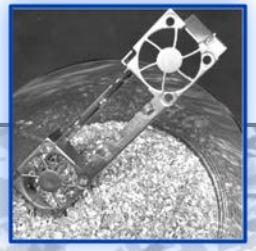
PARKWAY

HIGH PERFORMANCE POLYMERS

MAGNESIUM THIXOMOLDING



THERMOPLASTIC MOLDING

PAINT & LASER ETCH

THERMOSET MOLDING

ENERGY & INFRASTRUCTURE

AUTOMOTIVE ELECTRONICS

INDUSTRIAL

AUTOMOTIVE FUNCTIONAL

AEROSPACE & DEFENSE

TECHNOLOGY

HEALTHCARE

Thixomolded Magnesium Injection Molding Design Guide

Design to the benefits of Thixomolding

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1. Part Design Rules and Approach similar to Injection Molded Plastic
   - More Aggressive on Walls, Reinforcements, etc.

2. Tooling Features and Capabilities similar to Plastic Mold Tooling
   - Mold runs at 400 - 500 F

3. Mechanical Properties 20X unfilled Thermoplastics

4. Designs inherently EMI Shielding - no plating or painting required

5. Parts inherently Thermally Conductive

6. Corrosion Issues : a) General Corrosion better than Al & Steel
   b) Galvanic Corrosion - follow Aluminum Rules

7. Fastening/Joining : Snap Fits, Thread Forming Screws, Welding all applicable

8. Variety of Cosmetic Treatments : Powder Coat, Paint, Plating

9. Complete Recyclability regardless of cosmetic treatment

Areas to consider in design

Nominal Wall Thickness:
- Gradual transition: 3:1 Rule
- Core-out thick sections
- Remove sharp corners
- Thick to Thin
- Limitations

Equivalent Stiffness:
- Stiffness = E x I
- Greater Moment of Inertia

Reinforcement Structures:
- Ribs
- Gussets
- Bosses

Draft Angle:
- Facilitate Part Ejection
- Suggested : 0.5° - 3.0°

Processing Concerns:
- Flow Length

Machinability vs. Other Metals

Corrosion :
- **General**
- **Galvanic**

Assembly Methods:
- Snap-Fit
- Interference Fits
- Fasteners
- Joint Designs

Wall Thickness

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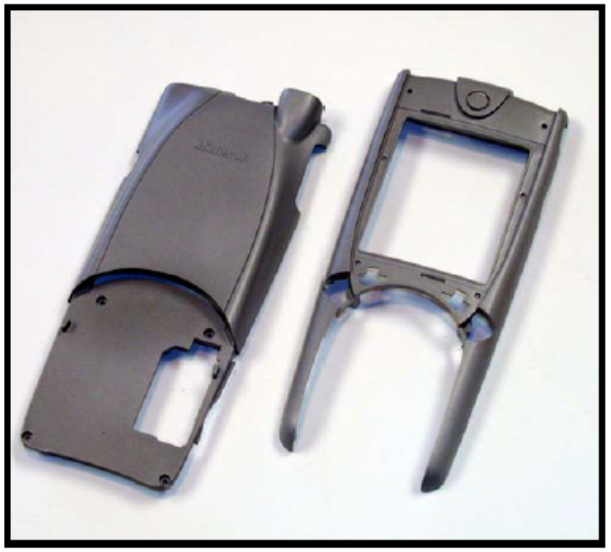
- **Nominal Part Thickness**

  Minimum: 0.018” (0.5 mm)

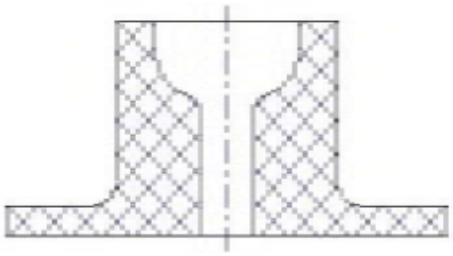
  Maximum: 0.120” (3.0 mm)



