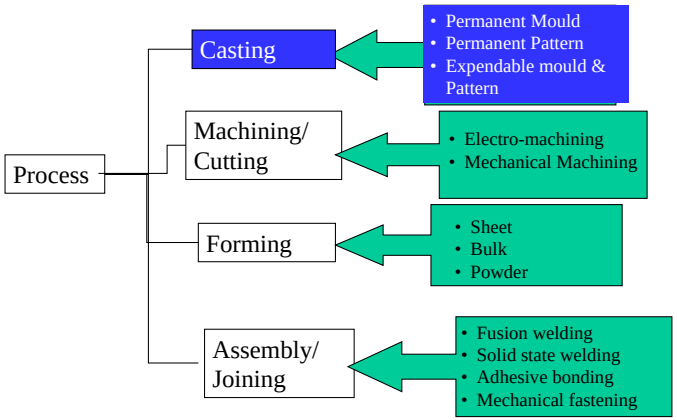
CASTING PROCESS - 1

Assoc Prof Zainal Abidin Ahmad
Universiti Teknologi Malaysia

Outline

- Overview of casting technology
  - What is casting
  - Brief history of casting
  - Advantages & disadvantages of casting
  - Products made by casting
  - Casting Classifications
  - Casting Foundries

Classification of Manufacturing Processes

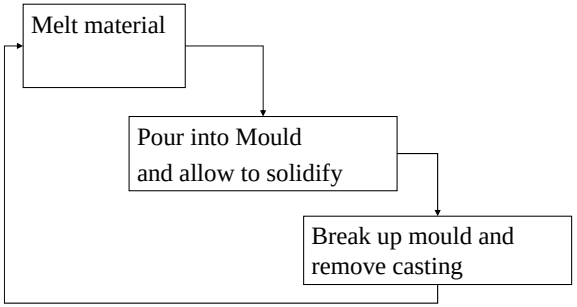


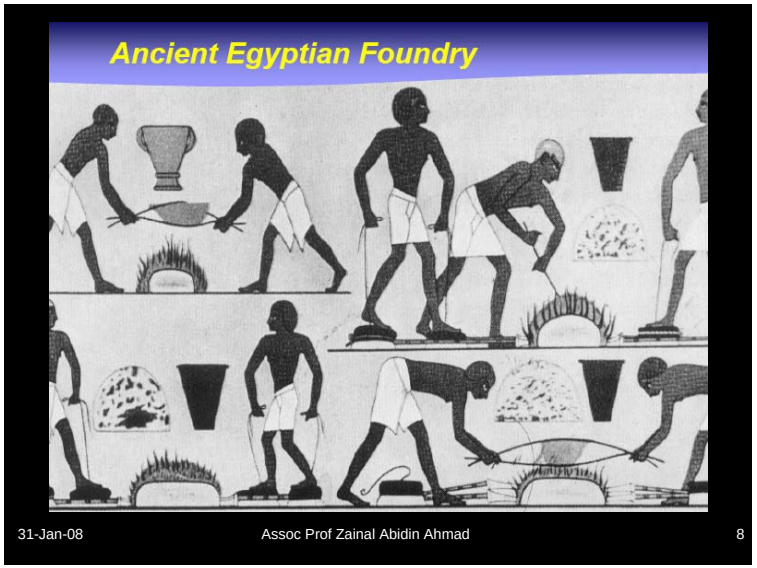
What is Casting?

Process in which molten metal flows by gravity or other force into a mold where it solidifies in the shape of the mold cavity

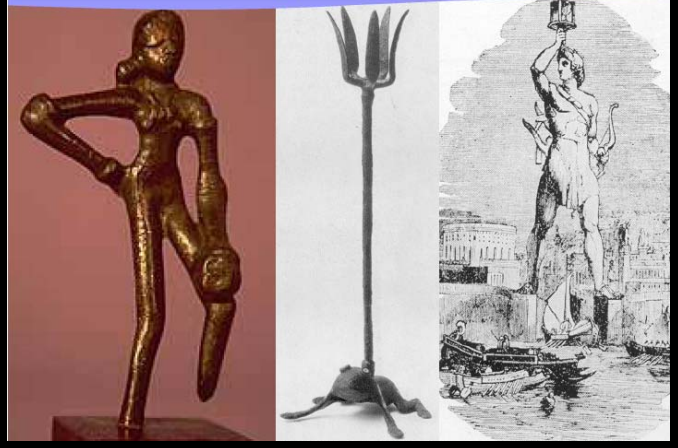
- The term *casting* also applies to the part made in the process
- Steps in casting seem simple:
  1. Melt the metal
  2. Pour it into a mold
  3. Let it freeze
  4. Break-up or open mold and remove casting

What is Casting?





