MANUFACTURING PROCESSES (CLASS #2)

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"Globalization is the integration and interdependency of world markets and resources in producing consumer goods and services"

MATERIALS AND MANUFACTURING PROCESSES

Reference: Chapter 1 from "De Garmo's Materials and Processes in Manufacturing" - JT Black and Ronald Kohser - 2012

Manufacturing Process

- "A **manufacturing process** converts unfinished materials to finished products, often using machines or machine tools.

  For example, injection molding, die casting, progressive stamping, milling, arc welding, painting, assembling, testing … are commonly called processes or manufacturing processes.

  A **machine tool** is an assembly of related mechanisms on a frame or bed that together produce a desired result.

  Motors, controls, and auxiliary devices are included. Cutting tools and workholding devices are considered separately.
  A machine tool may do a single process (e.g., cutoff saw) or multiple processes, or it may manufacture an entire component. Machine sizes vary from a tabletop drill press to a 1000-ton forging press."

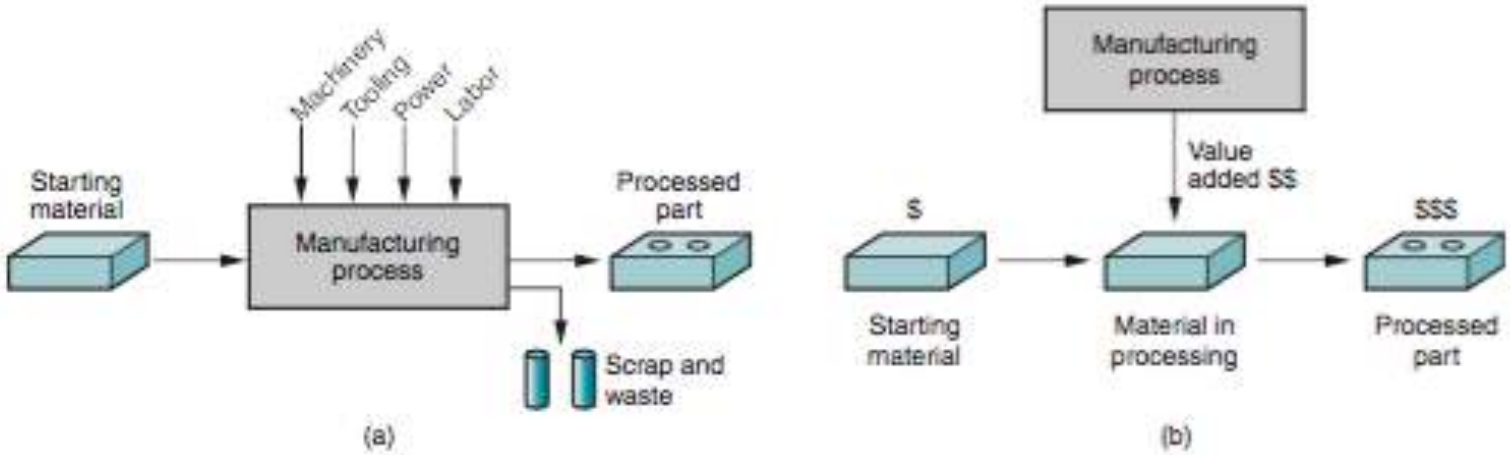
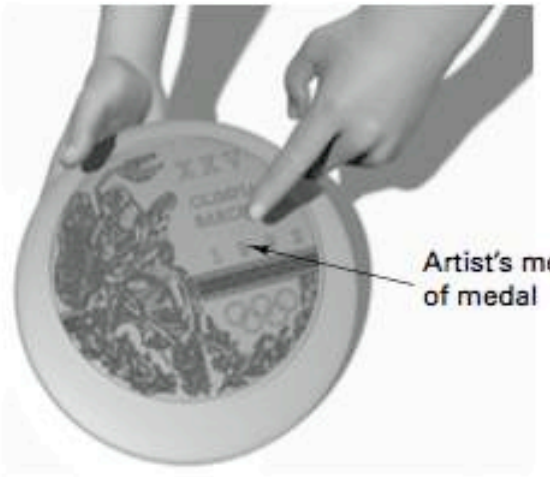
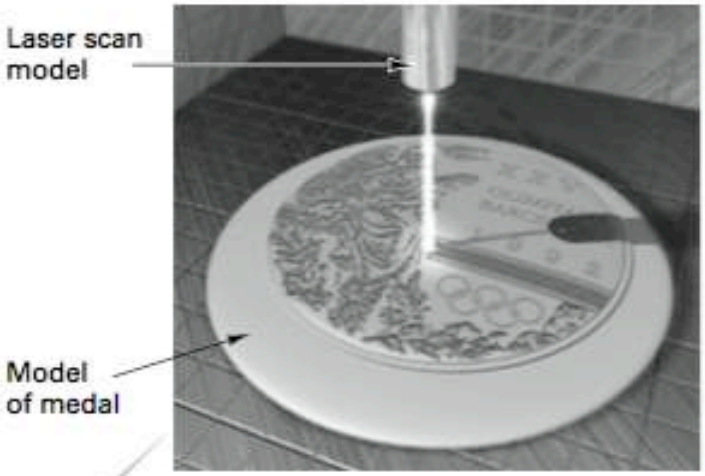