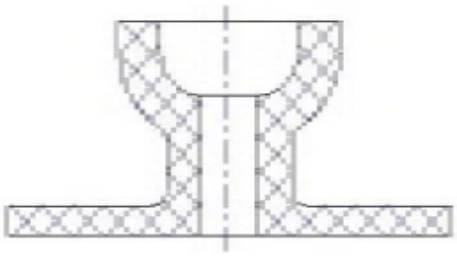
- **Flow length to Wall Thickness Ratio : L/D**

Thixomolded Magnesium Designs	**> 150:1**
Thixomolded Magnesium Spiral Flow Tests	**> 400:1**
Conventional Plastic	**< 100:1**

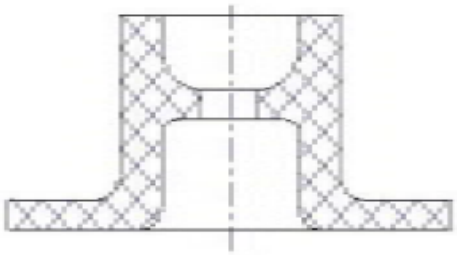
Wall Thickness



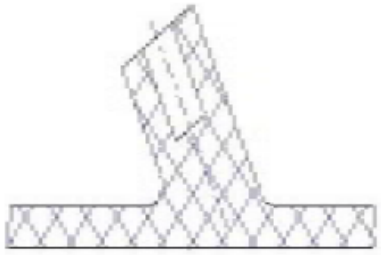
Poor Design
Heavy Walls



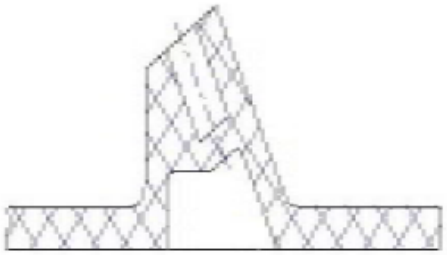
Better Design
Shape would require slides