Ancient Castings – India, Middle East



Ancient Castings from China

Sun wagon - Early bronze period

The golden sun wagon of Trundholm, Seeland

Trundholm, Højby, Holbæk, Dänemark
14th cent. b. chr.
bronze and gold
length: 59,6 cm

source: Nationalmuseum, Kopenhagen

Major Cast Metals and Alloys

METAL	USE	CHARACTERISTICS	APPLICATIONS
Grey Iron	54%	Heat resistance, damping, low cost, high fluidity, low shrinkage	Engine block, brake drum, machine tool beds, housings
SG Iron	20%	Strength, wear and shock resistance, dimensional stability, machinability	Crank shafts, camshafts, valves, differential housing, brackets, rollers
Al alloys	12%	Strength to weight ratio, corrosion resistance	Pistons, oil and fuel pumps, connecting rod, clutch housings
Steel	9%	Strength, machinability, weldability	Machine parts, gears, valves
Cu alloys	2%	High ductility, corrosion resistance	Marine impellers, hydraulic pump parts, valves
Zn alloys	1%	Good corrosion resistance, high fluidity	Handles, grills, toys, fuel pumps

Other emerging metals: Magnesium and Titanium.

Capabilities and Advantages of Casting

- Can create complex part geometries
- Can create both external and internal shapes
- Some casting processes are *net shape;* others are *near net shape*
- Can produce very large parts
- Some casting methods are suited to mass production

Disadvantages of Casting

- Different disadvantages for different casting processes:
  - Limitations on mechanical properties
  - Poor dimensional accuracy and surface finish for some processes; e.g., sand casting
  - Safety hazards to workers due to hot molten metals
  - Environmental problems

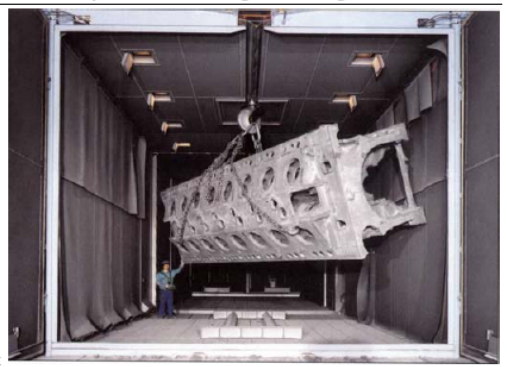
Major Applications of Castings

- **Transport**:
  automobile, aerospace, railways, shipping
- **Heavy equipment:**
  construction, farming and mining
- **Machine tools:**
  machining, casting, plastics moulding, forging, extrusion, forming
- **Plant machinery:**
  chemical, petroleum, paper, sugar, textile, steel and thermal plants
- **Defense:**
  vehicles, artillery, munitions, storage and supporting equipment
- **Electrical machines:**
  motors, generators, pumps, compressors
- **Municipal castings:**
  pipes, joints, valves and fittings
- **Household:**
  appliances, kitchen and gardening equipment, furniture, fittings
- **Art objects:**
  sculptures, idols, furniture, lamp stands, decorative items

Parts Made by Casting

- Big parts: engine blocks and heads for automotive vehicles, wood burning stoves, machine frames, railway wheels, pipes, church bells, big statues, and pump housings
- Small parts: dental crowns, jewelry, small statues, and frying pans
- All varieties of metals can be cast, ferrous and nonferrous