FIGURE 1.1 Two ways to define manufacturing: (a) as a technical process, and (b) as an economic process. (Credit: *Fundamentals of Modern Manufacturing*, 4th Edition by Mikell P. Groover, 2010. Reprinted with permission of John Wiley & Sons, Inc.)

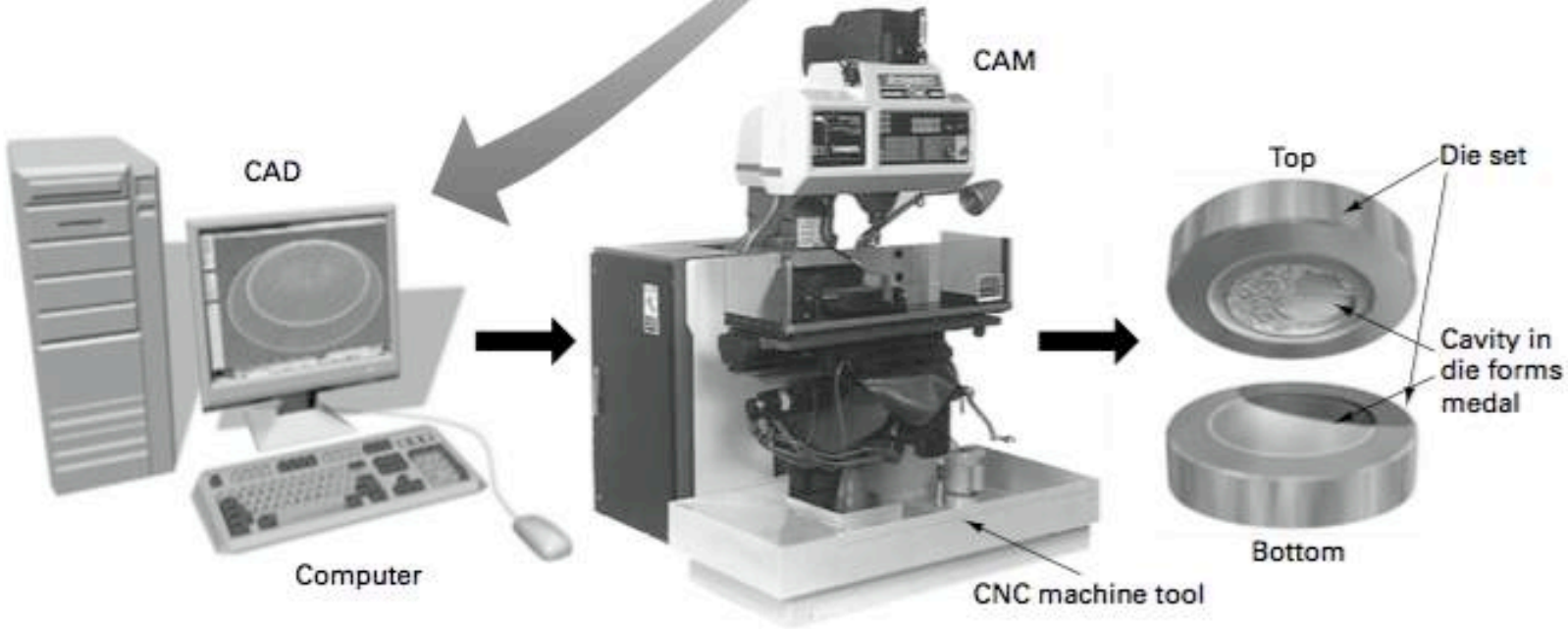
How an olympic medal is made using the CAD/CAM process



