Design Consideration for castings

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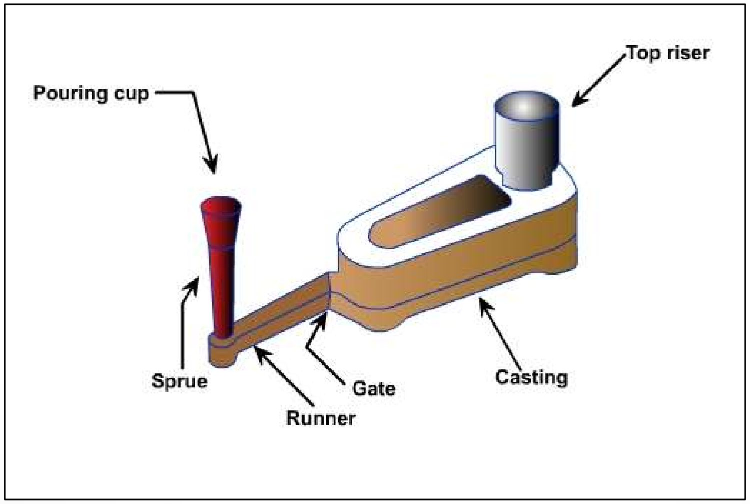
Introduction

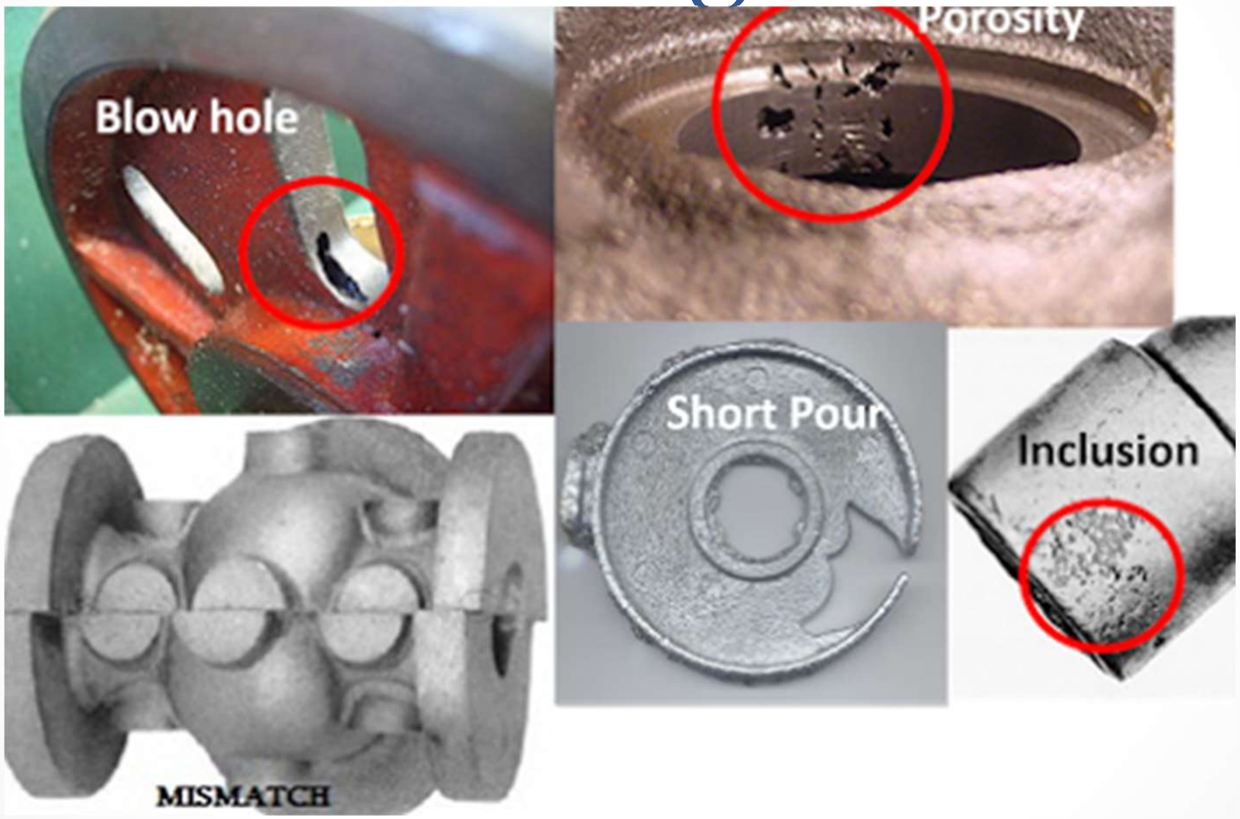
- Variables in Casting process: characteristics of the metals (or alloys) casts, method of casting, mold/die materials, mold/die design.
- The **flow** of the molten metal in the mold cavities, the **gating** systems, the **rate** of cooling, and the **gases** evolved all influence the quality of a casting.