Best Design
Uniform walls
No slides

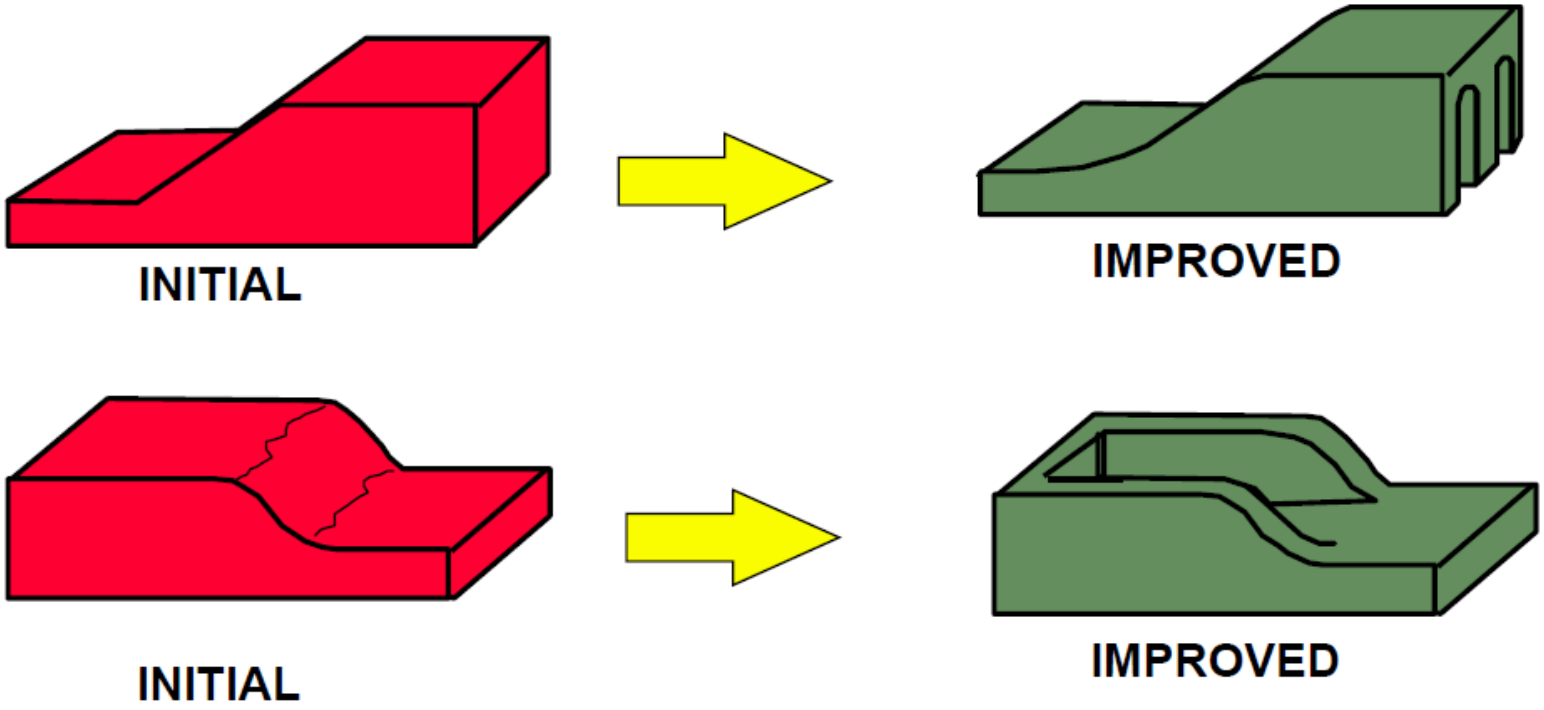


Poor Design
Heavy section promotes internal shrinkage



Good Design
Coring eliminates heavy section

Nominal Wall Design



- Radius Transitions from Thin to Thick
- Core Thick Sections where Possible

Wall Transitions

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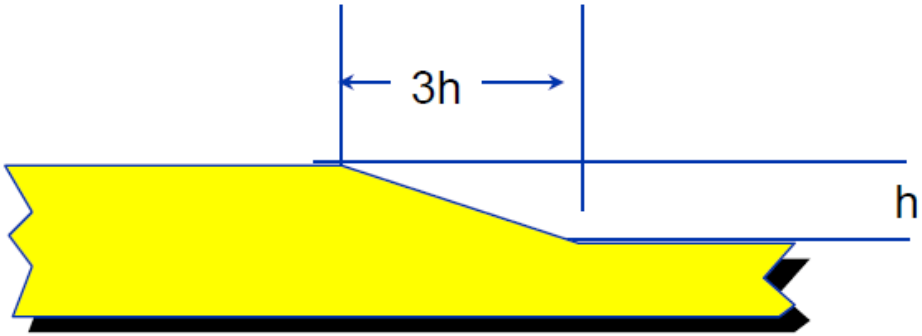
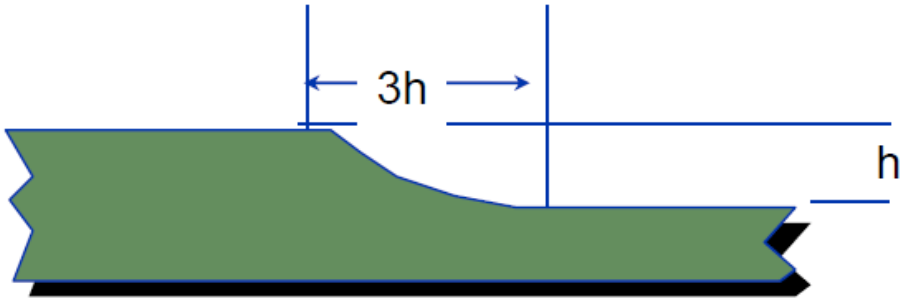
Initial