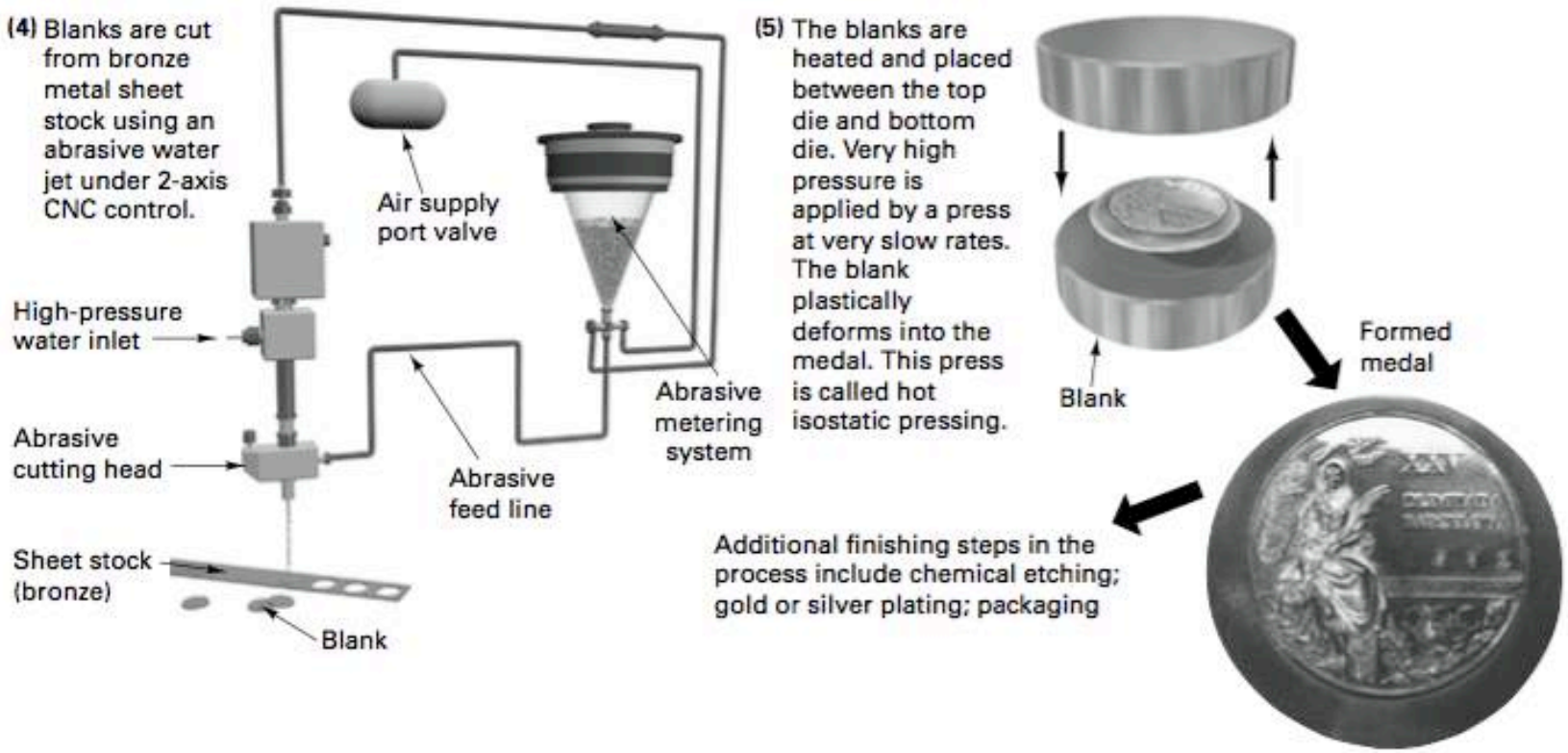
(1) An oversized 3D plaster model is made from the artist's conceptual drawings.



