Aalto University

Casting

Introduction

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http://mciron.mw.tu-dresden.de/lut/vorlesung/script_ft1/FT1%20VL%20%201%20Einf%C3%BChrung%20allg..pdf

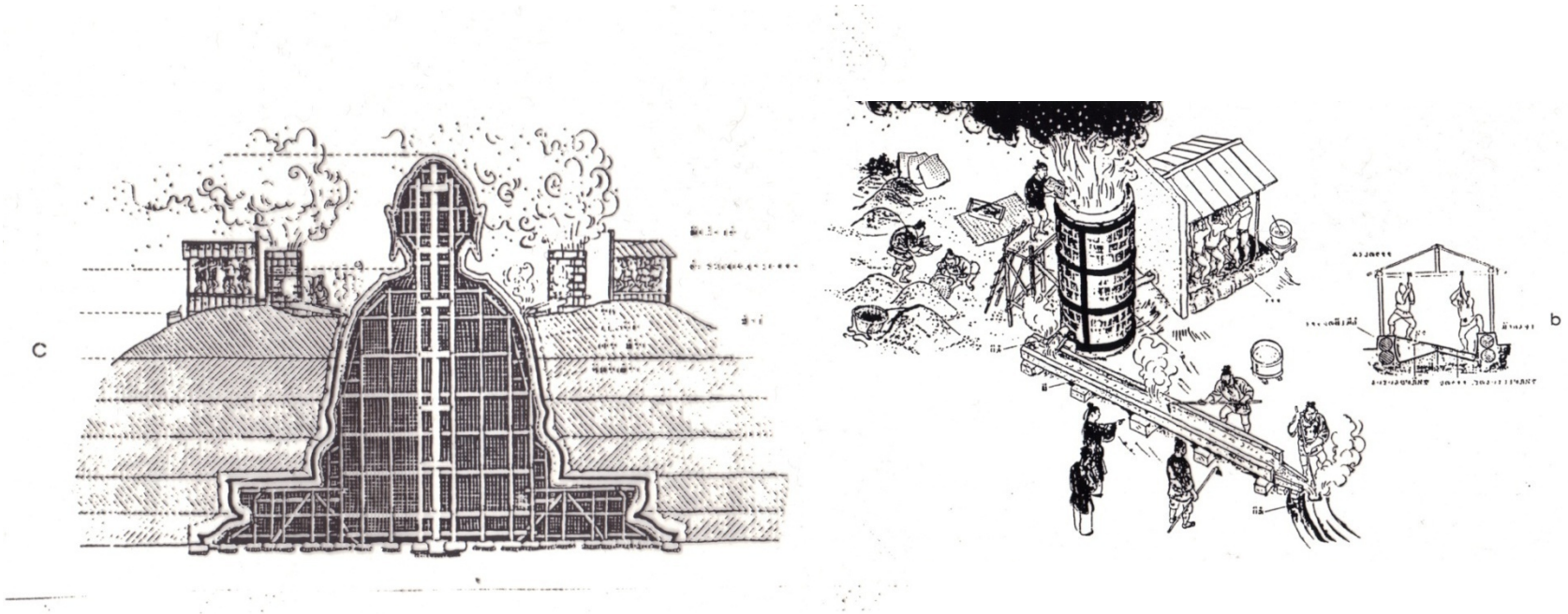
History

- 5000 BC Cast gold (middle east)
- 4000 BC Cast copper (Shaan´xi, China)
- 3000 BC Cast bronze in India and Mesopotamia
- 2700 BC Copper Age in Europe
- **1800 BC Bronze Age in Europe**
- **500 BC Cast iron (China)**
- 475 BC Tempering (China)
- **1390 Cast iron (Europe)**
- 1630 First temper patent in England
- 1845 Cast steel (J.Mayer, J.C. Fischer)
- 1894 First aluminum alloy
- 1909 First magnesium alloy
- **1942 Spheroidal graphite iron**
- 1950 Cast titanium

Great Buddha at Kamakura, Japan

- High-lead tin bronze
- 13.35 m high
- 140 tons
- Start ca. 700 AD

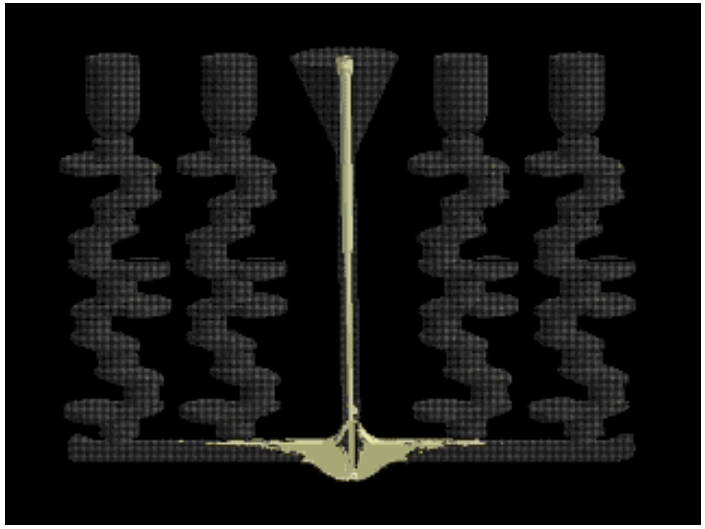
The ancient way



Nowadays

- Metallurgy and automation

- 3D CAD modelling, simulation and 3D-printing



http://goliath.ecnext.com/coms2/gi_0199-7343654/41st-Census-of-World-Casting.html

