Production drawings, design concepts, material selection

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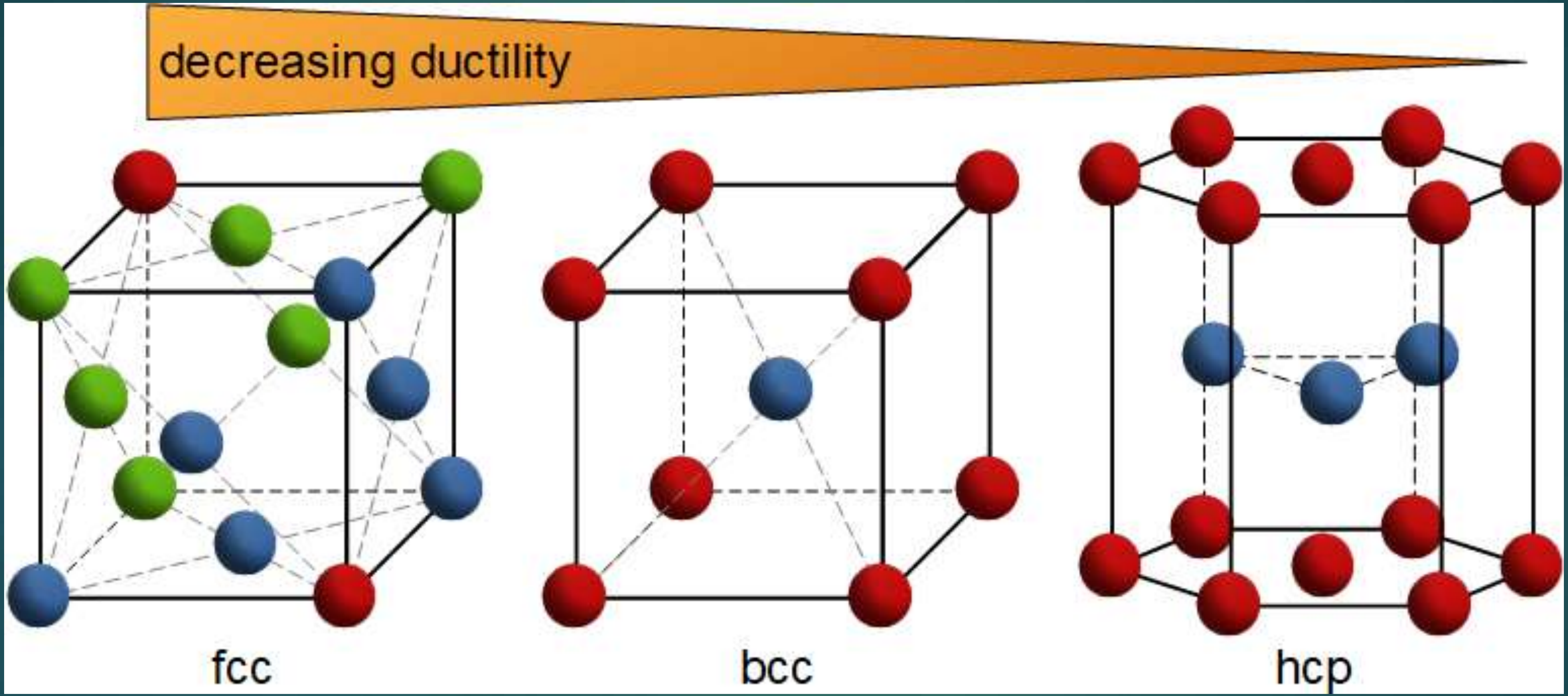


