or buy based on:
  - Process Design
  - Production Systems

Manufactured Products

- **Final products divide into two major classes:**
  1. **Consumer goods - products purchased directly by consumers**
     - **Cars, clothes, TVs, tennis rackets**
  2. **Capital goods - those purchased by companies to produce goods and/or provide services**
     - **Aircraft, computers, communication equipment, medical apparatus, trucks, machine tools, construction equipment**

Manufacturing Processes

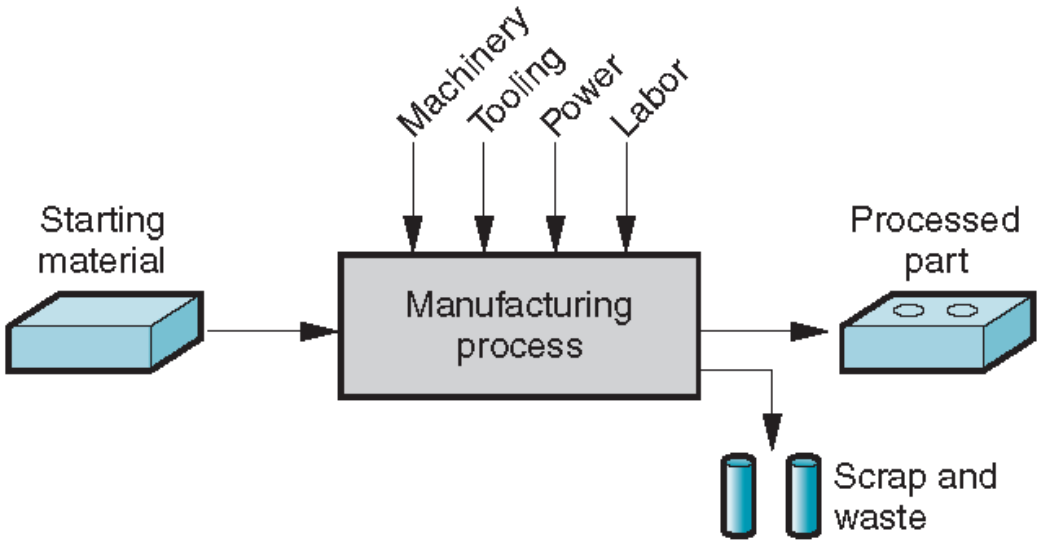
Two basic types:

1. **Processing operations - transform a work material from one state of completion to a more advanced state**
   - **Operations that change the geometry, properties, or appearance of the starting material**

2. **Assembly operations - join two or more components to create a new entity**

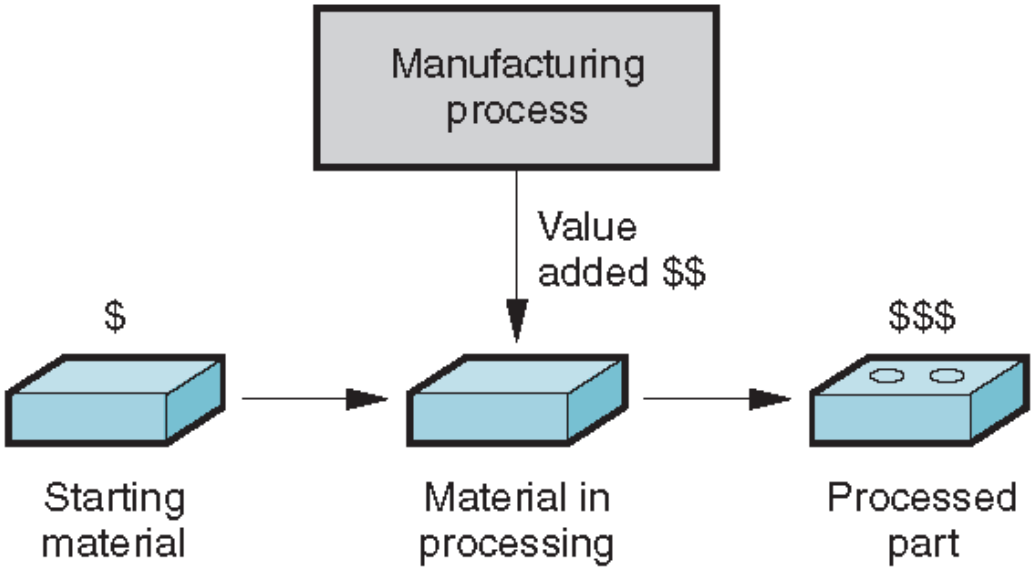
Manufacturing - Technological

- Application of physical and chemical processes to alter the geometry, properties, and/or appearance of a starting material to make parts or products



