What is Forging?

The Forging Foundation

Who is the Forging Foundation?

- The Forging Industry Educational & Research Foundation (FIERF) is a non-profit organization with the mission to advance technology and education on behalf of the North American forging industry.
- The Foundation is a supporting organization of the Forging Industry Association (FIA) headquartered in Cleveland, Ohio.
- FIA membership accounts for approximately 73% of the custom forgings produced in the U.S., Canada and Mexico.
- The association also has members that supply equipment, materials or technical services to the industry.
- The Association, with its predecessor organizations, has served the forging industry since 1913.

www.fierf.org

What is forging?

Forging is one of the oldest known metalworking processes where metal is pressed, pounded or squeezed under great pressure into high strength parts known as forgings.

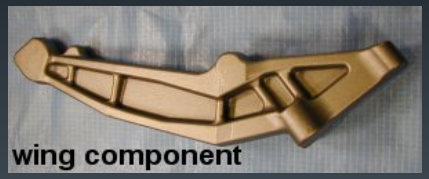
What is forging?

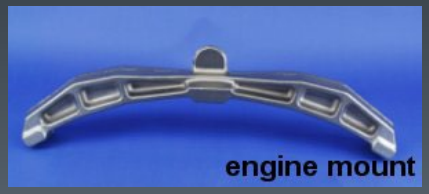
- Forging is a bulk forming process where metal is deformed into shaped components.
- It can be performed cold, warm or hot, with warm and hot forging requiring a preheating operation.
- Input material can be an ingot, billet, bar, wire or preform shape.
- Forging is a solid-state process (unlike casting, where the metal is melted and poured).
- It is also a constant volume process (unlike machining or welding).

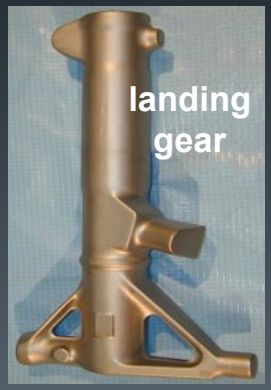
Why are forgings important?

Forged parts are strong and reliable and therefore, vital in safety critical applications. Rarely seen by consumers, forgings are normally component parts inside assemblies. If it moves on land, in the air, or on the sea, it contains forgings.