(2) The model is scanned with a laser to produce a digital computer called a computer-aided design (CAD).



(3) The computer has software to produce a program to drive numerical control machine to cut a die set.


(4) Blanks are cut from bronze metal sheet stock using an abrasive water jet under 2-axis CNC control.
Air supply port valve
High-pressure water inlet
Abrasive cutting head
Abrasive metering system
Abrasive feed line
Sheet stock (bronze)
Blank
(5) The blanks are heated and placed between the top die and bottom die. Very high pressure is applied by a press at very slow rates. The blank plastically deforms into the medal. This press is called hot isostatic pressing.
Blank
Formed medal
Additional finishing steps in the process include chemical etching; gold or silver plating; packaging

Operations

An operation is a distinct action performed to produce a desired result or effect. Typical manual machine operations are loading and unloading. Operations can be divided into suboperational elements. For example, loading is made up of picking up a part, placing part in jig, closing jig. However, suboperational elements will not be discussed here.

Operations categorized by function are:

1. Materials handling and transporting: change in position of the product.
2. Processing: change in volume and quality, including assembly and disassembly; can include packaging.
3. Packaging: special processing; may be temporary or permanent for shipping.
4. Inspecting and testing: comparison to .the standard or check of process behavior
5. Storing: time lapses without further operations.

Treatments

- Treatments operate continuously on the workpiece.
- They usually alter or modify the product-in-process without tool contact. Heat treating, curing, galvanizing, plating, finishing, (chemical) cleaning, and painting are examples of treatments. Treatments usually add value to the part.
- These processes are difficult to include in manufacturing cells because they often have long cycle times, are hazardous to the workers' health, or are unpleasant to be around because of high heat or chemicals.
- They are often done in large tanks or furnaces or rooms.
- The cycle time for these processes may dictate the cycle times for the entire system. These operations also tend to be material specific.

MANUFACTURING CAPABILITY

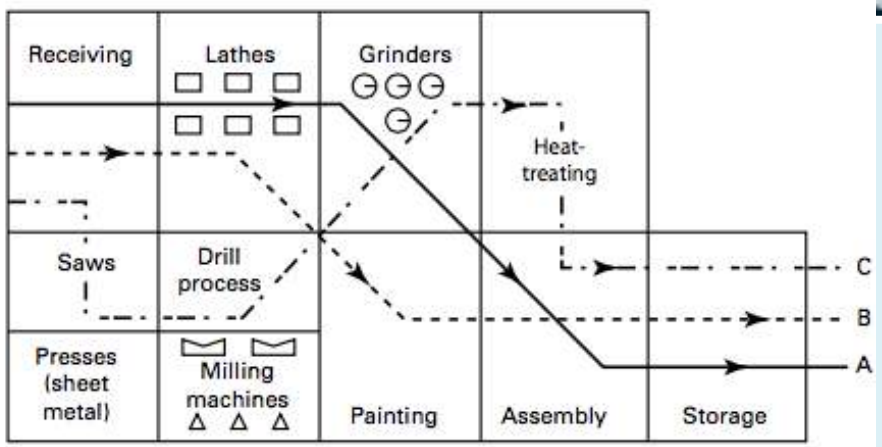
“A company engaged in manufacturing cannot do everything. It must do only certain things, and it must do those things well in order to remain competitive in its industry.” Manufacturing capability refers to the technical and physical limitations of a manufacturing firm and each of its plants.