Manufacturing – Economic

- Transformation of materials into items of greater value by one or more processing and/or assembly operations



Manufacturing Industries

- Industry consists of enterprises and organizations that produce or supply goods and services
- Industries can be classified as:
  1. Primary industries - cultivate and exploit natural resources, e.g., agriculture, mining
  2. Secondary industries - take the outputs of primary industries and convert them into consumer and capital goods
  3. Tertiary industries - service sector

Manufacturing Industries - Continued

- **Secondary industries** include manufacturing, construction, and electric power generation
- For our purposes, manufacturing means production of hardware
  - Nuts and bolts, forgings, cars, airplanes, digital computers, plastic parts, and ceramic products

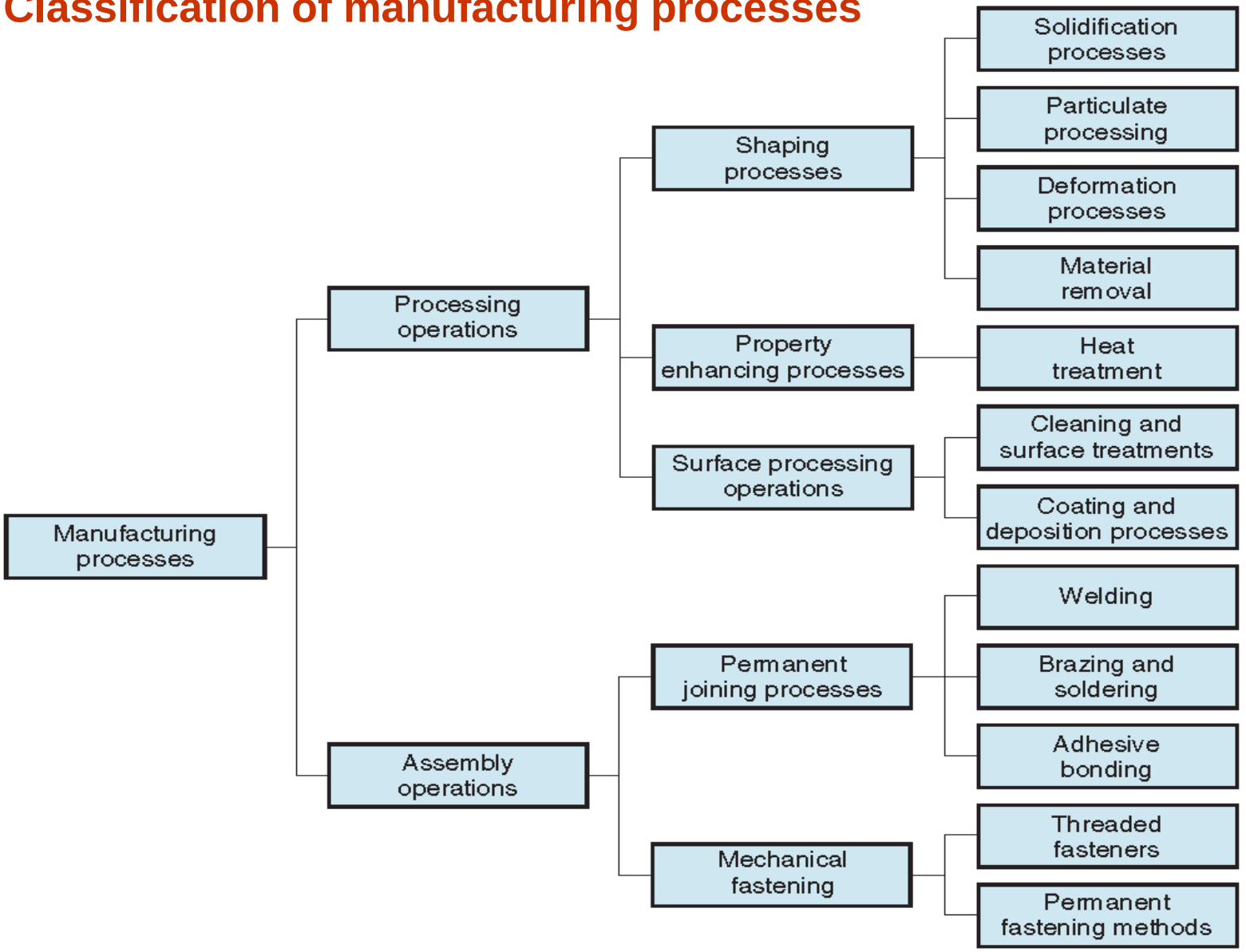
Manufacturing

- Manufacturing: 20% of U.S. Gross National Product
- Service Sector: 70% of U.S. GNP (retail, transportation, banking, education, communications, insurance & government)
- Agriculture, Construction, etc.: 10% of U.S. GNP
- Manufacture is derived from the Latin words *manus* (hand) & *factus* (make)
- Definition: the application of physical and chemical processes to alter the geometries, properties and appearance of a starting material in order to make and assemble it into a product.