Better



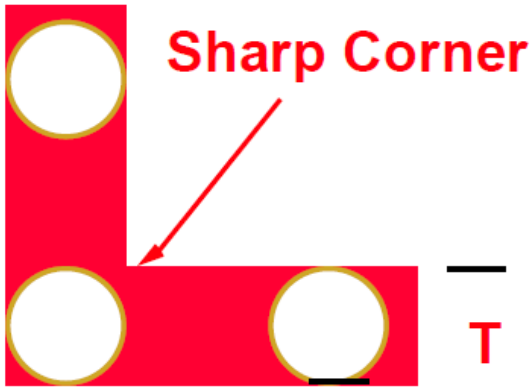
Best



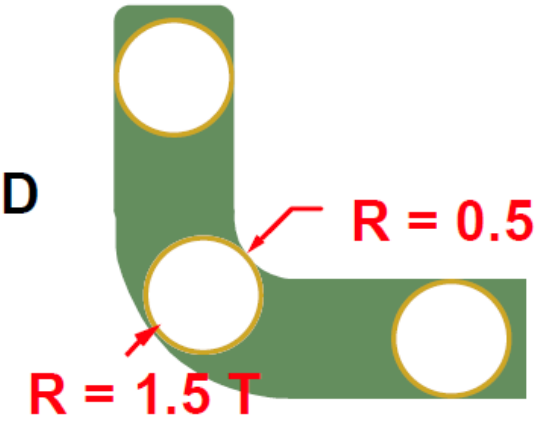
Gradual Radiused Transitions are best

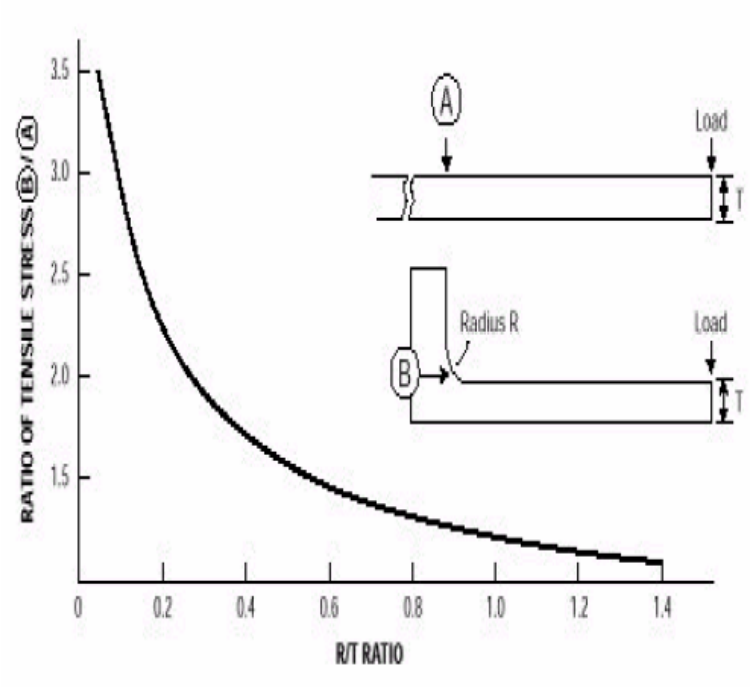
Corner Design

INITIAL



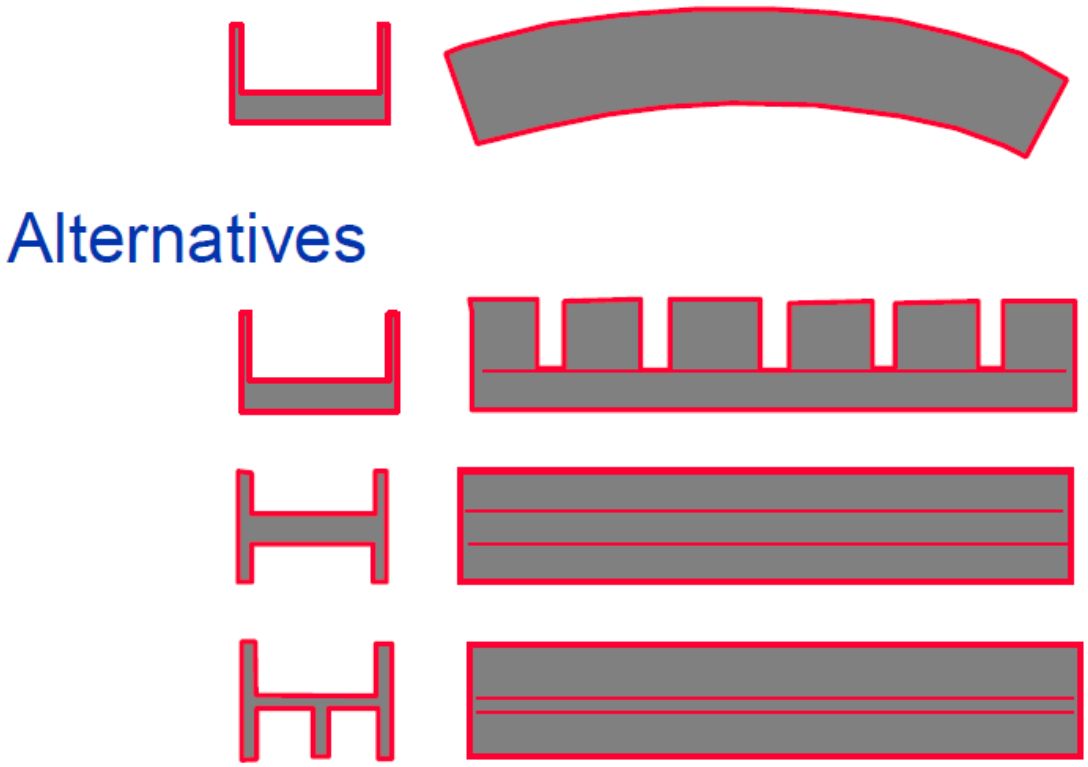
IMPROVED