Forging Applications Aerospace



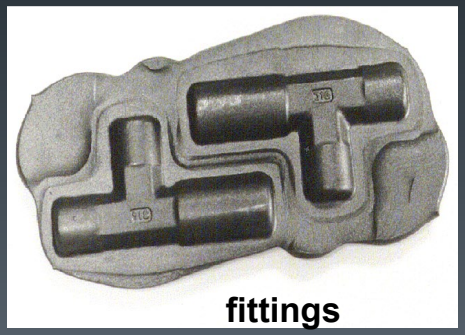




Forging Applications Transportation

Forging Applications Energy

valves

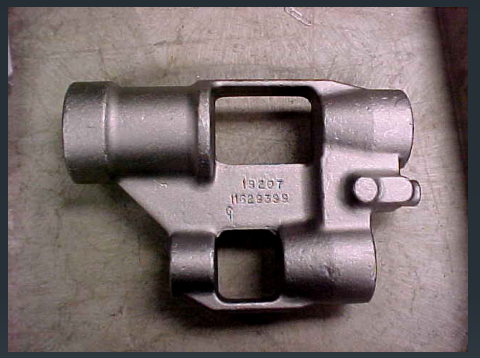


fittings

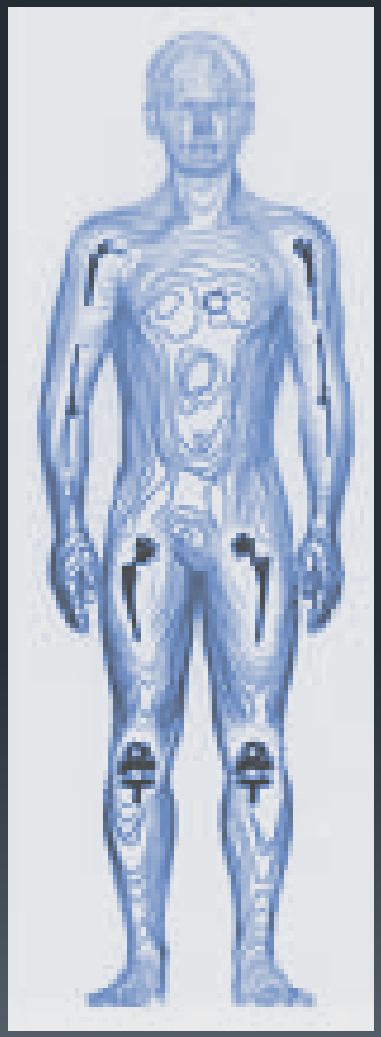
impellers

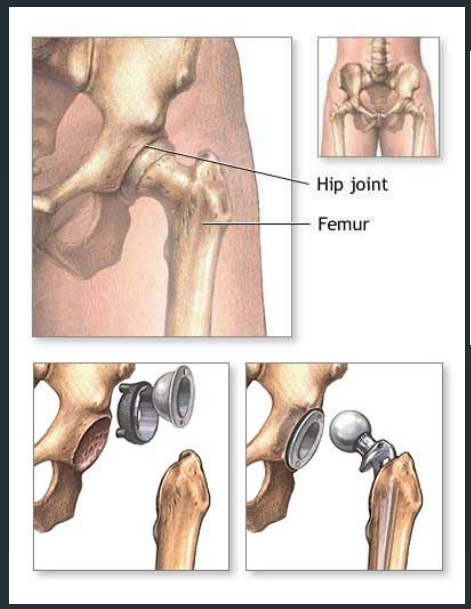
Courtesy Ellwood Texas Forge & SSP

Forging Applications Defense

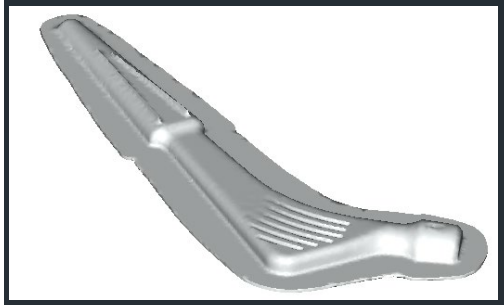


Forging Applications Medical

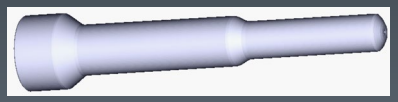




implants



pins & screws



Forging Applications Miscellaneous

therapy

tools

safety devices

hydraulics

What are the benefits of forging?

- Forgings are necessary in critical service applications, where superior mechanical properties are required.