Design Considerations in Casting

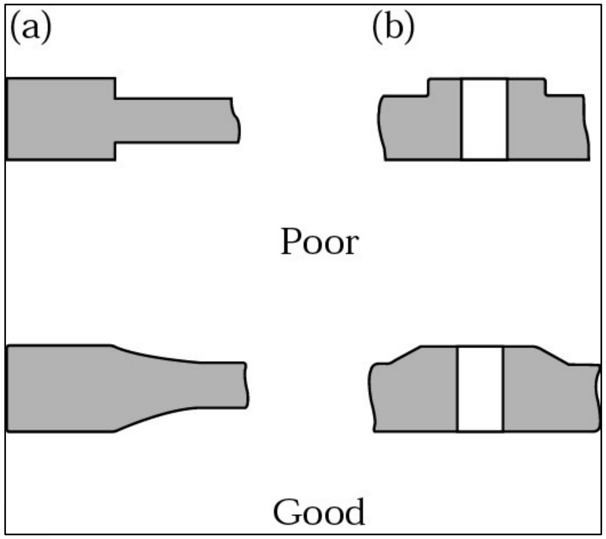
1. Design the part so that the shape is cast easily.
2. Select a casting process and material suitable for the part, size, mechanical properties, etc.
3. Locate the parting line of the mold in the part.
4. Locate and design the gates to allow uniform feeding of the mold cavity with molten metal.
5. Select an appropriate runner geometry for the system.
6. Locate mold features such as sprue, screens and risers, as appropriate.
7. Make sure proper controls and good practices are in place.

Why design considerations for casting?