Historical Notes

- Powder processing (clay) (4000BC)
- Casting – Lost Wax (investment Casting)…Centrifugal casting (2500BC – 1850)
- The First Industrial Revolution (1760-1830)
  - Adam Smith (1723-1790) – division of labor
  - James Watt – Steam Engine
  - John Wilkinson – Machine Tools
  - Eli Whitney (1797) – Interchangeable Parts
- Henry Ford (1913) – Assembly Line
- The Second Industrial Revolution (1950)
  - Invention & usage of computers
  - Microchips

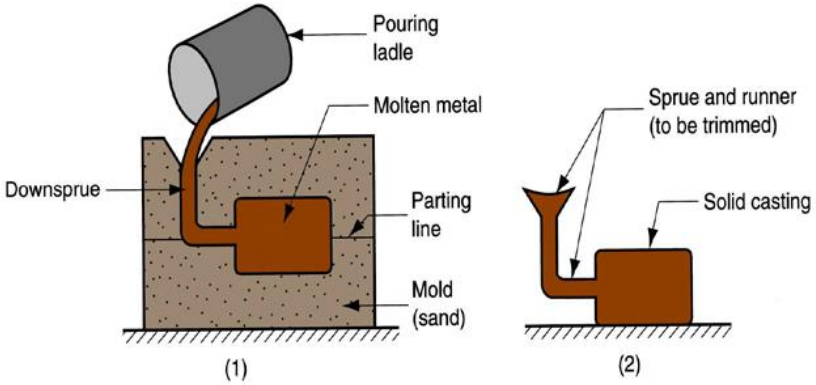
Classification of manufacturing processes



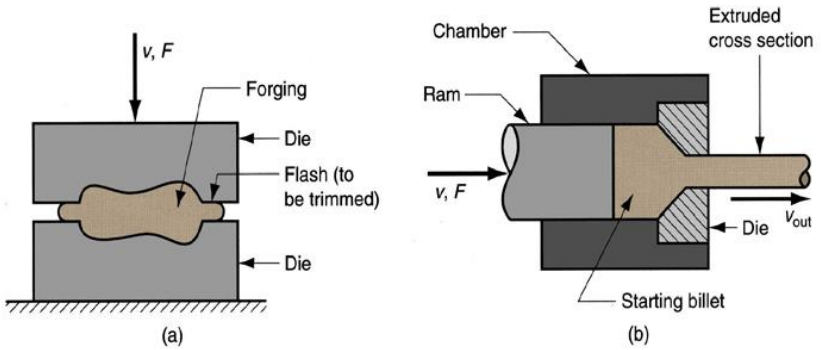
Manufacturing Processes

- Solidification processes - starting material is a heated liquid or semi-fluid
- Particulate processing - starting material consists of powders
- Deformation processes - starting material is a ductile solid (commonly metal)
- Material removal processes - starting material is a ductile or brittle solid