  strength

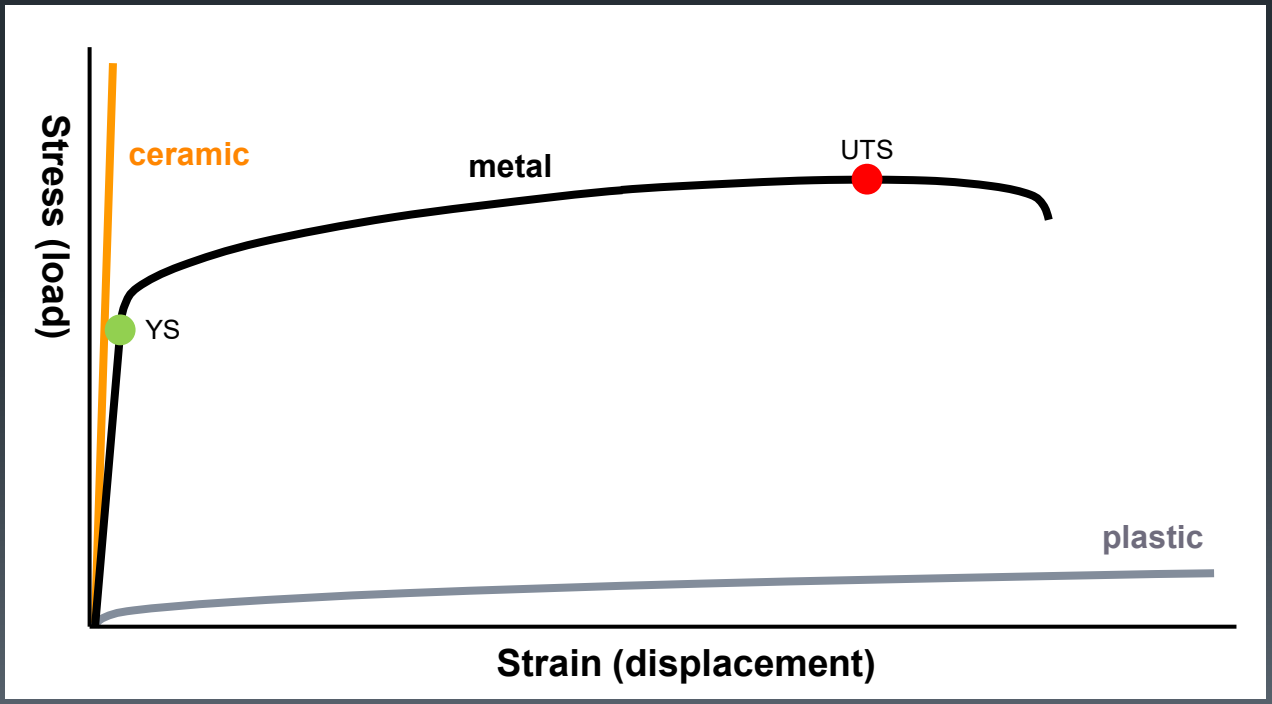
  toughness

  fatigue resistance

- Forgings are not commodities – they are highly engineered products designed for critical applications.

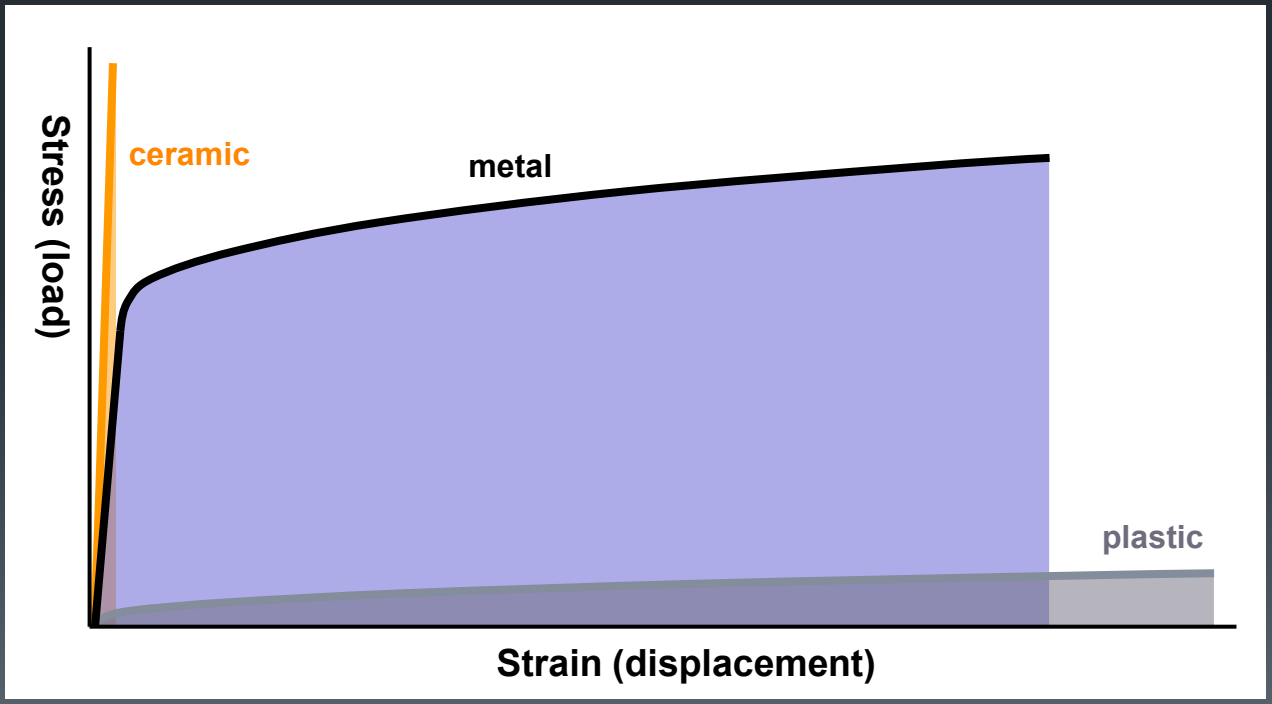
Strength

- Strength is the ability to bear load without failure.
- Yield strength (YS) measures failure due to the onset of permanent, plastic deformation.
- Tensile strength (UTS) measures failure due to fracture.