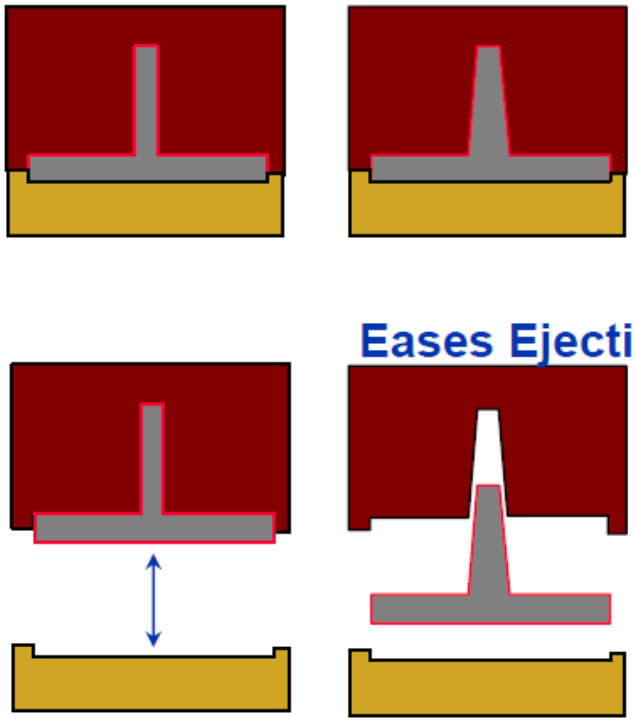
Radius Corners / Maintain Nominal Wall

Nominal Wall



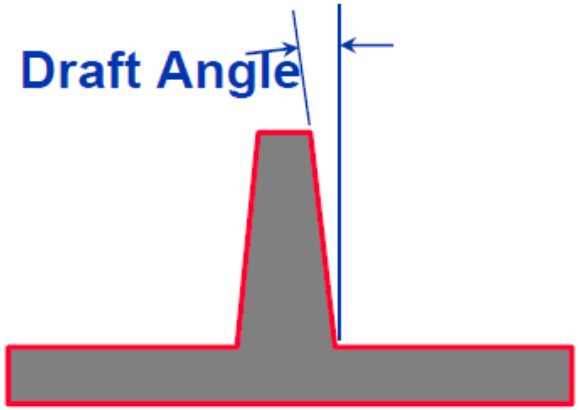
DESIGN FOR UNIFORM NOMINAL WALL :
MAXIMUM STIFFNESS WITH MINIMAL SHRINKAGE

Draft Angle & Part Removal



1) Suggested Draft Angle 1°