World Casting Production

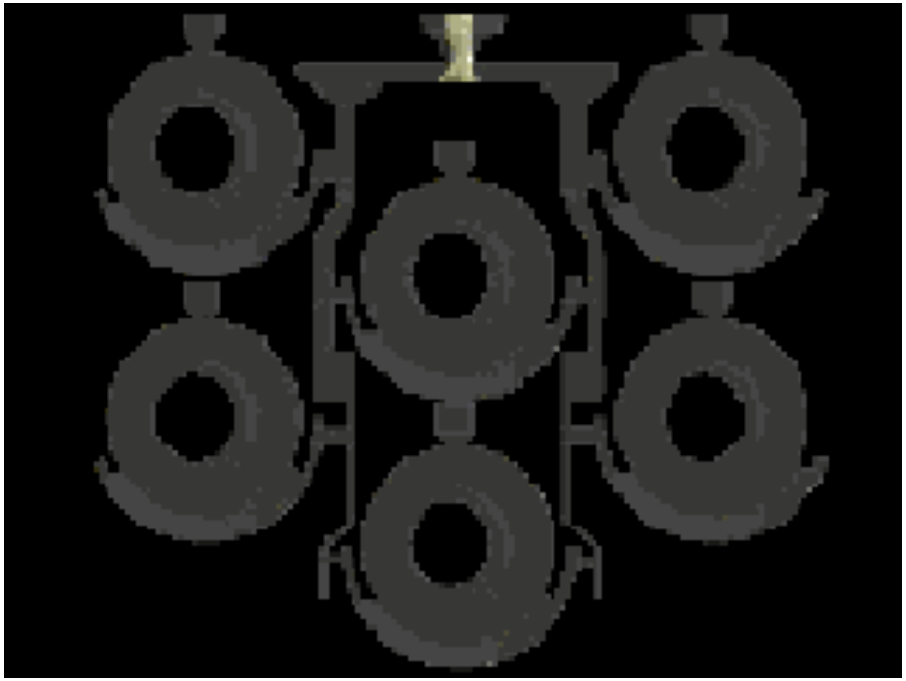
	Finland [t]	China [t]	Worldwide [t]
GJL	46,780	13,928,086	42,539,286
GJS	67,250	6,843,019	21,685,421
Steel	19,816	3,811,210	9,938,806
Copper	4,328	470,189	1,485,341
Aluminum	11,743	2,310,350	12,278,534
Other	…	…	…
Total	150,412	28,094,168	91,368,121

http://www.magmasoft.de/ms/products_de_processes/

Casting

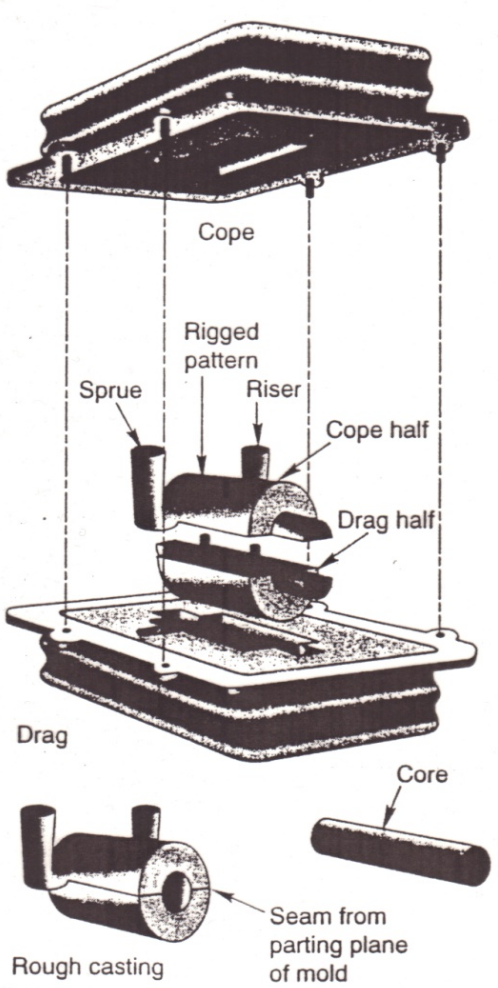
- Fluid metal poured into a mold and solidified by cooling

Casting six cover plates (Gravity casting)



Sand casting

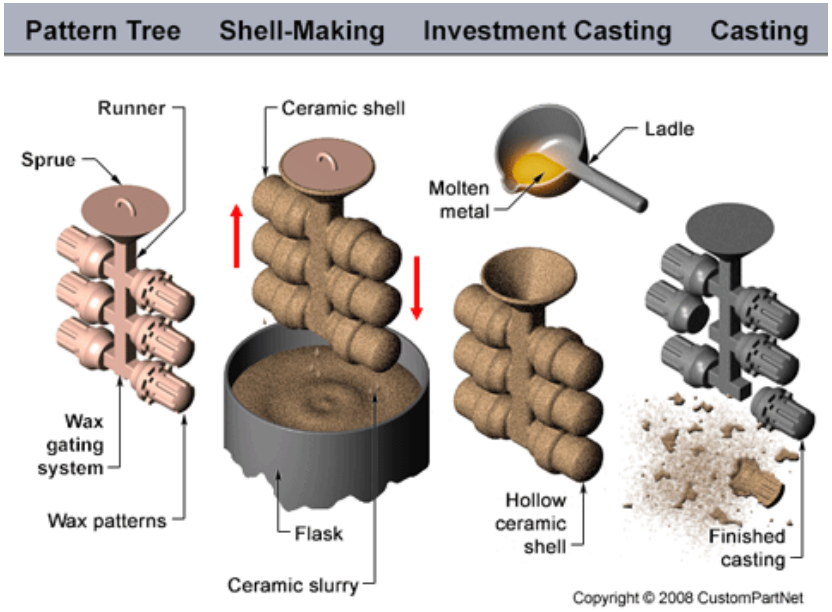
- Most common casting method
- Pattern
  - Form cavity in the moulding sand
- Cores
  - Hollows inside the cast part
- Gating system
  - For uniform flow of the metal
  - Risers prevent cavities due to shrinkage
  - Gas while casting can leak



Principles of sand molding.