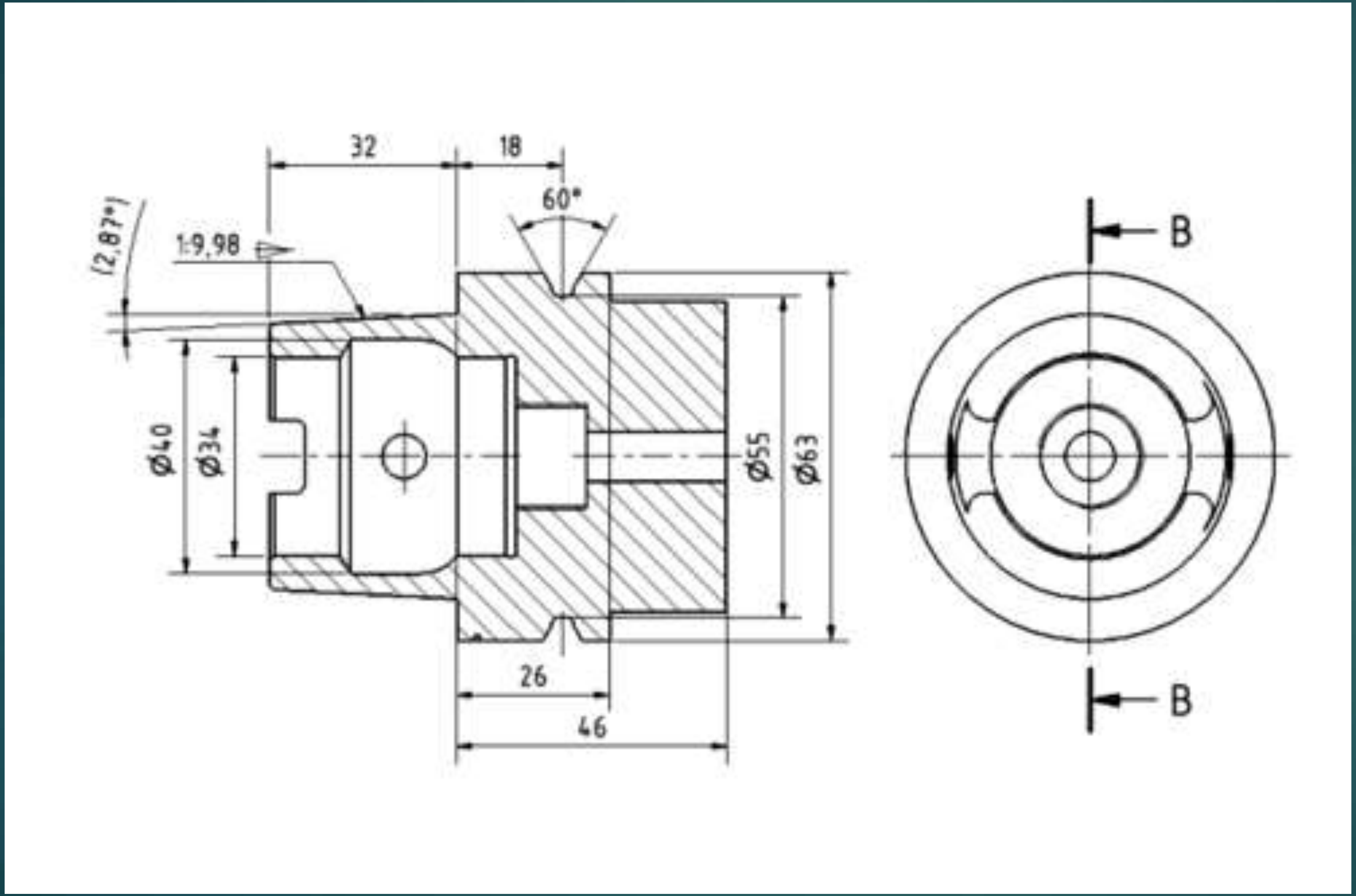
Learning Objective

- Introduction to Materials
- Introduction to structure of the materials

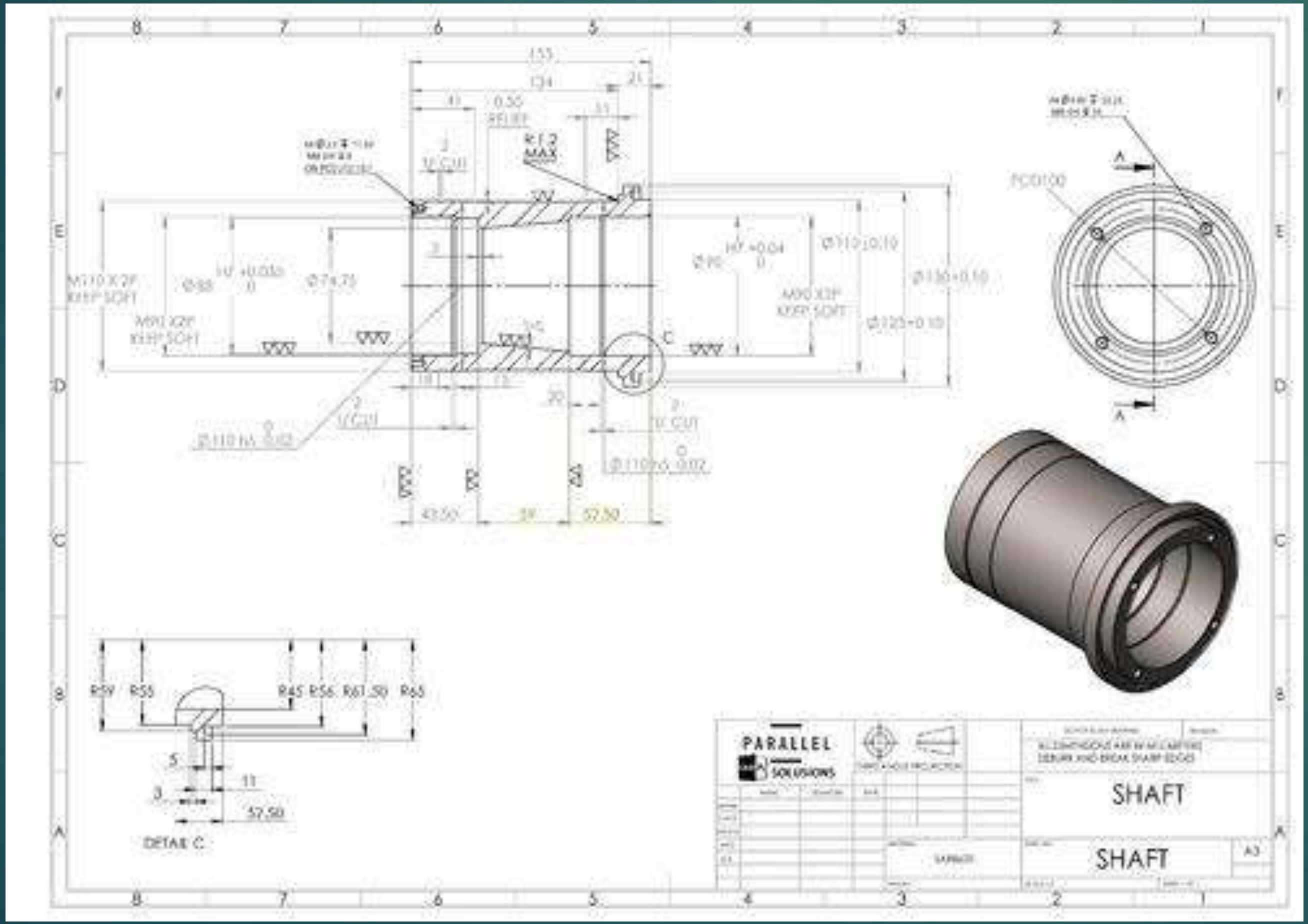
Production Drawings

- **Production drawings** (sometimes called working **drawings**) are complete sets of **drawings** that detail the **manufacturing** and assembly of products (as distinct from engineering **drawings** prepared by and/or for **production** engineers whose task is to decide how best to manufacture the products).

Production Drawings



Production Drawings



Design Concept

- A design concept is the idea behind a design.
- It's how one plans on solving the design problem in front of oneself.
- It's the underlying logic, thinking, and reasoning for how one will design a product.