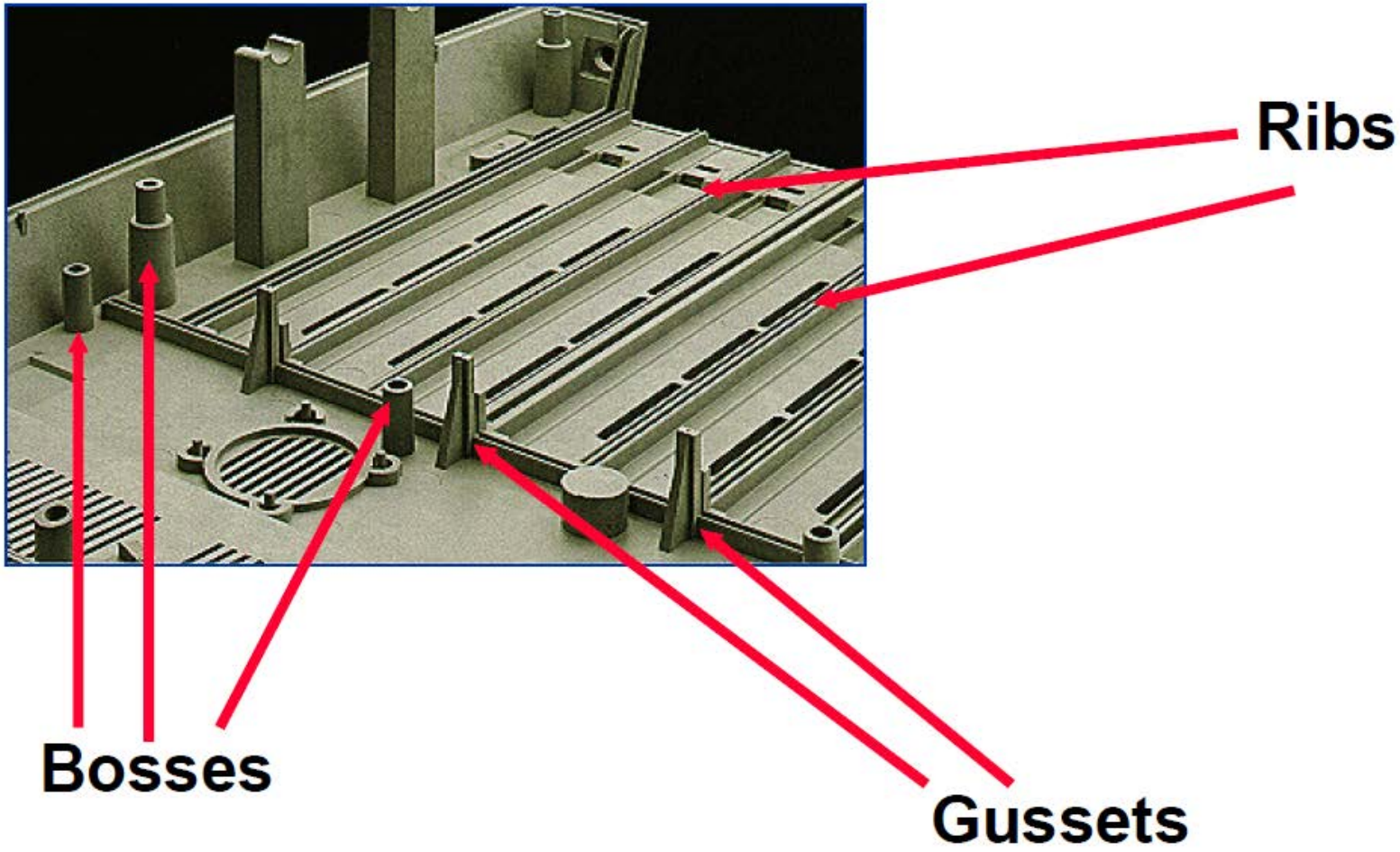
Equivalent to 0.017 in/in/deg



2) Minimum Draft Angle = 0.5°

3) No draft in some areas.

Reinforcement Design



Reinforcement Design Rules

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Thixomolded Magnesium Rules