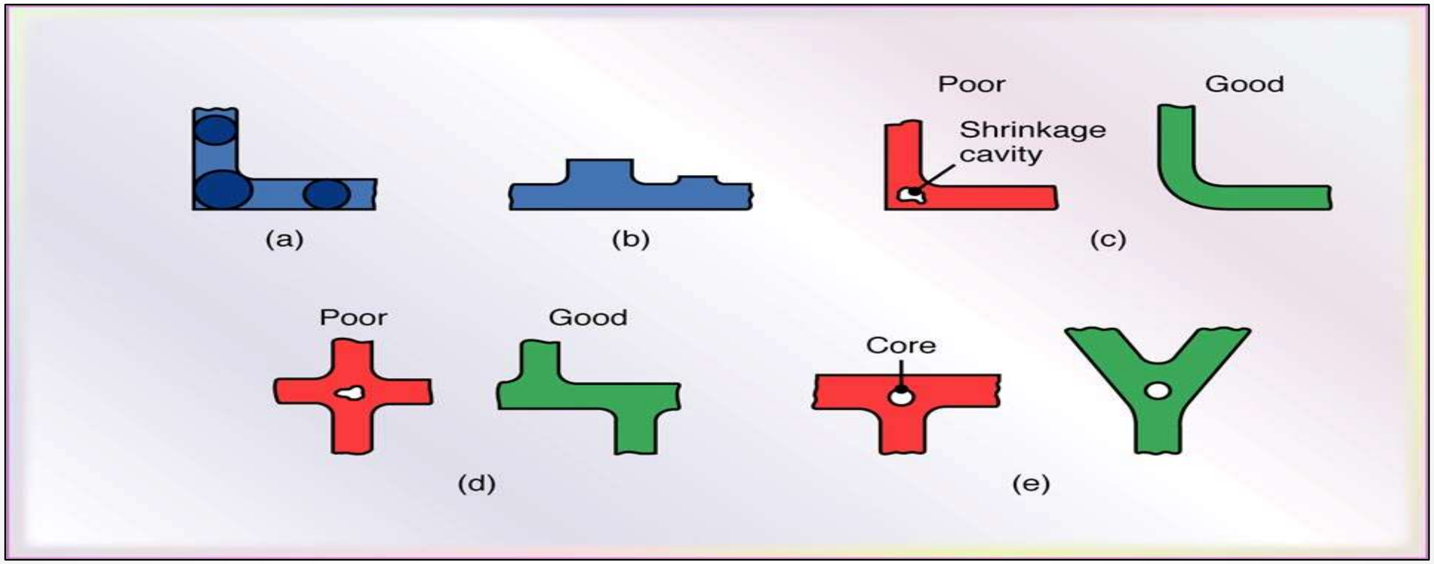
Design Considerations in Casting

- **Corners, angles and section thickness**: avoid using sharp corners and angles (act as stress raisers) and may cause cracking and tearing during solidification. Use fillets with radii ranging from 3 to 25 mm



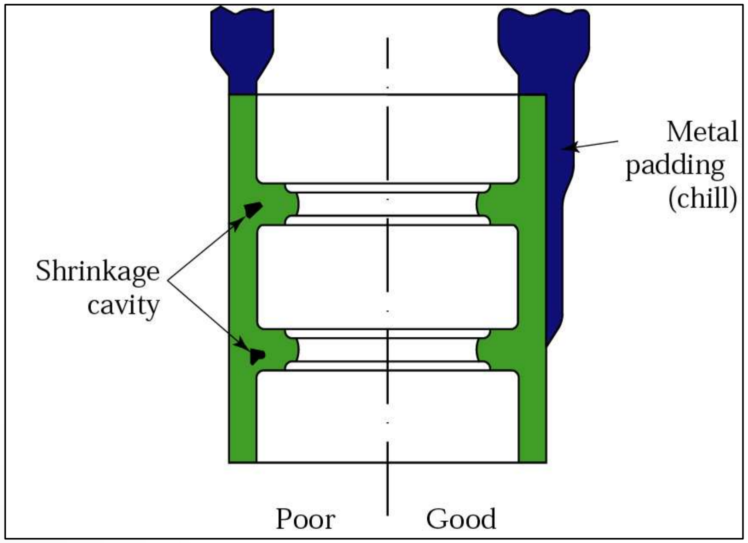
Design Considerations in Casting

- Sections changes in castings should be blended smoothly into each other.
- Because the cooling rate in regions with large circles is lower, they are **called hot spots**.
- Cavities at hot spots can be eliminated by using small cores (e).



Design Considerations in Casting

•It is important to maintain (as much as possible) uniform cross sections and wall thicknesses throughout the casting to avoid or minimize shrinkage cavities. Metal chills in the mold can eliminate or minimize hot spots.



The use of metal padding (chills) to increase the rate of cooling in thick regions in a casting to avoid shrinkage cavities

Design Considerations in Casting

- **Draft:** a small draft (taper) typically is provided in sand mold pattern to enable removal of the pattern without damaging the mold. Depending on the quality of the pattern, draft angles usually range from 0.5^o to 2^o.
- **Dimensional tolerances:** tolerances should be as wide as possible, within the limits of good part performance; otherwise, the cost of the casting increases. In commercial practices, tolerances are usually in the range of ± 0.8 mm for small castings. For large castings, tolerances may be as much as ± 6 mm.