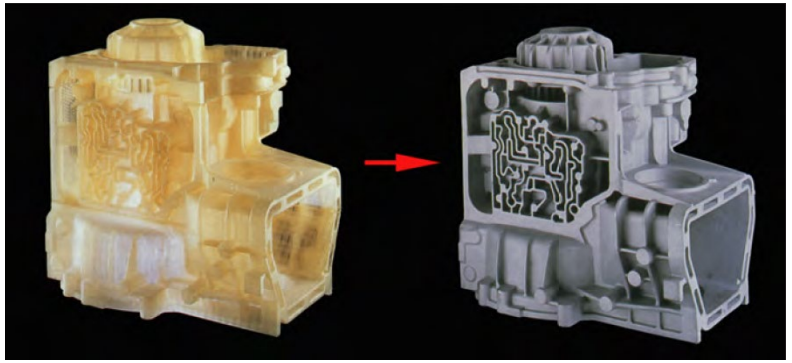
Investment casting

- Pattern Tree
  - Wax patterns
  - Connected at a gating system
- Shell
  - Ceramic slurry
  - Sand and fireclay
  - Drying
- Melting of the wax
- Casting
- Breaking of the ceramic shell



Investment casting

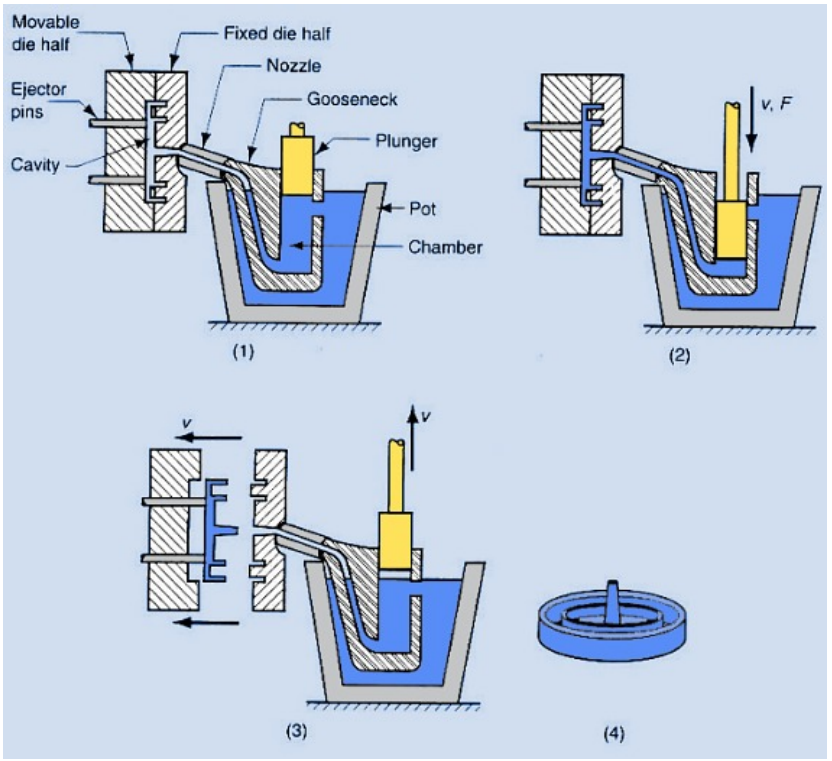
- Complex shapes
- Details
- Accurate casting
  - Little machining needed
- Very good surface
- CAD-Models directly usable
  - Advanced Manufacturing, 3D-printing



•http://www.ortal.co.il/Index.asp?CategoryID=77&ArticleID=72

Die casting (hot chamber)

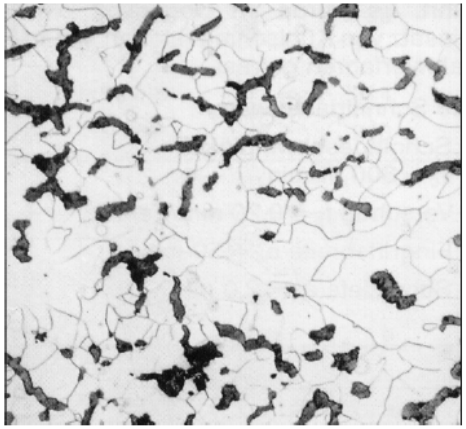
- Permanent mould
  - 200-400 shots per hour
- Injection by plunger through a gooseneck
- Static pressure until the material solidifies
  - 70 – 350 bar

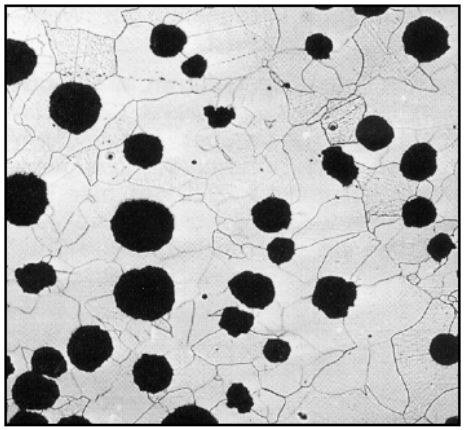


http://mciron.mw.tu-dresden.de/lut/vorlesung/script_ft1/FT1%20VL%20%202%20Gu%C3%9Ftechnik.pdf

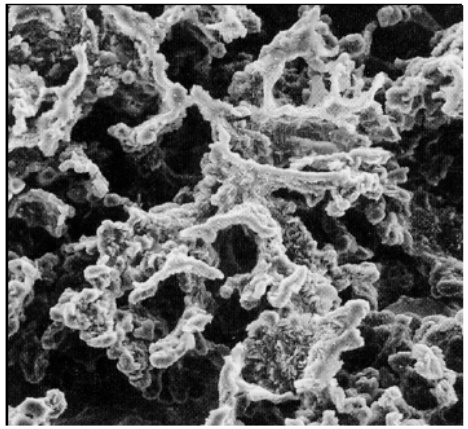
Grey cast iron - Overview

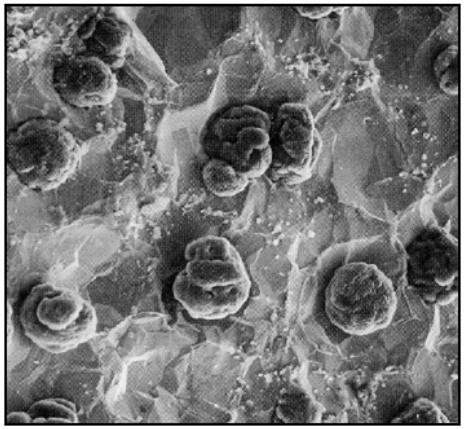
Un-etched photomicrograph





SEM image





Quelle: CLAAS GUSS

http://www.kug.bdguss.de/fileadmin/content/Publikationen-Normen-Richtlinien/buecher/GJL.pdf