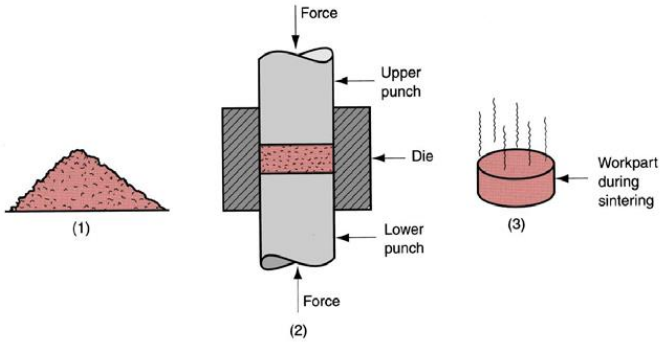
Manufacturing Processes



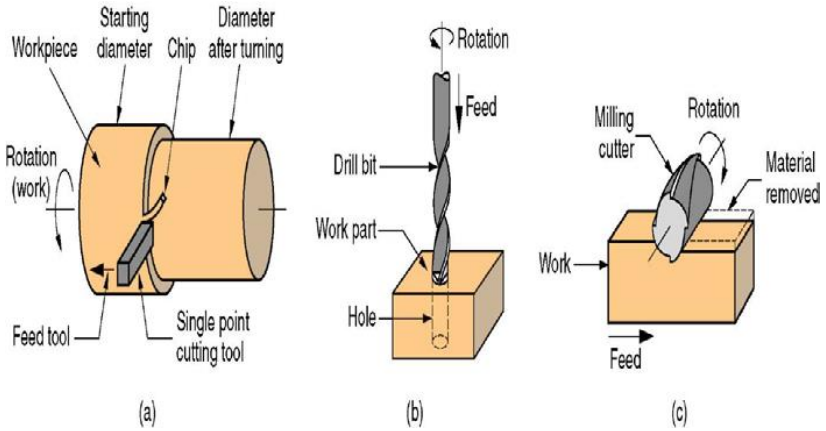
Casting: Constant Mass Operation



Metal Forming: Constant Mass Operation

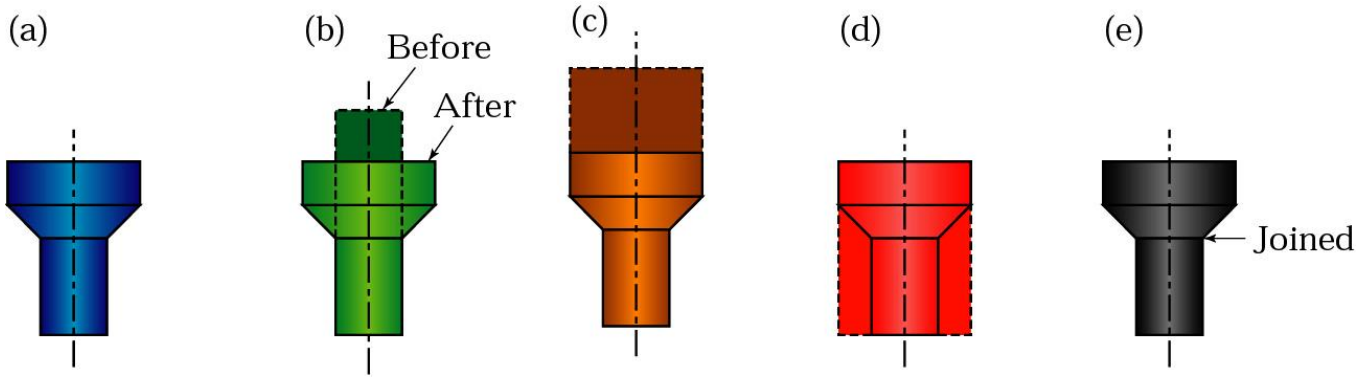


Powder Metallurgy: Constant Mass Operation



Machining: Material Removal Process

Methods of Making a Simple Part



Various methods of making a simple part: (a) casting or powder metallurgy, (b) forging or upsetting, (c) extrusion, (d) machining, (e) joining two pieces (Mass Addition Process).

Other Processing Operations

- Property Enhancing Processes
  - Heat Treatment: Improve physical properties of the material without changing its shape
  - Alloying
  - Composites
- Surface Processing – Cleaning, surface treatment & coating deposition

Materials

- **Ferrous metals:** carbon-, alloy-, stainless-, tool-and-die steels
- **Non-ferrous metals:** aluminum, magnesium, copper, nickel, titanium, superalloys, refractory metals, beryllium, zirconium, low-melting alloys, gold, silver, platinum, …
- **Plastics:** Thermoplastics (acrylic, nylon, polyethylene, ABS,) Thermosets (epoxies, Polymides, Phenolics, …)

  Elastomers (rubbers, silicones, polyurethanes, …)
- **Ceramics, Glasses, Graphite, Diamond, CBN**
- **Composites:** reinforced plastics, metal-, ceramic matrix composites
- **Nanomaterials, shape-memory alloys, superconductors, …**

Properties of materials

- Mechanical properties:

  Strength, Toughness, Hardness, Ductility, Elasticity, Fatigue and Creep

- Physical properties:

  Density, Specific heat, Melting and boiling point, Thermal expansion and conductivity, Electrical and magnetic properties

- Chemical properties:

  Oxidation, Corrosion, Flammability, Toxicity, …

Production Systems

- Production facilities
  - Low-quantity Production (1~100 units/yr)
    - Job shop, prototyping
  - Medium-quantity Production (100~10,000 units/yr)
    - Batch production & cellular manufacturing
  - High-quantity Production (>10,000 units/yr)
    - Mass production
  - Two categories of mass production
    - Quantity Production – Mass production of single parts on single machine or small numbers of machines
    - Flow Line Production – Multiple machines or workstations arranged in sequence, e.g. production line