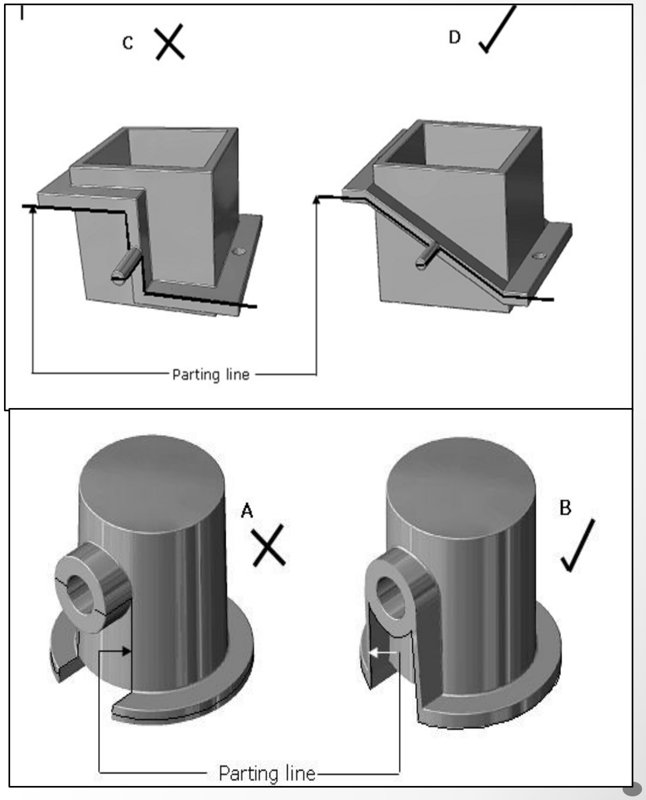
Design Considerations in Casting

- **Lettering and markings:** it is common practice to include some form of part identification (such lettering or corporate logos) in castings. These features can be sunk into the casting or protrude from the surface.

- **Machining and finishing operations:** should be taken into account. For example, a hole to be drilled should be on a flat surface not a curved one. Better yet, should incorporate a small dimple as a starting point. Features to be used for clamping when machining.

Design Considerations in Casting - Locating the parting line

- A part should be oriented in a mold so that the large portion of the casting is relatively lower and the height of the casting is minimized.
- The parting line is a line or a plane separating the upper (cope) and lower (drag) halves of mold. In general, the parting line should **be along a flat plane** rather than be contoured.
- The parting line should be placed as low as possible relative to the casting for less dense metal (such as aluminum alloys) and located at around mid-height for denser metals (such as steels).



Design Considerations in Casting - Locating the parting line

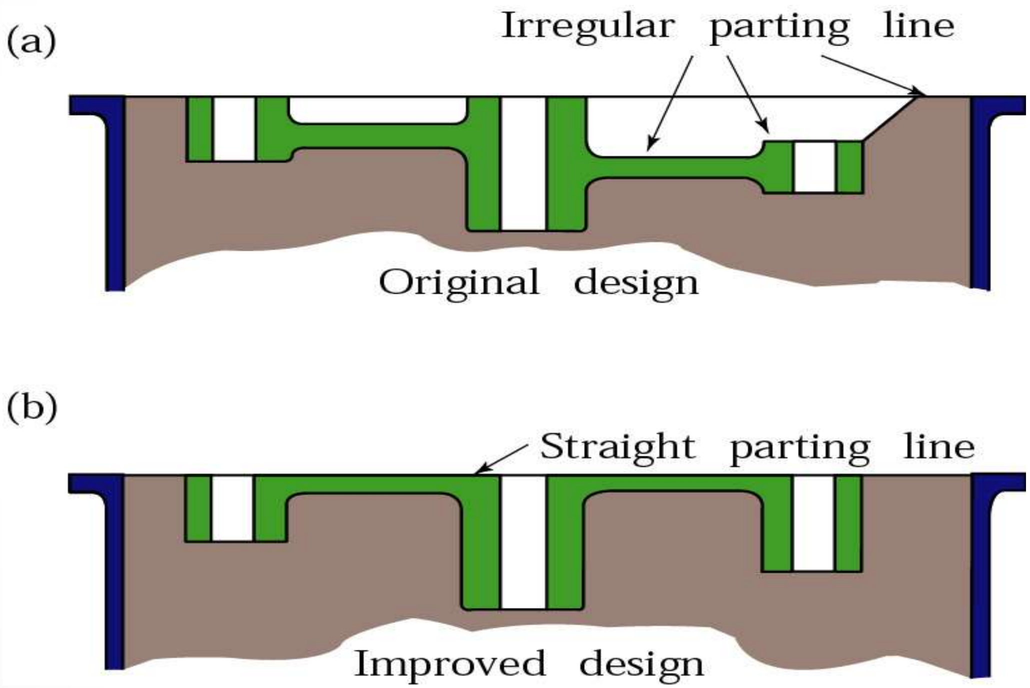
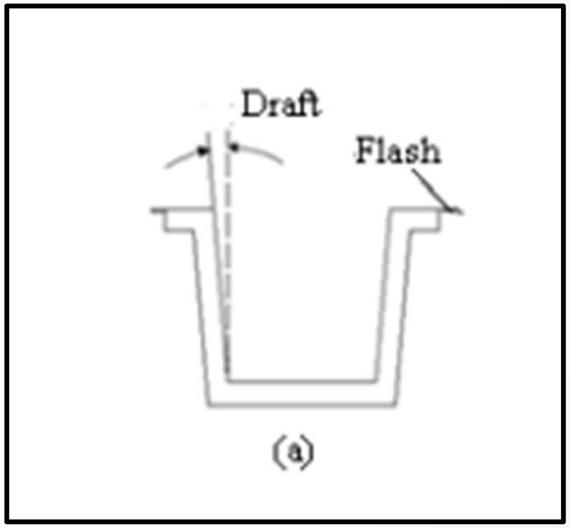