Several dimensions of this capability can be identified:

(1) technological processing capability

(2) physical size and weight of product

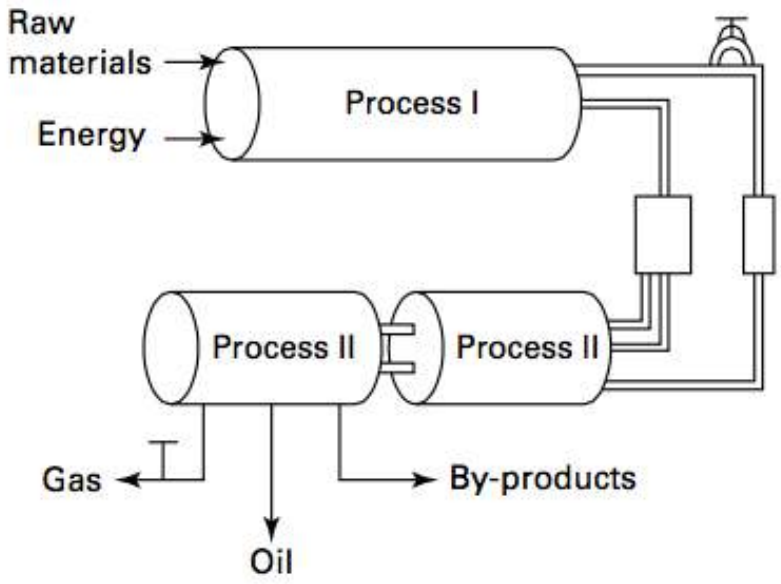
(3) production capacity.



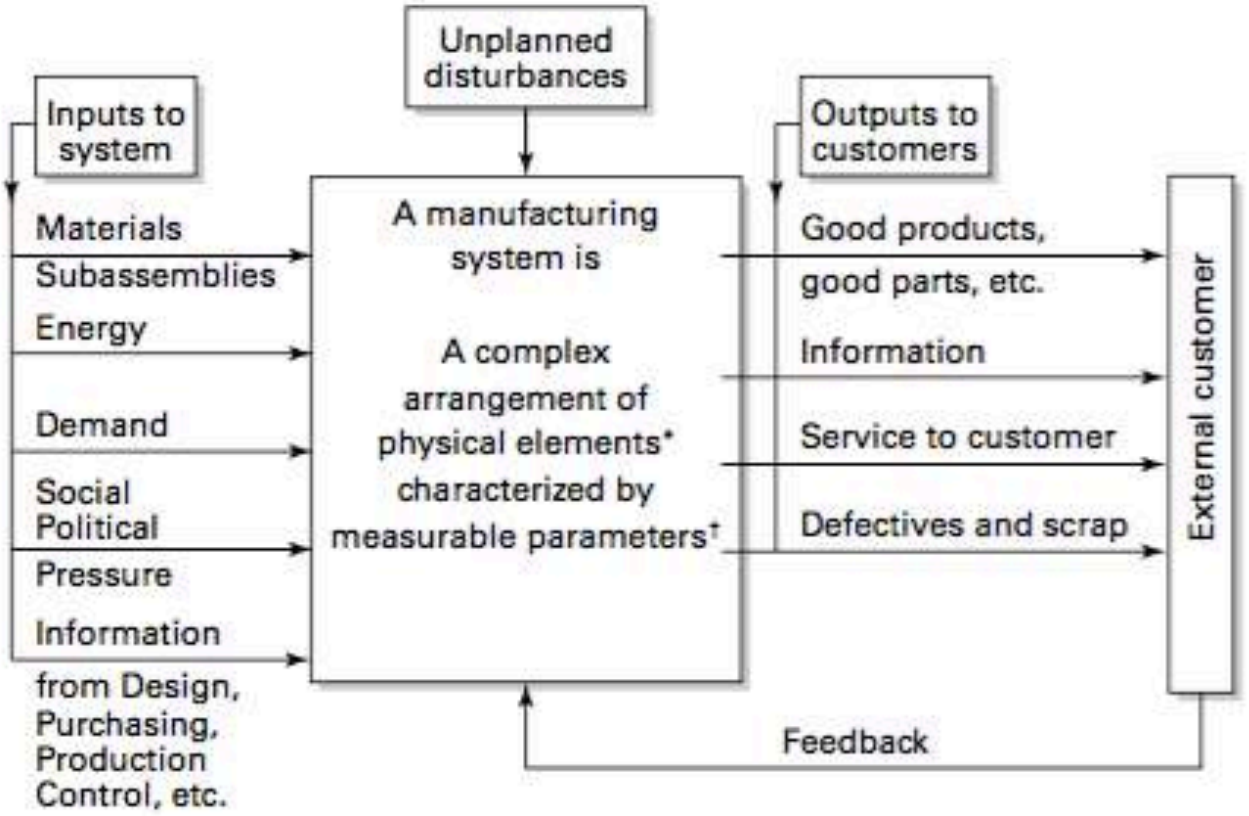
Job shop makes components for subassembly using a functional layout.