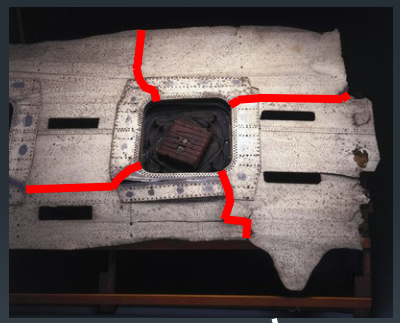
Toughness

- Toughness is the ability to absorb deformation energy without fracturing.
- Materials with low impact resistance are brittle.
- Materials with high impact resistance are ductile.



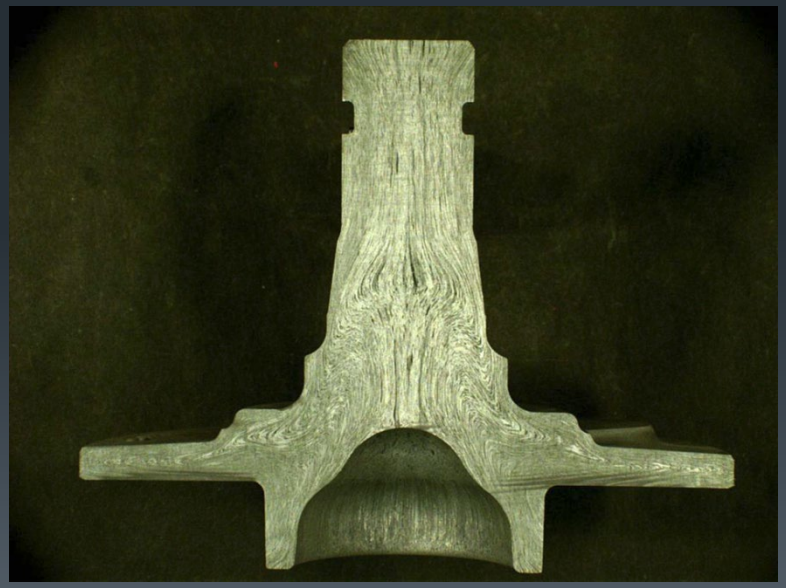
Fatigue Resistance

- Fatigue Resistance is the ability to not fracture under repeated or cyclic loading.
- Rotating parts are most susceptible to fatigue failures.
- Fatigue resistance is controlled by the metal alloy, strength and ductility.



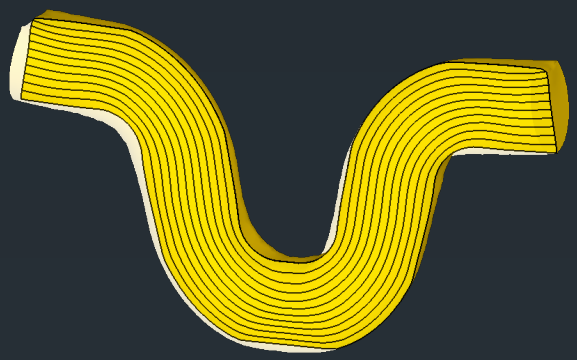
Grain Flow

- Grain flow is the directional orientation of metal grains after forging.
- Mechanical properties vary due to the grain orientation.
- Grain flow in forgings is influenced by the process and design.
- The directional properties produced by grain flow can enhance the service life of a part.