Figure 12.5 Redesign of a casting by making the parting line straight to avoid defects.

Factors affecting selection of parting direction and parting line

- **Draft**- To facilitate removal of manufactured component from mould the cross-sectional area should gradually decrease from the parting surface in parting direction.
- Necessary draft has to be applied to the part in the parting direction if the projected area does not decrease on the parting direction.
- An optimal parting direction and line will have minimum possible draft.



Factors affecting selection of parting direction and parting line

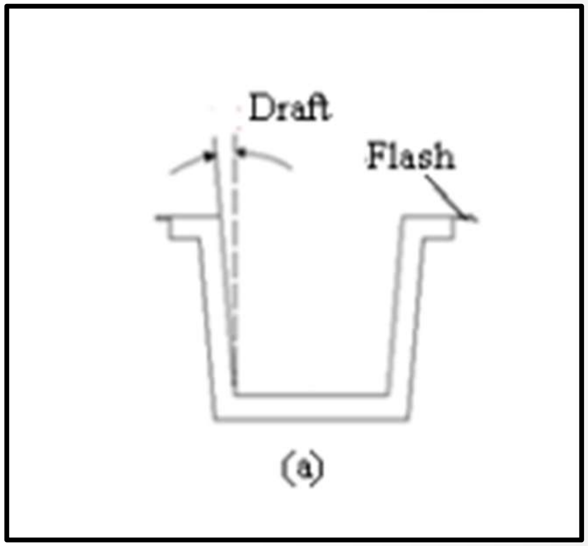
- **Flash-** Material flowing into gaps at the plane of separation of the two mould halves produces fin like protrusions or flash and is treated as imperfection.

- This is generally trimmed after manufacturing. For optimal parting direction and parting line the flash must be less and easy to trim.

- **Flatness-** The selection of the parting direction should ensure the flatness of the parting line.

- A flat parting line alone can take care of the other aspects like side thrust, dimensional stability, sealing off, flash etc.