Lamellar graphite iron GJL

- Most common casting material
- Lamellar graphite
- $R_m \leq 400$ MPa

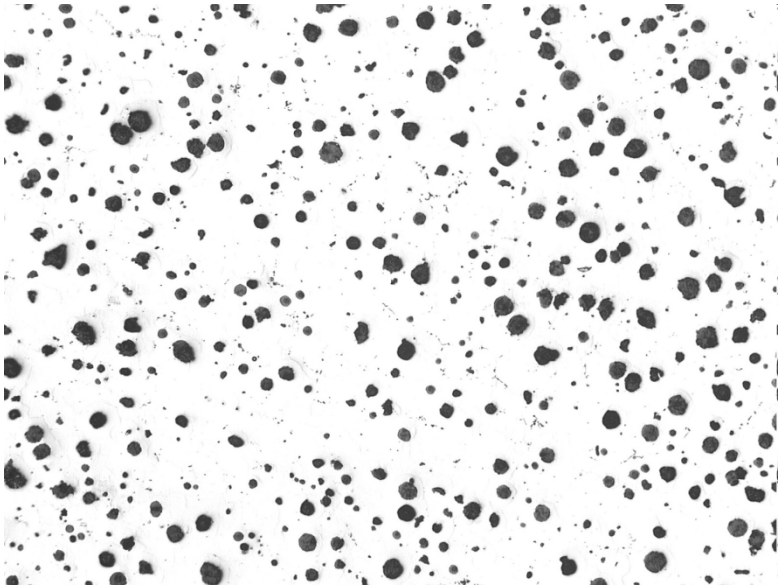
- Cylinder crankcase
  - High compressive strength
  - Very good damping capacity

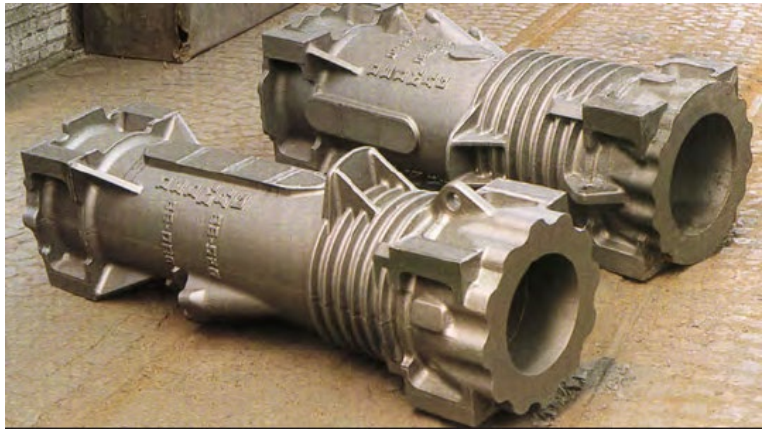
http://www.kug.bdguss.de/fileadmin/content/Publikationen-Normen-Richtlinien/buecher/GJS.pdf

Spheroidal graphite iron GJS

- Spherodial graphite
- $R_m \leq 800$ MPa

- Rear side of cylinder for diesel hammer
  - Ductile
  - Less notch-sensitive than GJL

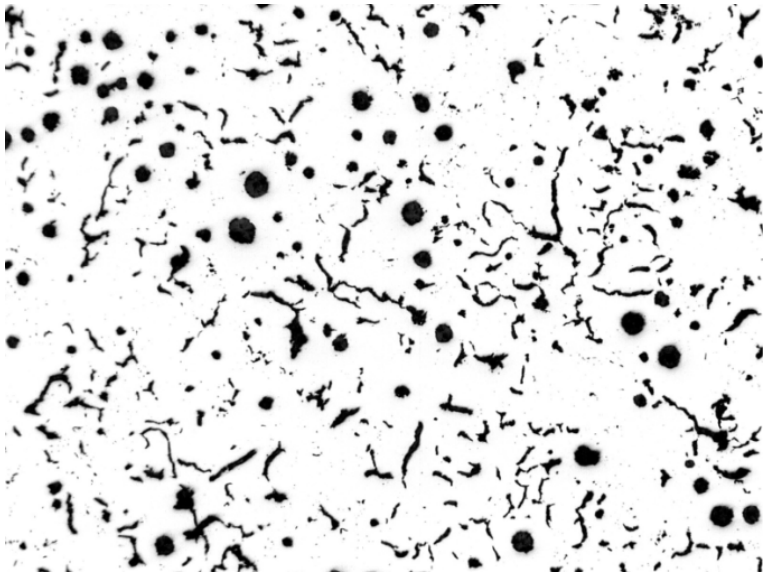




http://www.kug.bdguss.de/fileadmin/content/Publikationen-Normen-Richtlinien/buecher/GJS.pdf