Production of high-volume components through casting

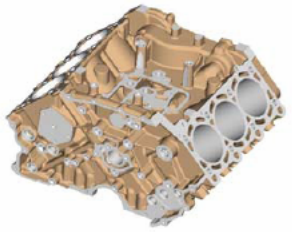


Abrasive blasting process of a 16-cyl.- motor unit made of GJL-300 (CrCu-alloyed) in a completely encapsulated sand blast chamber with dust extraction set

Motor unit- AUDI 059 2.5 L TDI: Audi A6, A4, A8, Passat

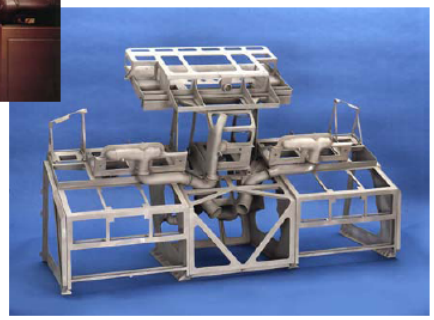
Cast part

Part with machined surfaces



Boeing Instrument Panel - Aluminium investment casting

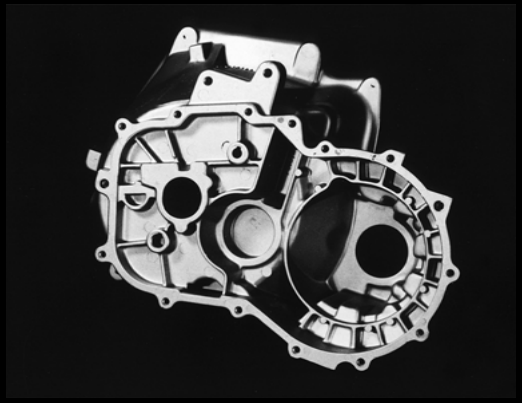
Dimensions
1700x600x1200 mm



source: Tital

Parts Made by Casting

Parts Made by Casting



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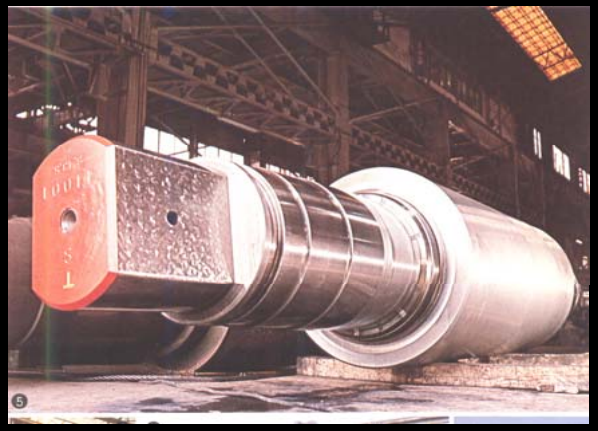

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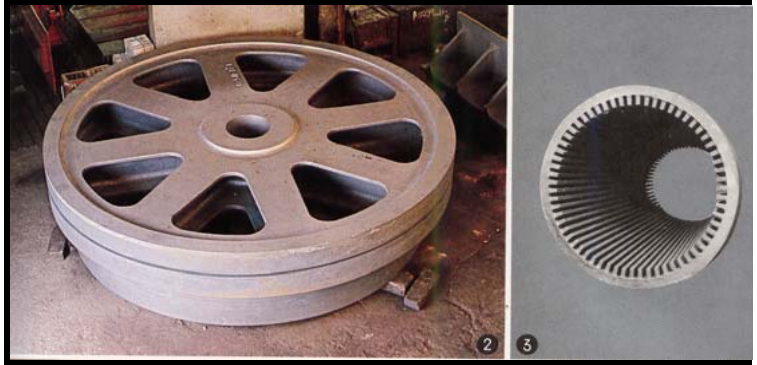