- The complexity of a non-flat parting line should be minimum possible



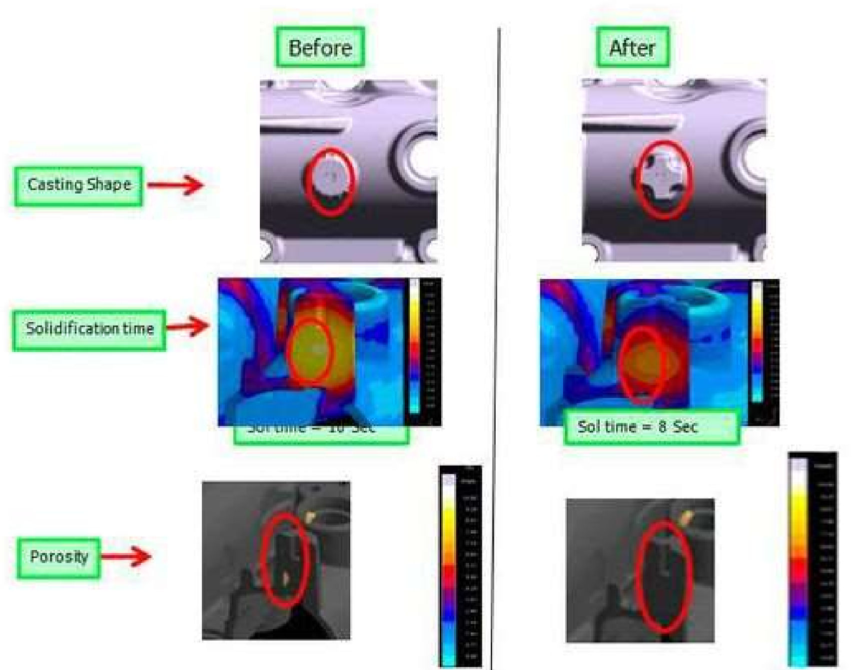
Decision criteria for parting line selection

- Factors affecting parting line selection are rated according to high, medium and low priority.
- The criteria with high priority are number of undercuts, draft, projected area and dimensional stability.
- Criteria with medium priority are draw, flash, flatness and placement of ejector pins.
- The criteria with low priority are side thrust, placement of overflow wells, trimming and finishing operations, scrap generated.

Change in Parting Line

The example shown in figure indicates the effect of Air Pressure in the cavity before (~3.8 bar) and after changing the parting line (~1.8 bar) in the product design. The customer requirement was porosity level 1 as per ASTM E 505.

Source: ALUCAST India

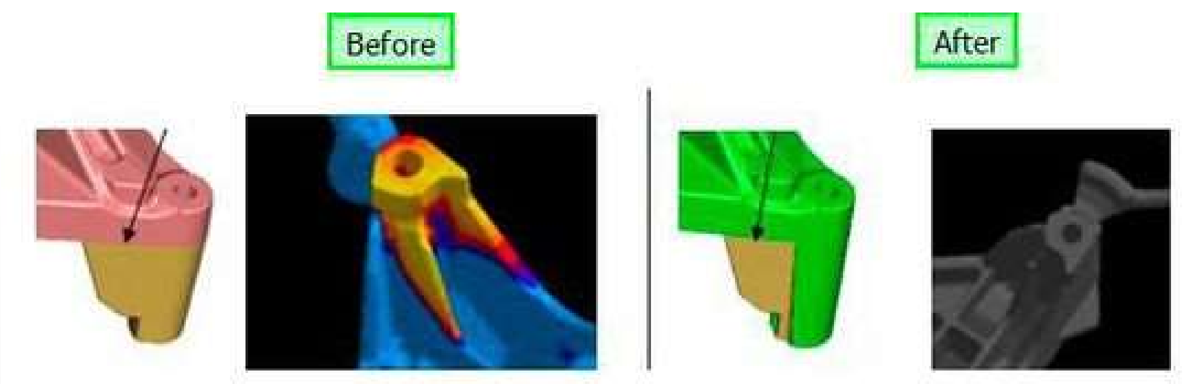


Solidification Time – Before (10 Sec) and after (8 Sec) change in shape of the boss

Additional rib for providing material flow

The following example indicates how the addition of ribs change the filling pattern and sudden change in cross section to improve the material filling and reduce the air pressure in the cavity. This has helped to reduce the cold fill and shrink porosity.

Source: ALUCAST India



Air Pressure – Before (3.8 bar) and after 1.8 bar) change in parting line near the boss.