Collaborative Engineering

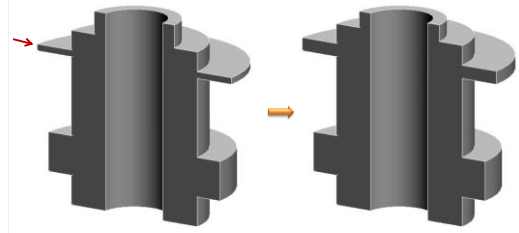
DFM Rules

- Design for Casting
- Design for Molding
- Design for Forming
- Design for Machining

OrthoCAD Lab, I.I.T. Bombay

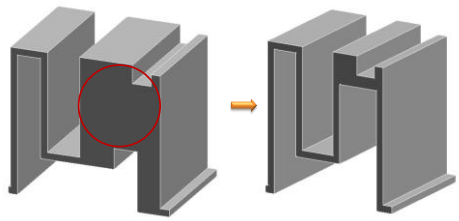
Casting DFM – Thin Walls

- **Issue:** Isolated thin section → cold shut
- **Solution:** Increase thickness



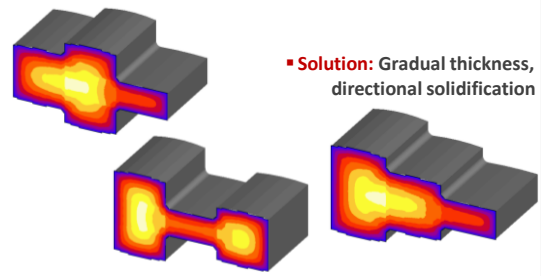
Casting DFM – Thick Regions

- **Issue:** Isolated thick section → shrinkage porosity
- **Solution:** Reduce thickness



Casting DFM – Thickness Change

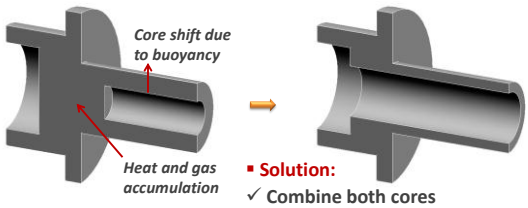
- **Issue:** Isolated hot spot, difficult to feed
- **Solution:** Gradual thickness, directional solidification



- **Issue:** Intermediate thin section, requires two feeders

Casting DFM – Adjacent Holes

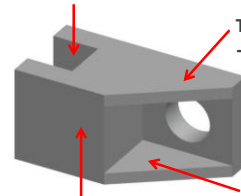
- **Issues:** Cantilever core can shift → non-concentricity
  Thin core will become hot → sand fusion
  Hot spot between cores → shrinkage porosity
  Poor transfer of core gases → blow hole



- **Solution:**
  ✓ Combine both cores
  ✓ Increase core diameter

Casting DFM – Example

Sharp corners → Turbulence
→ Mold erosion → **Sand inclusion**

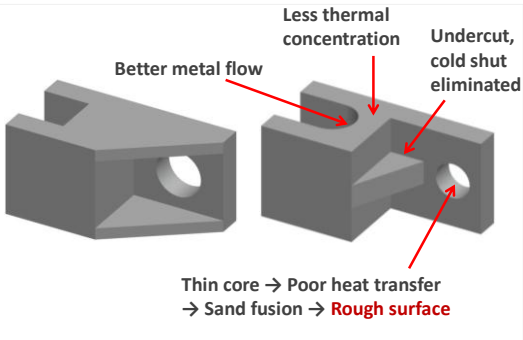


Thin rib → Premature solidification
→ Incomplete filling → Cold shut

Undercut → Hindered withdrawal
→ core → **High tooling cost**

Thick section → Solidification hot spot
→ Poor feeding → **Shrinkage porosity**

Casting DFM – Example



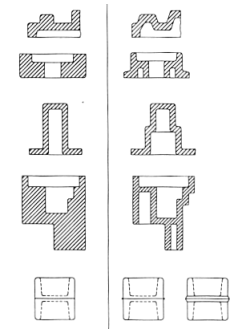
Plastic Injection Molded Parts

Maintain uniform wall thickness and provide for gradual changes in wall thickness