Vermicular graphite iron GJV

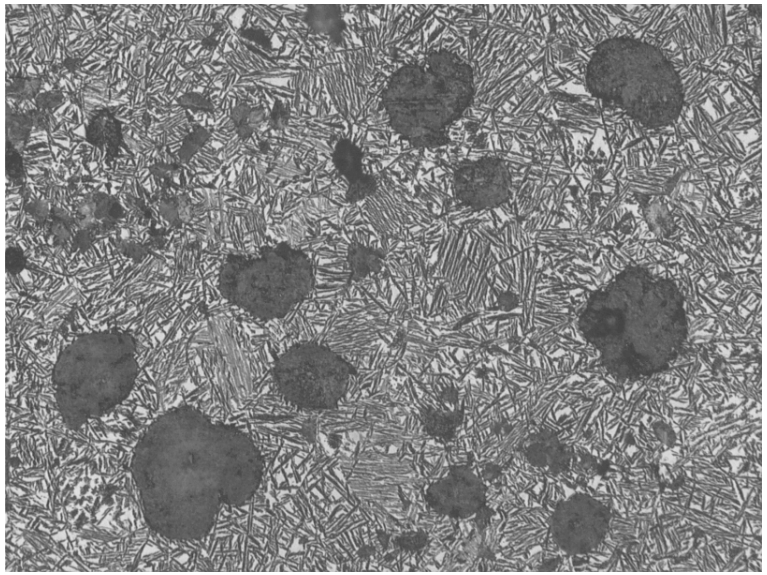
- Graphite as worms
- Properties between GJL and GJS
- $R_m \leq 600$ MPa



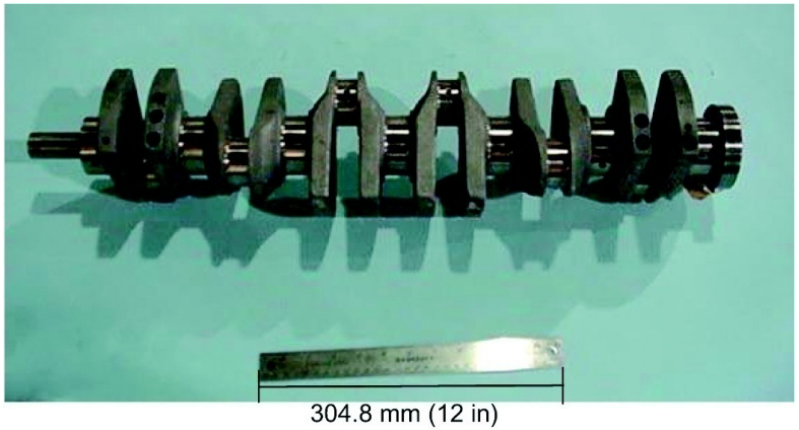
- V8-TDI engine block
  - More rigid and fatigue-resistant
    - Thinner walls and less weigh

Austempered ductile iron ADI

- Multi-step heat treatment of GJS
- Bainitic-similar structure
- $R_m \leq 1400$ MPa

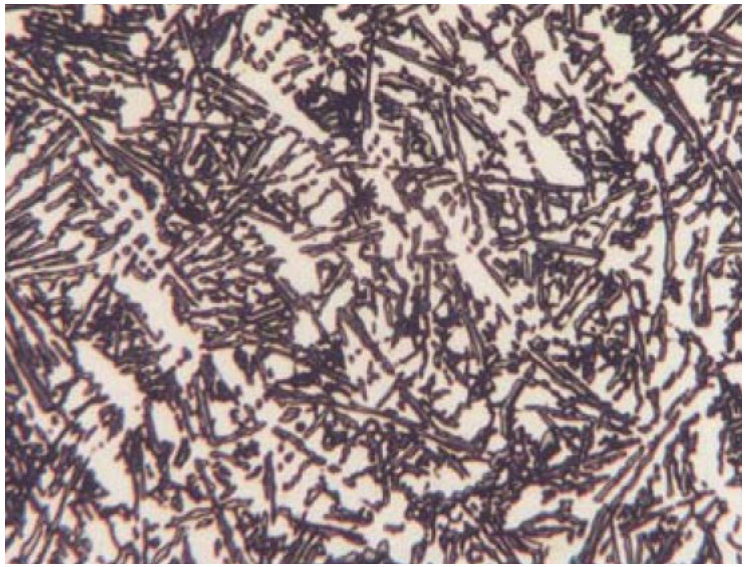


- TVR sportscar crankshaft
  - Steely characteristics



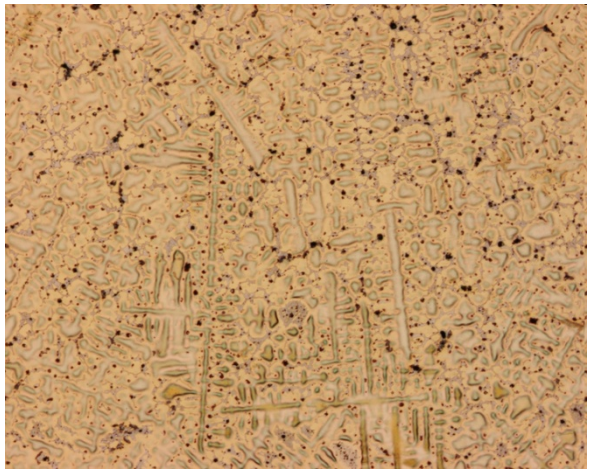
Aluminium alloy

- Aluminium-Silicon (4xxx)
  - Near eutectic (12% Si)
    - Low melting point (576°C)
    - Good fluidity
- BMW integral cross member
  - Good strength-weight ratio
  - Weldable without pre-treatment

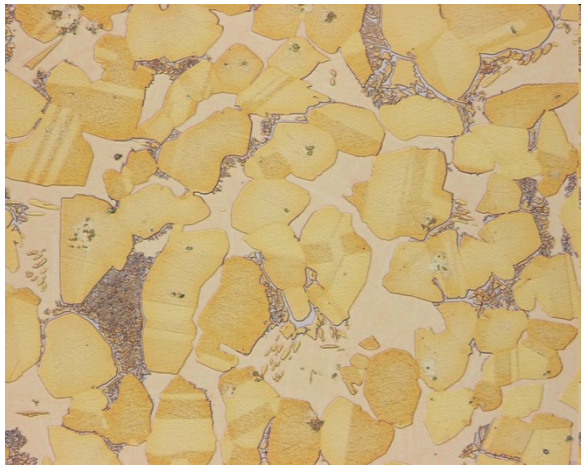


Copper alloy

- Properties
  - Corrosion resistance
  - Good bearing qualities
  - Attractive appearance
- Bronze
  - CuSn
- Brass
  - CuZn
- Red brass (gunmetal)
  - CuZnSn
- Aluminium bronze
  - CuAl