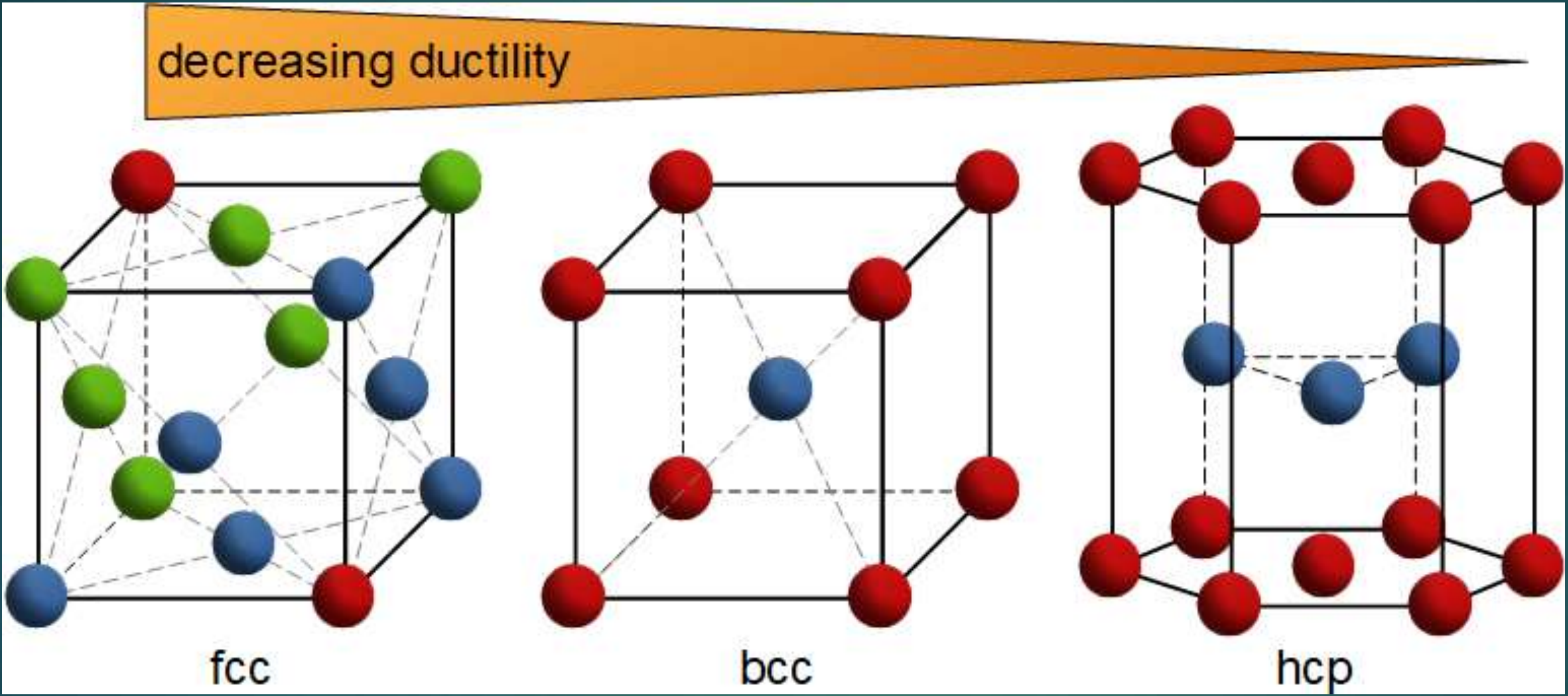
Engineering Materials

- This section summarizes how atomic structure, bonding, and crystal structure (or absence thereof) are related to the type of engineering material: metals, ceramics, and polymers.

Engineering Materials

- **Metals** have crystalline structures in the solid state, almost without exception.
- The unit cells of these crystal structures are almost always BCC, FCC, or HCP.
- The atoms of the metals are held together by metallic bonding, which means that their valence electrons can move about with relative freedom (compared with the other types of atomic and molecular bonding).

Decreasing Ductility



Face-centered-cubic (fcc) configuration

- Solid copper can be described as the arrangement of copper atoms in a face-centered-cubic (fcc) configuration. A copper atom is found at each corner and in the center of each face of a cube as depicted in the Figure.