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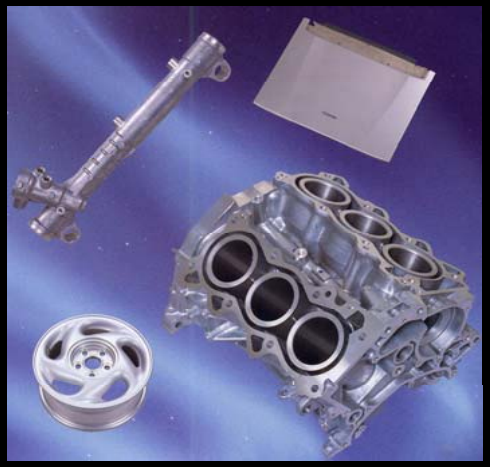

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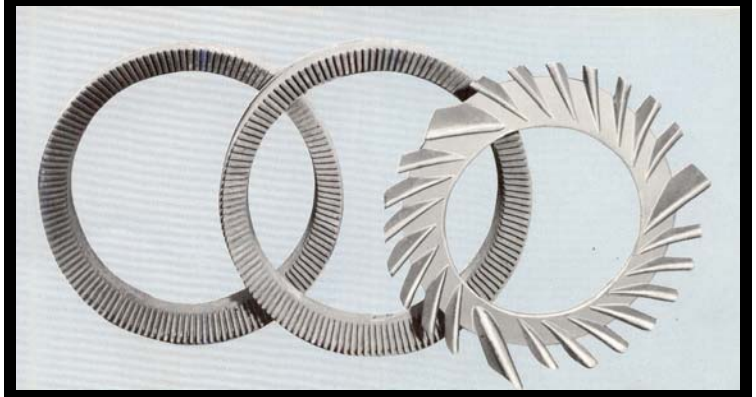

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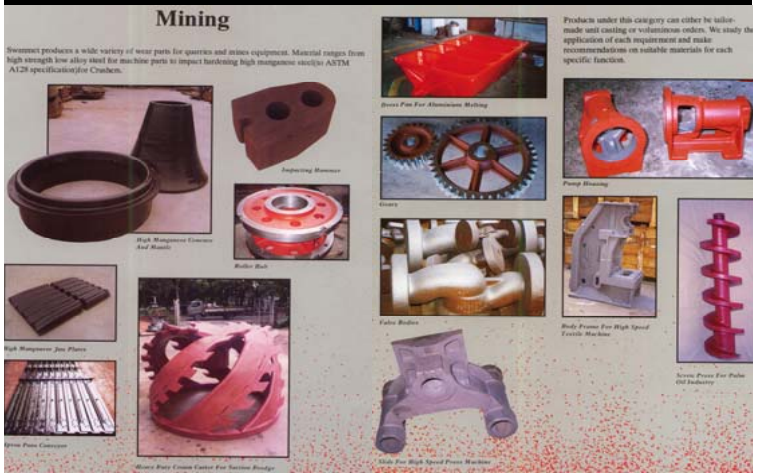

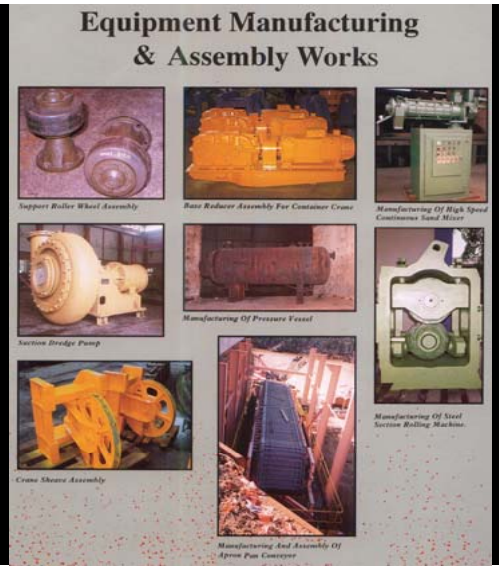

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Parts Made by Casting

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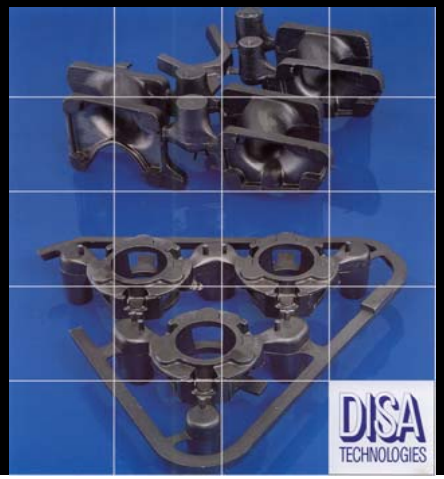