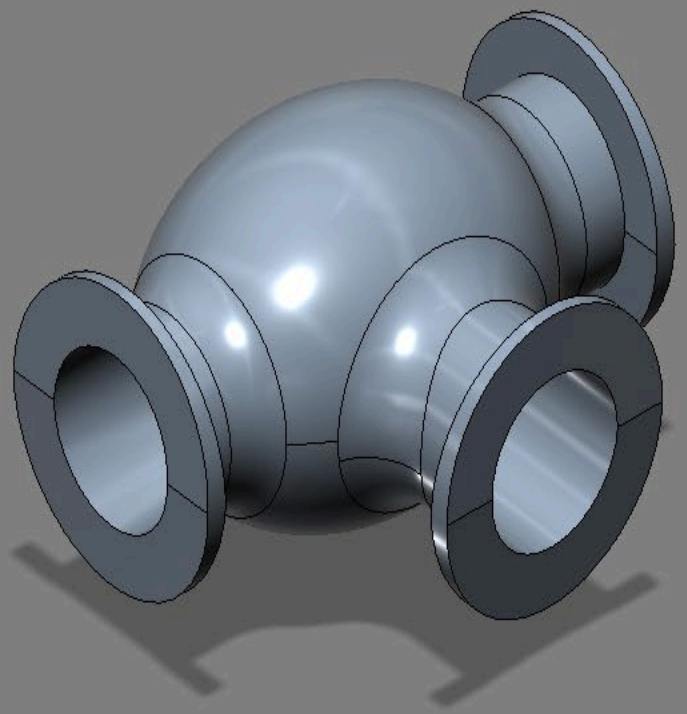


CuSn11 (50:1)

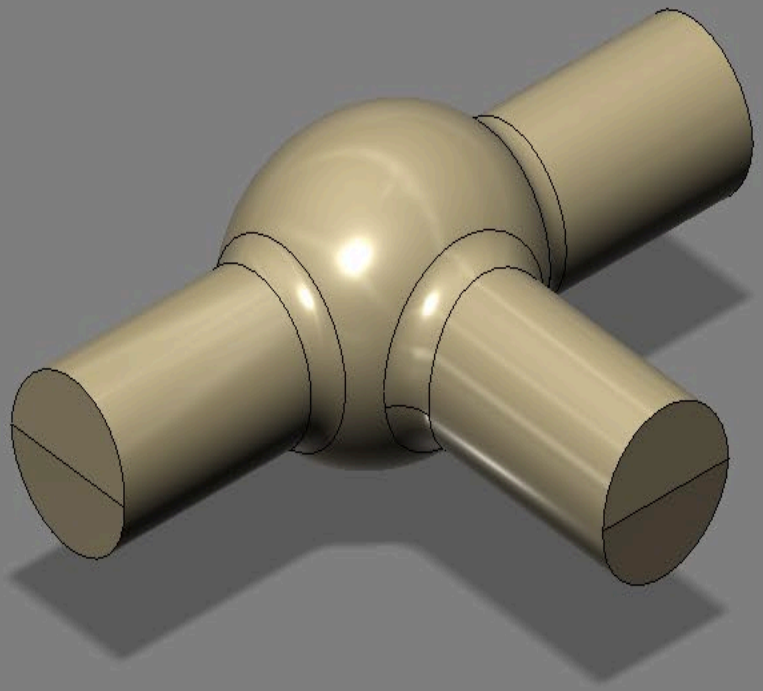


CuAl20 (500:1)