HCP, FCC and BCC structures

- The hexagonal closest packed (**hcp**) has a coordination number of 12 and contains 6 atoms per unit cell.

HCP, FCC and BCC structures

- The **face-centered cubic (fcc)** has a coordination number of 12 and contains 4 atoms per unit cell.
- The body-centered cubic **(bcc)** has a coordination number of 8 and contains 2 atoms per unit cell

Engineering Materials

- These structures and bonding generally make the metals strong and hard. Many of the metals are quite ductile (capable of being deformed, which is useful in manufacturing), especially the FCC metals.
- Other general properties of metals related to structure and bonding include high electrical and thermal conductivity, opaqueness (impervious to light rays), and reflectivity (capacity to reflect light rays).

Ceramics

- Ceramic molecules are characterized by ionic or covalent bonding, or both.
- The metallic atoms release or share their outermost electrons to the nonmetallic atoms, and a strong attractive force exists within the molecules.
- The general properties that result from these bonding mechanisms include high hardness and stiffness (even at elevated temperatures) and brittleness (no ductility).
- The bonding also means that ceramics are electrically insulating (nonconducting), refractory (thermally resistant), and chemically inert.

Ceramics

- Ceramics possess either a crystalline or noncrystalline structure. Most ceramics
- have a crystal structure, whereas glasses based on silica (SiO_2) are amorphous.
- In certain cases, either structure can exist in the same ceramic material.
- For example, silica occurs in nature as crystalline quartz.

Ceramics

- When this mineral is melted and then cooled, it solidifies to form fused silica, which has a noncrystalline structure.

Polymers

- **Polymers** A polymer molecule consists of many repeating ***mers*** to form very large molecules held together by covalent bonding.
- Elements in polymers are usually carbon plus one or more other elements such as hydrogen, nitrogen, oxygen, and chlorine.
- Secondary bonding (van der Waals) holds the molecules together within the aggregate material (intermolecular bonding).
- Polymers have either a glassy structure or mixture of glassy and crystalline.

Polymers

- There are differences among the three polymer types. In ***thermoplastic polymers***, the molecules consist of long
- chains of mers in a linear structure.

Polymers

- These materials can be heated and cooled without substantially altering their linear structure.
- In ***thermosetting polymers***, the molecules transform into a rigid, three-dimensional structure on cooling from a heated plastic condition.
- If thermosetting polymers are reheated, they degrade chemically rather than soften.
- ***Elastomers*** have large molecules with coiled structures.
- The uncoiling and recoiling of the molecules when subjected to stress cycles motivate the aggregate material to exhibit its characteristic elastic behavior.

Polymers

- The molecular structure and bonding of polymers provide them with the following typical properties: low density, high electrical resistivity (some polymers are used as insulating materials), and low thermal conductivity.
- Strength and stiffness of polymers vary widely.
- Some are strong and rigid (although not matching the strength and stiffness of metals or ceramics), whereas others exhibit highly elastic behavior.

Numerical Problem

A GO/NO GO plug gage is designed to check a hole diameter that is dimensioned 20.00 mm $\pm$ 0.10 mm. A wear allowance of 2.5% of the total tolerance band is applied to the GO side of the gage. Determine the nominal sizes of the GO and NO GO sides of the gage.

Solution

Solution: The total tolerance band = 0.10 + 0.10 = 0.20 mm. The wear allowance = 0.025(0.20) = 0.005 mm. The GO gage is used to check the minimum acceptable hole diameter, which is 20.00 − 0.10 = 19.90 mm. Because this is the surface that will wear, the wear allowance is applied to it. Accordingly, the nominal size of the GO gage = 19.90 + 0.005 = 19.905 mm.

The NO GO gage is used to check the maximum hole diameter. Because insertion of the gage will occur only in an out-of-tolerance situation, its wear should be negligible. Therefore, the nominal size of the NO GO gage = 20.00 + 0.10 = 20.10 mm.


Thank you