Example of application: Power transmission - sand casting

Truck wheel hub
(light weight design)
nodular cast iron
GJS-400-15
weight: 17.6 kg

Differential casting
nodular cast iron

Crankshaft
nodular cast iron
GJS-600-3
weight: 13.4 kg

Example of application: Aluminium sand casting

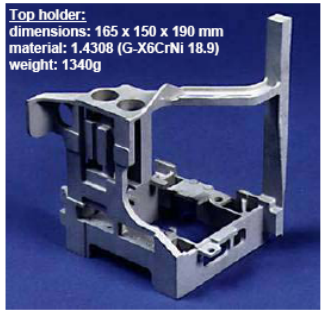
Suction inlet
Al - sand casting, G-AlSiCu3
weight: 16.8 kg

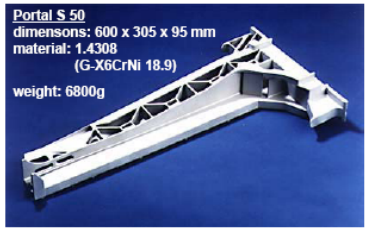
Oil pan
Al - sand casting / G-AlSiMg(wa)
weight: 4.5 kg

Clutch housing
Al - sand casting / G-AlSi9Cu3
weight: 44.6 kg

Examples for investment casting parts: High-tech components

Steel investment cast parts made of G-X6CrNi 18.9.
Parts of a component insertion machine, which are exposed with accelrating power up to 3,5 g.



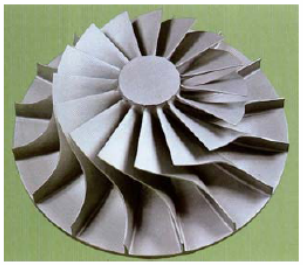


Examples for investment casting parts

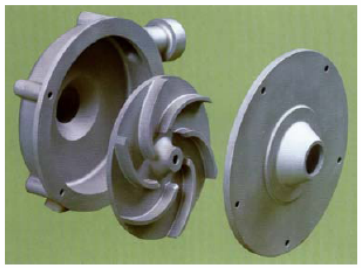
Spiral pump casing –
food processing industry
material: G-X 5 CrNiMoNb 18 10 (1.4581)
dimensions: 245 x 265 x 30 mm
weight: ca. 7 kg

Valve chamber
material: GS-38 (1.0416)
weights of pieces: up to 30 kg

Examples for investment casting parts



Compressor impeller
material: G-X 5 CrNiMo 16 5 (1.4405)
weight: 16 kg



Casing, impeller and cap for a pump used in th
food processing industry
material: G-X 5 CrNiMoNb 18 10 (1.4581)
diameter of casing: 220 mm
weights of pieces: up to 4,5 kg

Casting Processes – Classification

- **Type of Mould**
  - Consumable (sand): destroyed after each casting
  - Permanent (metal): reused many times
- **Type of Pattern** (for making a sand mould):
  - Consumable (wax): destroyed (melted) for each mould
  - Permanent (wood, metal): reused for many moulds
- **Type of Core** (for producing a hole in a casting):
  - Consumable (sand): used in both sand and metal mould
  - Permanent (metal): used in permanent mould only
- **Type of Filling** (metal flow in mould):
  - Gravity: sand casting, gravity die casting
  - Pressure: low and high pressure die casting
  - Vacuum: vacuum investment casting.