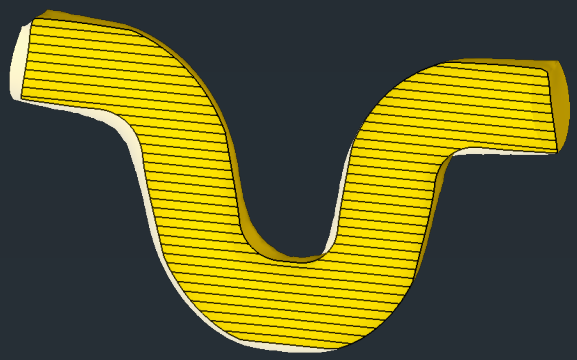


Courtesy HHI Forgings & Ellwood Texas Forge

Grain Flow



FORGING
True grain flow



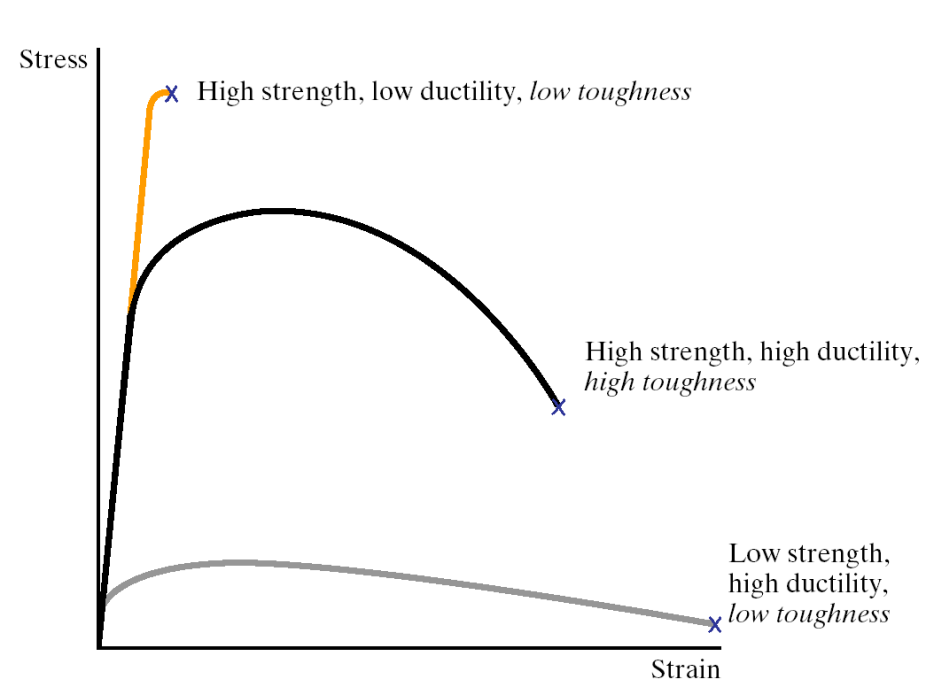
BAR STOCK
Grain flow broken by machining

CASTING
No grain flow

Grain orientation varies between processes.
A forging provides *optimized* grain flow within a part.
A machined part may have *broken* grain flow.
A casting has a *random* grain orientation.

Heat Treatment

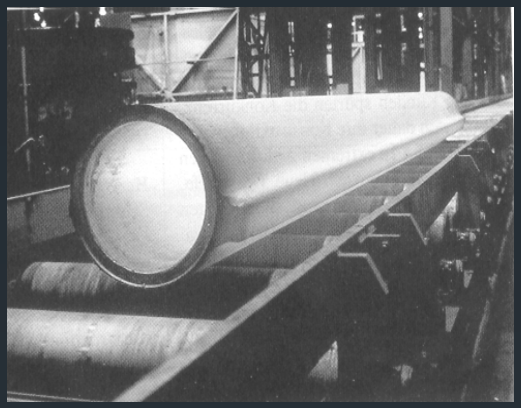
- For a given metal, the properties are frequently optimized to meet service requirements.
- Strength and ductility of a specific metal alloy are a trade-off, controlled by processing and heat treatment.