For a deep blind hole, use a stepped diameter

Maintain uniform wall thickness in thermoset parts

A bead at the parting line facilitates removal of mold flash



[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

Plastic Injection Molded Parts

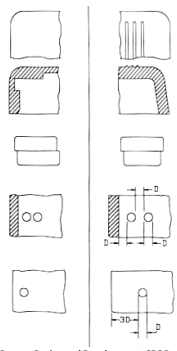
Use decorative design to conceal shrinkage

Avoid undercuts and variation in wall thickness

Deliberately offset side walls hide defects caused when mold halves do not line up properly

Minimum spacing for holes and sidewalls

Minimum distance between a hole and the edge of the part



[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

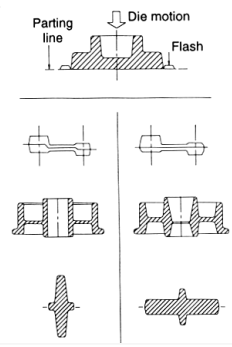
Forged Parts

Chose parting lines such that the part lies entirely in one die half

Avoid non-planar parting lines

Provide tapers

Locate parting line so that metal will flow parallel to the parting line



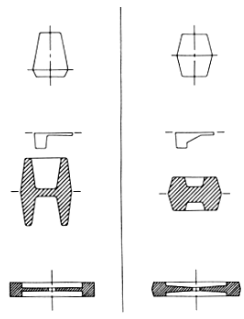
[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

Forged Parts

Design for parting lines at about half height

Avoid sharp changes in cross sections and cross sections that project excessively into the die

Avoid excessively thin sections

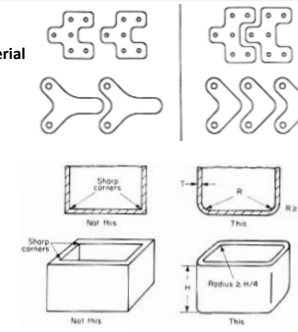


[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

Sheet Metal Parts

Part redesign can improve material utilization

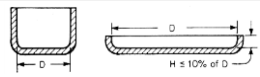
Avoid sharp corners to allow material forming



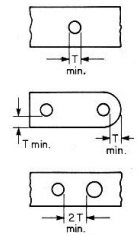
[Source: J.G. Bralla, Handbook of Product Design for Manufacturing, McGraw-Hill, 2000]

Sheet Metal Parts

Design to allow simple tooling, without blank-holding features



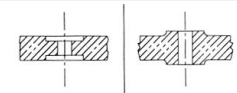
Allow minimum distance between punched hole and wall, and between adjacent holes



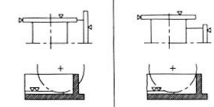
[Source: J.G. Bralla, Handbook of Product Design for Manufacturing, McGraw-Hill, 2000]

Machined Parts

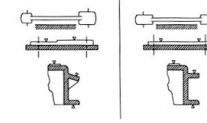
Provide for flat surfaces



Adapt runout to milling tool diameter



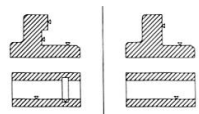
Arrange surfaces on one level and parallel to the clamping surface



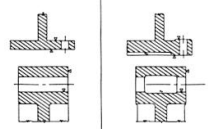
[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

Machined Parts

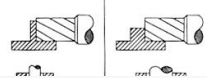
Avoid undercuts



Changes that reduce machining time



Parts and tools must not deflect



[Source: E.B. Magrab, Integrated Product and Process Design and Development, CRC Press, 1997]

SUMMARY

- Conventional product development: serial engineering
- Manufacturability issues are discovered late
- By that time, it is too expensive to change the design
- Design for manufacturability (DFM):
- Predict and prevent potential problems early in lifecycle
- Make part design compatible with process capabilities
- DFM guidelines are process-specific