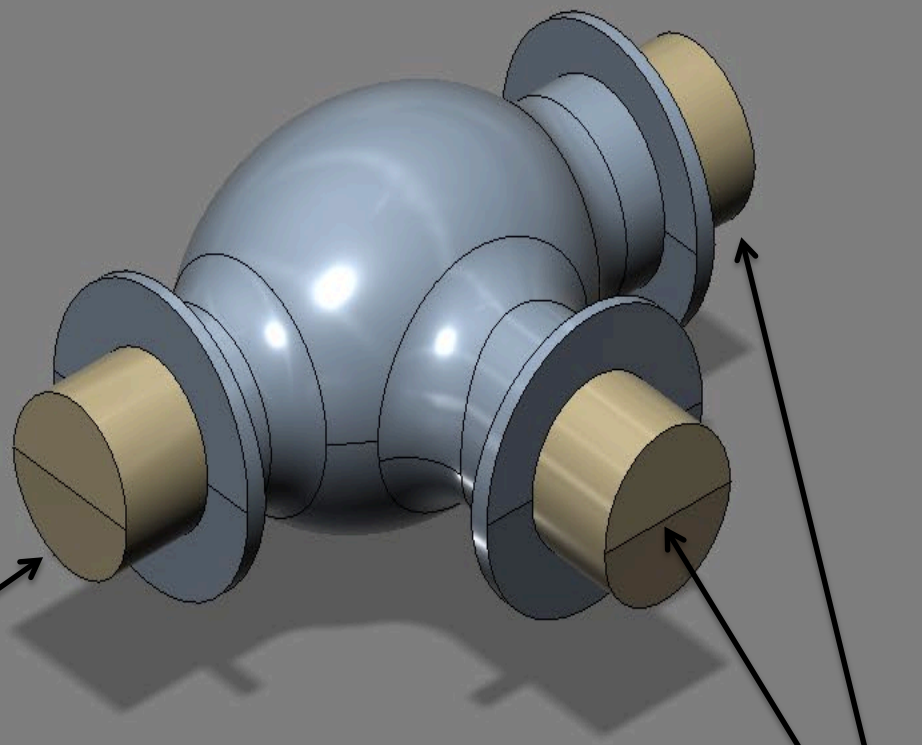
3D-model of a casting



3D-model of the core

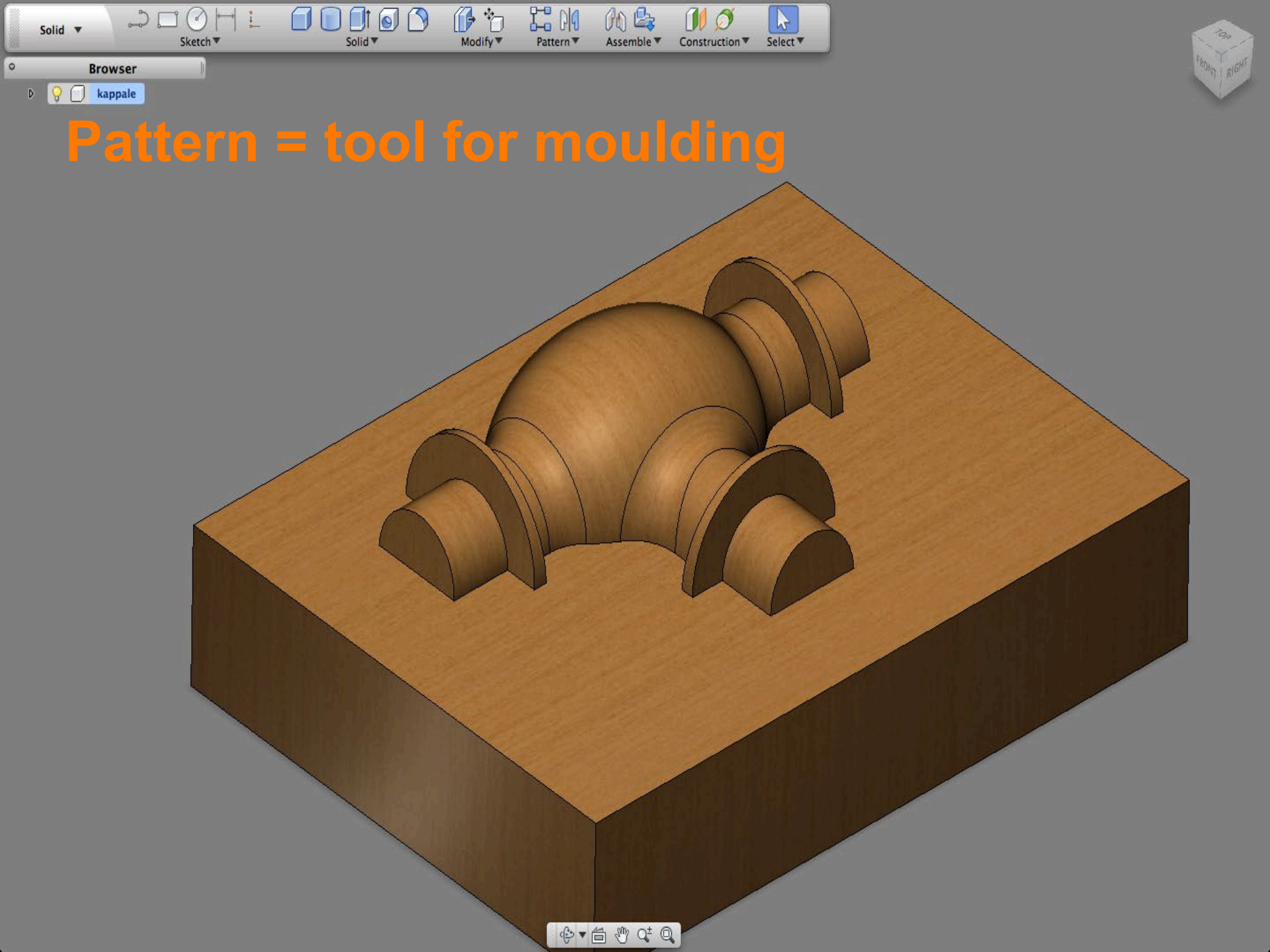


Core forms the inner shapes of the casting

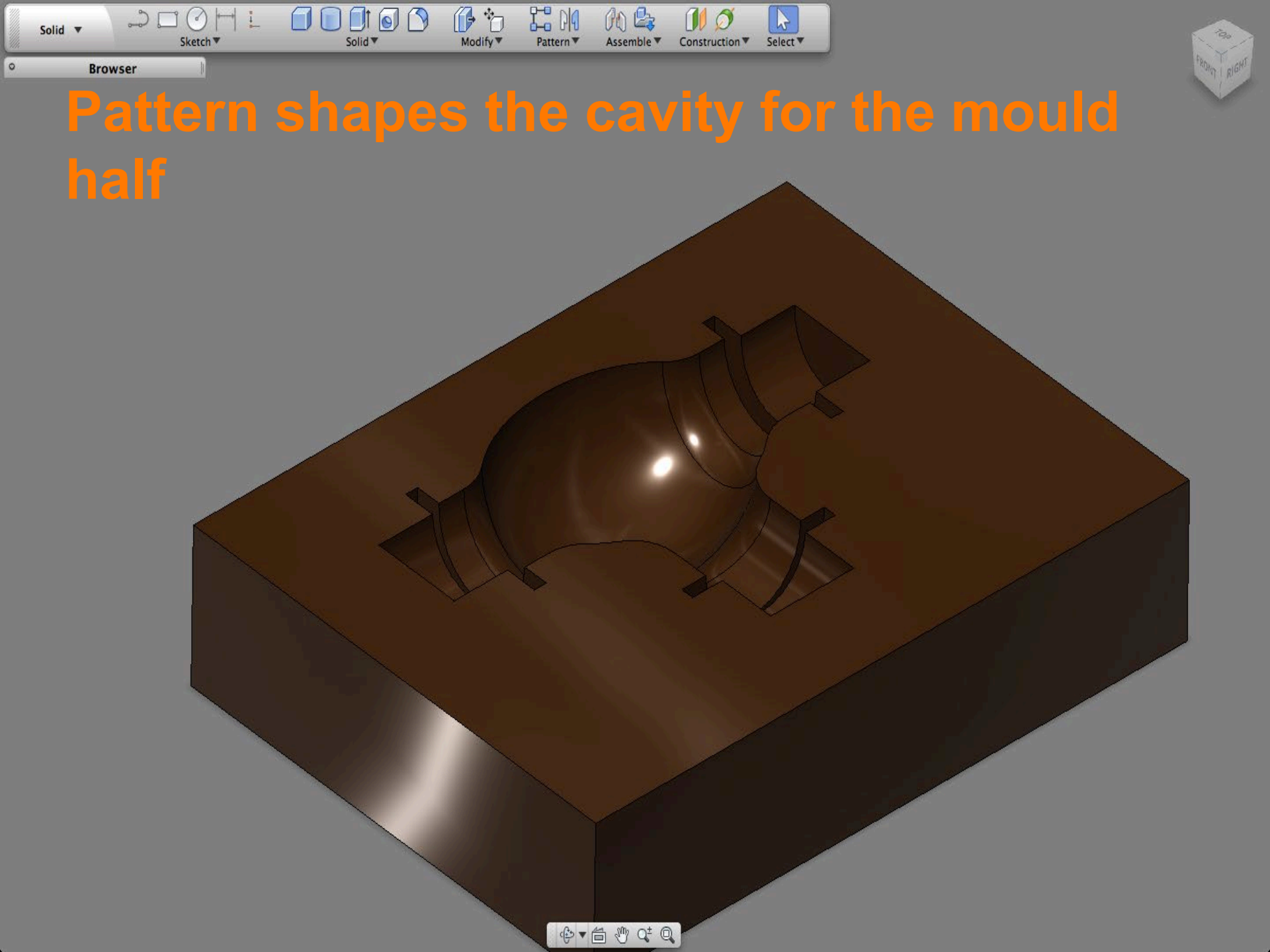


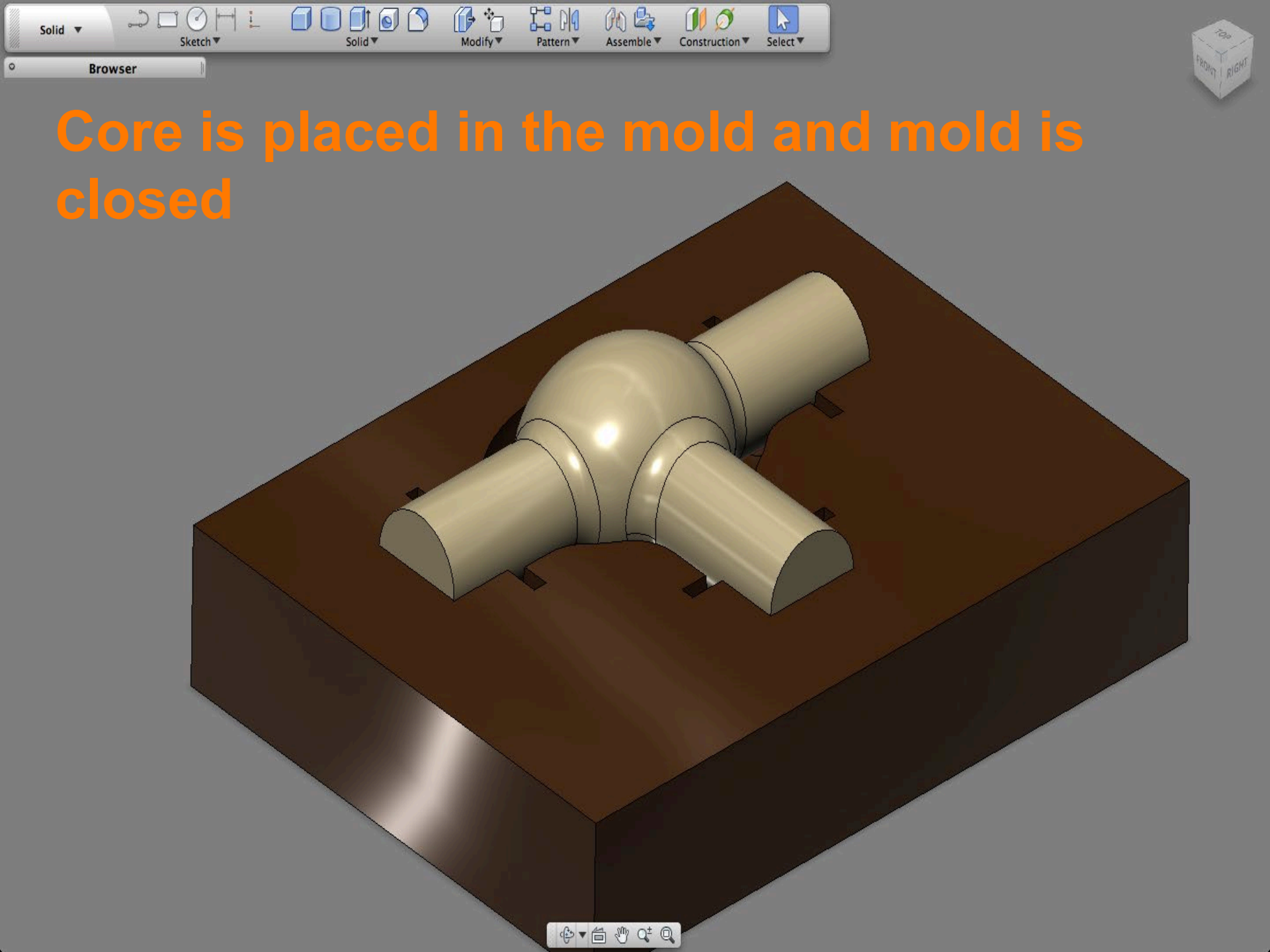
•Core print

•Core prints help the core stay in place between the mold halves


Solid
Sketch
Solid
Modify
Pattern
Assemble
Construction
Select
Browser
kappale
Pattern = tool for moulding

Pattern shapes the cavity for the mould half




Solid
Sketch
Solid
Modify
Pattern
Assemble
Construction
Select
Browser
Core is placed in the mold and mold is closed