Courtesy - Shackelford - Introduction to Materials Science and Engineering

Forging Processes

hot forging



hot extrusion

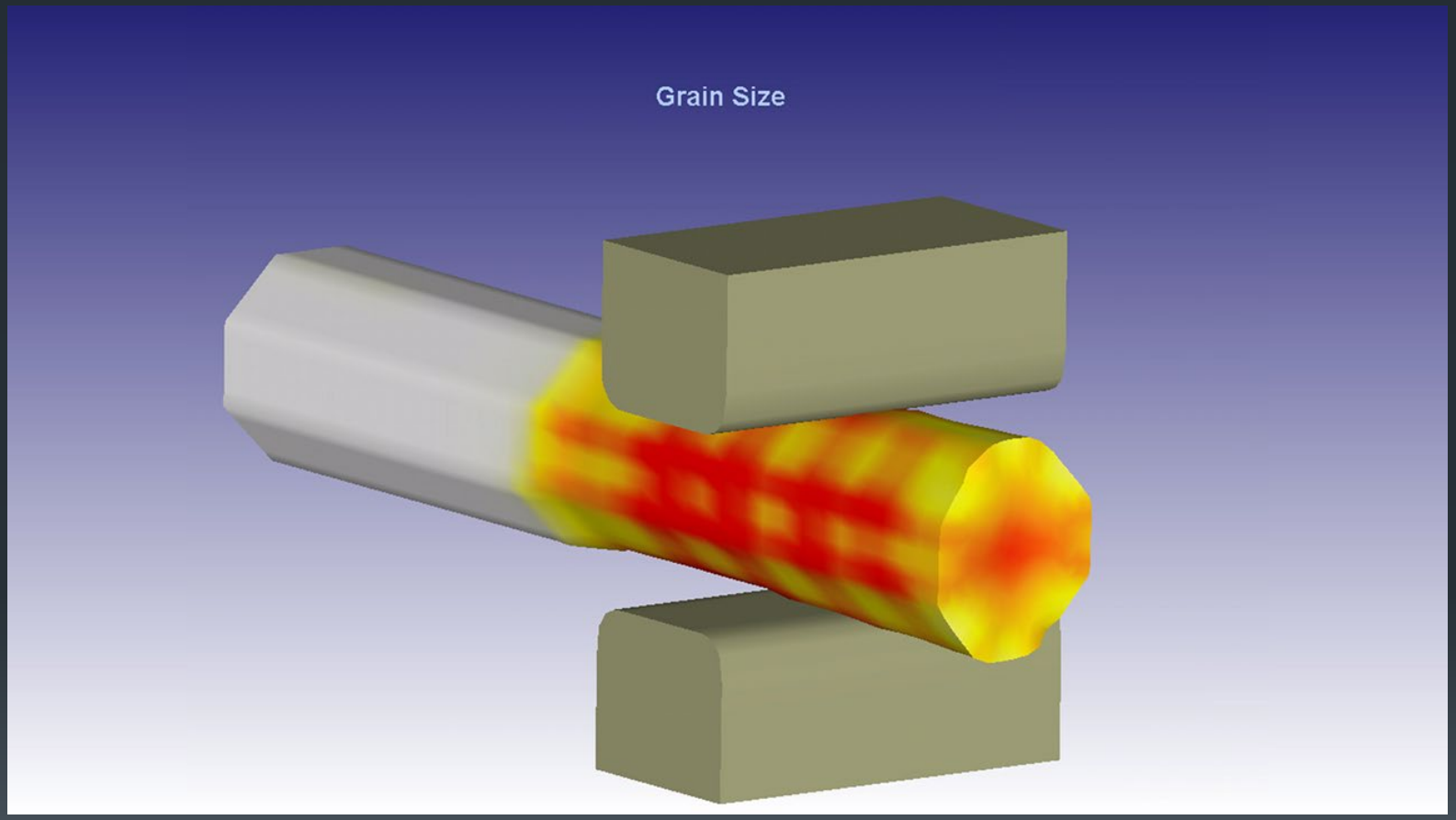
rolled ring

precision cold forming

coined forging

The Manufacturing Cycle

Open Die Forging



Open die forging processes, such as the cogging process shown here, are used reshape and refine cast ingot.

Closed Die Forging

- A finite-element simulation of a forging is shown at right.
- This forging is produced on a hammer in multiple blows.
- The forging obtains its shape through a series of progressively more detailed die cavities.