Job Shop

Continuous Process



Continuous process systems make products that can flow like gas and oil.



* Physical elements:

- Machines for processing
- Tooling (fixtures, dies, cutting tools)
- Material handling equipment (which includes all transportation and storage)
- People (internal customers) operators, workers, associates

† Measurable system parameters:

- Throughput time (TPT)
- Production rate (PR)
- Work-in-process inventory
- % on-time delivery
- % defective
- Daily/weekly/monthly volume
- Cycle time or takt time (TT)
- Total cost or unit cost

Manufacturing Processes

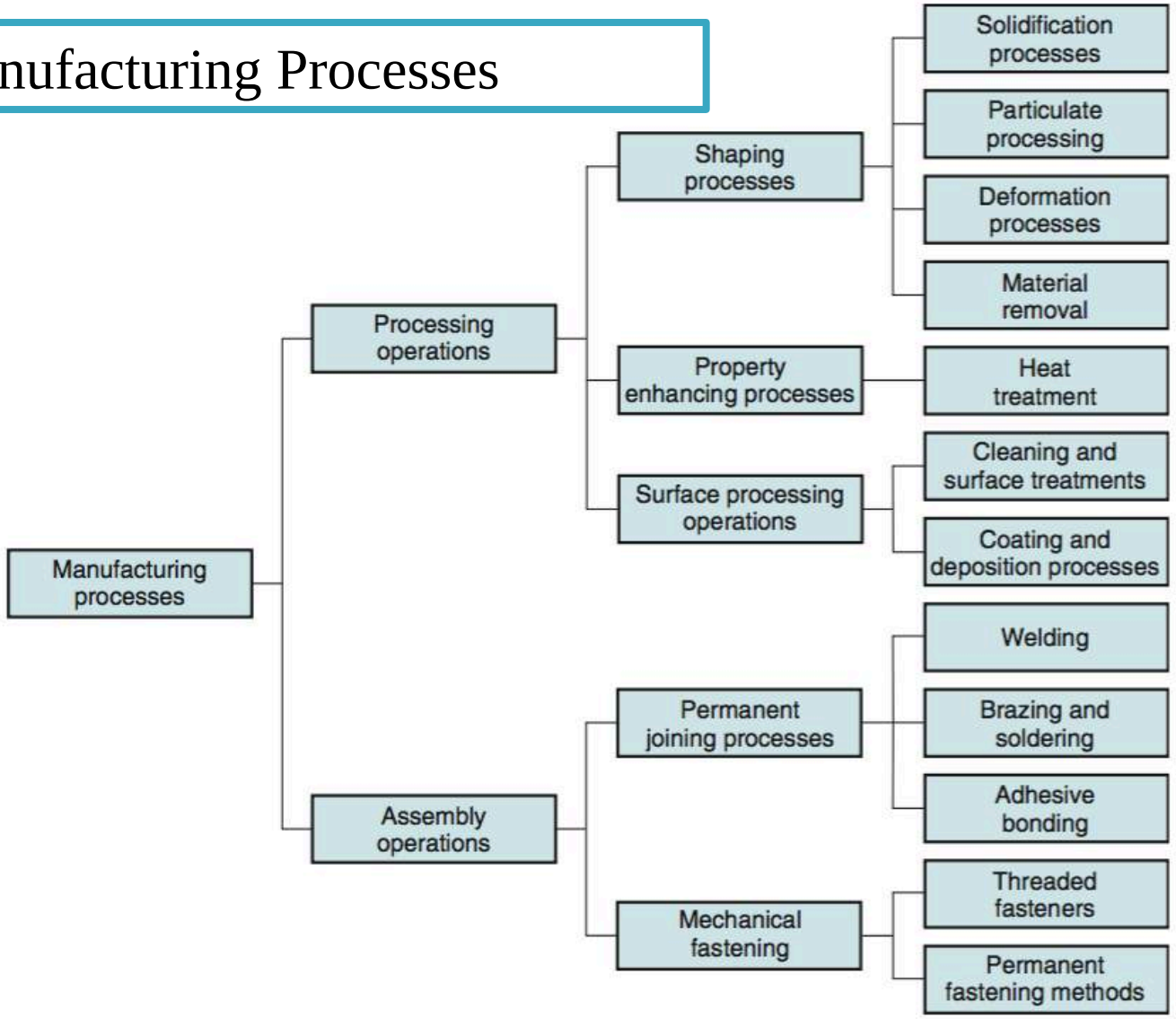


FIGURE 1.3 Classification of manufacturing processes. (Credit: *Fundamentals of Modern Manufacturing*, 4th Edition by Mikell P. Groover, 2010. Reprinted with permission of John Wiley & Sons, Inc.)

Routing/Operation Sheet (Process Planning)

Part no. 8060
Part name Drive Pinion

Ordering quantity 1000
Lot requirement 200

Material 430F Stainless steel, 1.780 ± 0.003 in. cold - finished 12-ft bars = 1000 pieces

Unit material cost $ 22.47

Workstation	Operation no.	Description of operations (list tools and gages)	Setup hour	Cycle hour/ 100 units	Unit estimate	Labor rate	Labor + overhead rate	Cost for labor + overhead rate
Engine lathe # 137	10	Face A-A end 0.05 center drill. A-A and rough turn has cast off to length 18.750	3.2	10.067	0.117	18.35	1.70	3.65
Engine lathe # 227	11	Center drill B-B end finish turn 1.100 turn 1.735 dirn	3.2	8.067	0.095	18.35	1.70	2.96

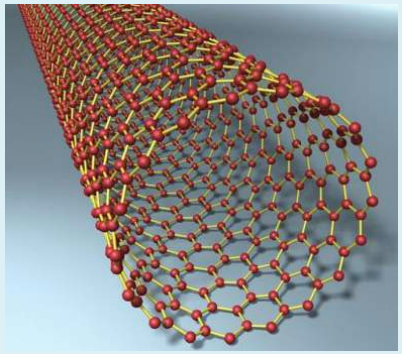
Materials

- Engineering Materials?

1. Metals
2. Polymers
3. Ceramics
4. Composites







Mechanics (statics and dynamics of the process)

- How does the process work?