Two Categories of Casting Process

1. *Expendable mold processes* – uses an *expendable mold* which must be destroyed to remove casting
   - Mold materials: sand, plaster, and similar materials, plus binders
2. *Permanent mold processes* – uses a *permanent mold* which can be used many times to produce many castings
   - Made of metal (or, less commonly, a ceramic refractory material

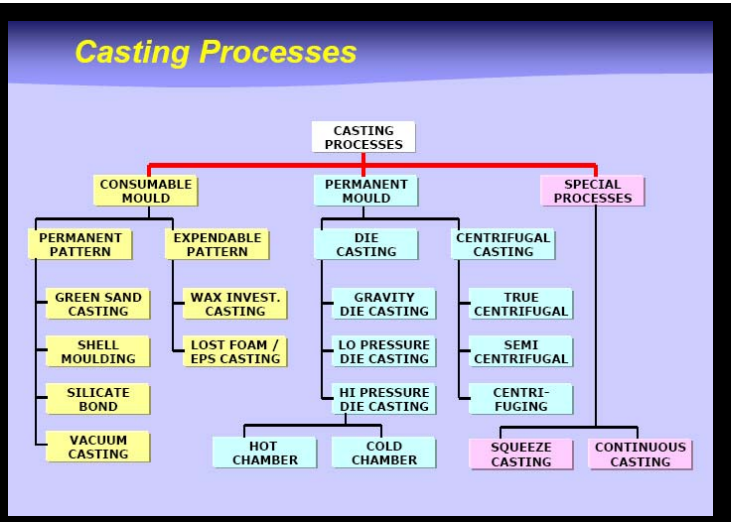
Casting Processes

Permanent mould
- •Continuous casting
- •Gravity die casting
- •Squeeze casting
- •Centrifugal casting
- •Reaction injection moulding
- •Injection moulding
- •Compression moulding
- •Rotational moulding

Permanent pattern
- Sand Casting
- Shell moulding

Expendable mould & pattern
- Investment Casting
- Ceramic/plaster mould casting
- Full mould evaporative pattern casting

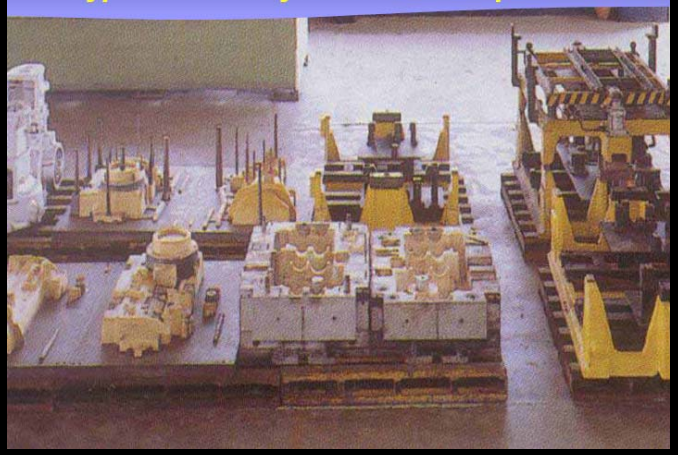
Casting Processes



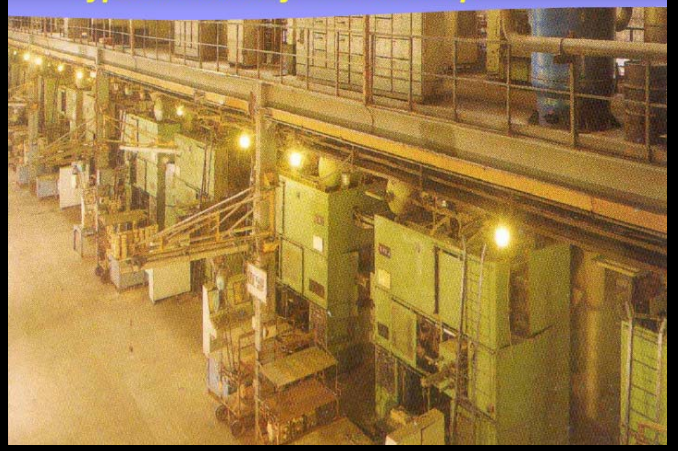
Advantages and Disadvantages

- More intricate geometries are possible with expendable mold processes
- Part shapes in permanent mold processes are limited by the need to open mold
- Permanent mold processes are more economic in high production operations

Typical Foundry – Pattern Shop



Typical Foundry – Core Shop



Typical Foundry – Moulding Shop

Typical Foundry – Melting Shop

Typical Foundry – Pouring Shop