Courtesy Delfasco Forge

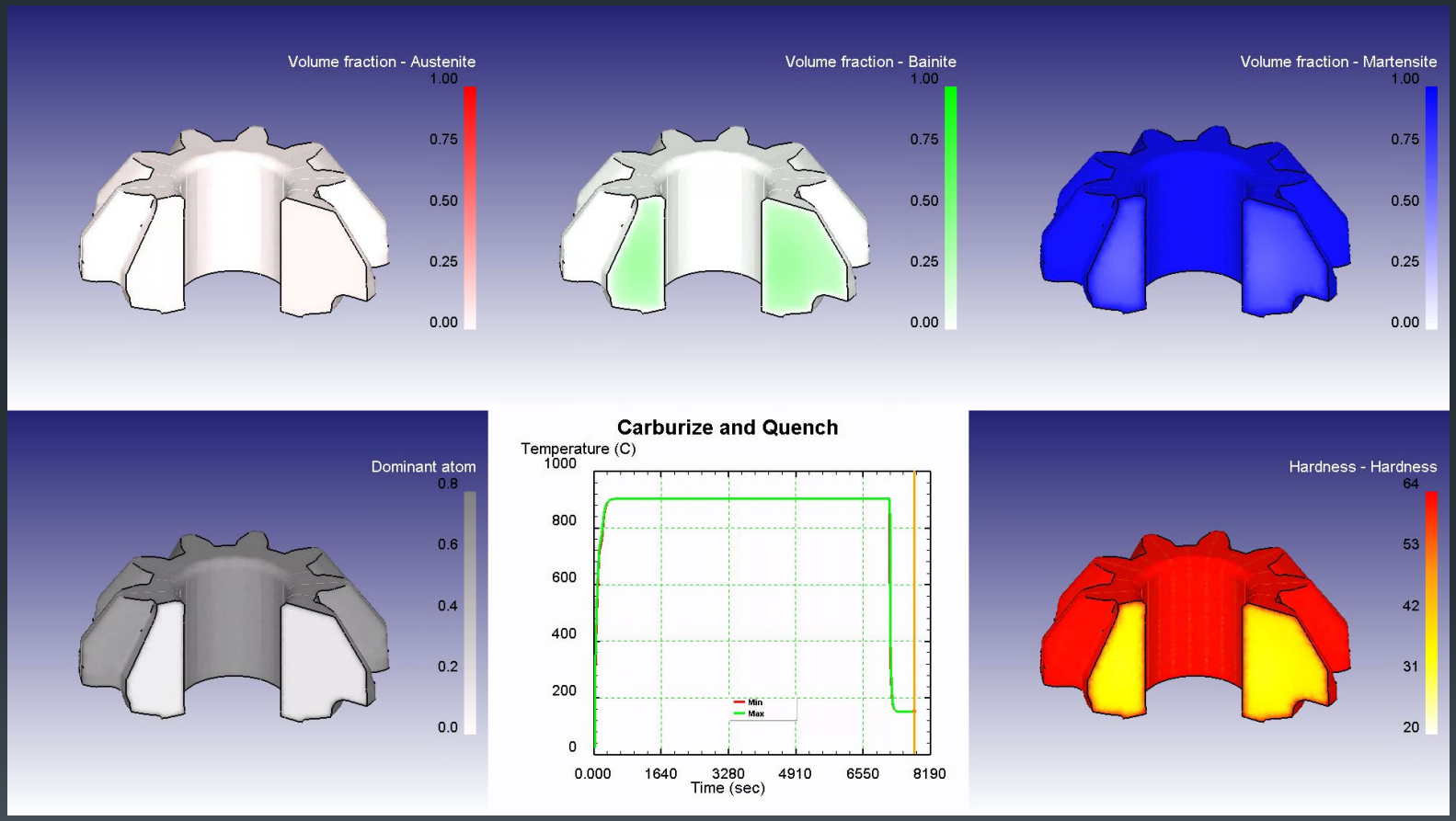
Closed Die Forging

This hammer forging video shows a typical steel forging process. Multiple hits (forging operations) in multiple die cavities are common.

Closed Die Forging

Automated press lines are used to produce a wide range of closed die forgings with excellent process control and production rates.

Heat Treatment



Forgings are subsequently heat treated to obtain the desired mechanical properties important to final part performance.

Forging Careers

- Management
- Metallurgist
- Tool/Die designer
- Simulation analyst
- Computer programmer
- Manufacturing engineer
- Quality assurance (QA) engineer
- Equipment operators

Forging Careers

The Forging Foundation

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