- What are the process mechanics (statics, dynamics, friction)?
- What physically happens, and what makes it happen? (Understand the physics.)

Economics or costs

- What are the tooling costs, the engineering costs?
- Which costs are short term, which long term?
- What are the setup costs?

Time spans

- How long does it take to set up the process initially?
- What is the throughput time?
- How can these times be shortened?
- How long does it take to run a part once it is set up (cycle time)?
- What process parameters affect the cycle time?

Constraints

- What are the process limits?
- What cannot be done?
- What constrains this process (sizes, speeds, forces, volumes, power, cost)?
- What is very hard to do within an acceptable time/cost frame?

Uncertainties and process reliability

- What can go wrong?
- How can this machine fail?
- What do people worry about with this process?
- Is this a reliable, stable process?

Skills

- What operator skills are critical?
- What is not done automatically?
- How long does it take to learn to do this process?

Flexibility

- Can this process be adapted easily for new parts of a new design or material?
- How does the process react to changes in part design and demand?
- What changes are easy to do?

Process capability

- What are the accuracy and precision of the process?
- What tolerances does the process meet? (What is the process capability?)
- How repeatable are those tolerances?

GLOBAL MANUFACTURING – Working groups

- Class Homework – 2 students (changing from class to class) [Answering the questions for each manufacturing processes]
- Project – 4 students / Choose the workpiece, explore the manufacturing processes into this wp and present in the end of the course all the steps done.