t ≤ 1.2t wall
h ≤ 5t wall
r ≥ 0.6mm
Θ ≥ 0.5°
OD ≈ 2ID

Plastic Rules

t ≤ 0.6t wall
h ≤ 4t wall
r ≥ 0.375mm
Θ ≥ 0.25°
OD ≈ 2ID

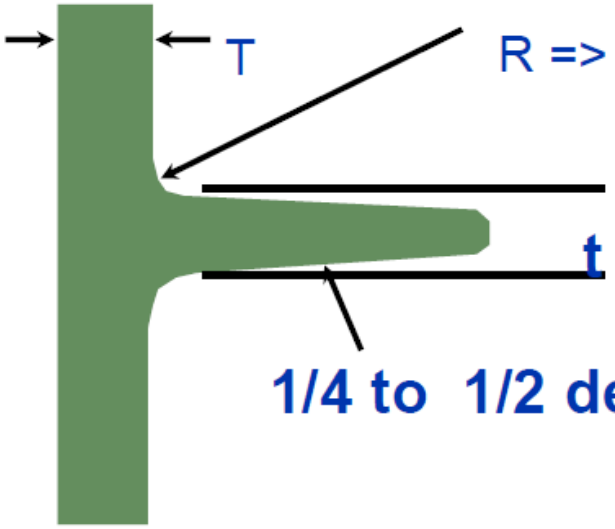
Ribs

Bosses

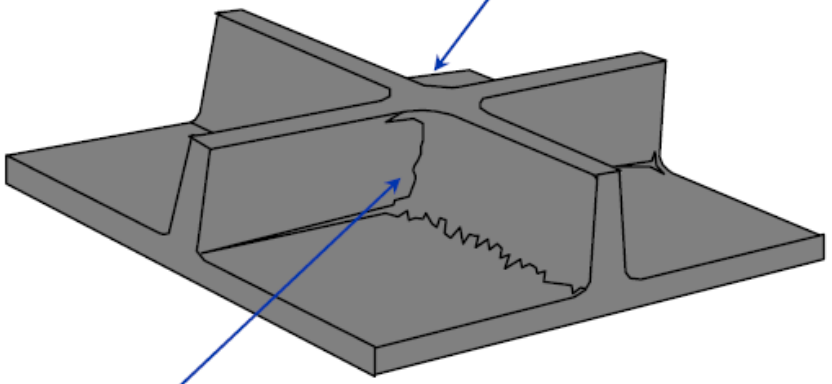
Gussets

More Aggressive than Plastic

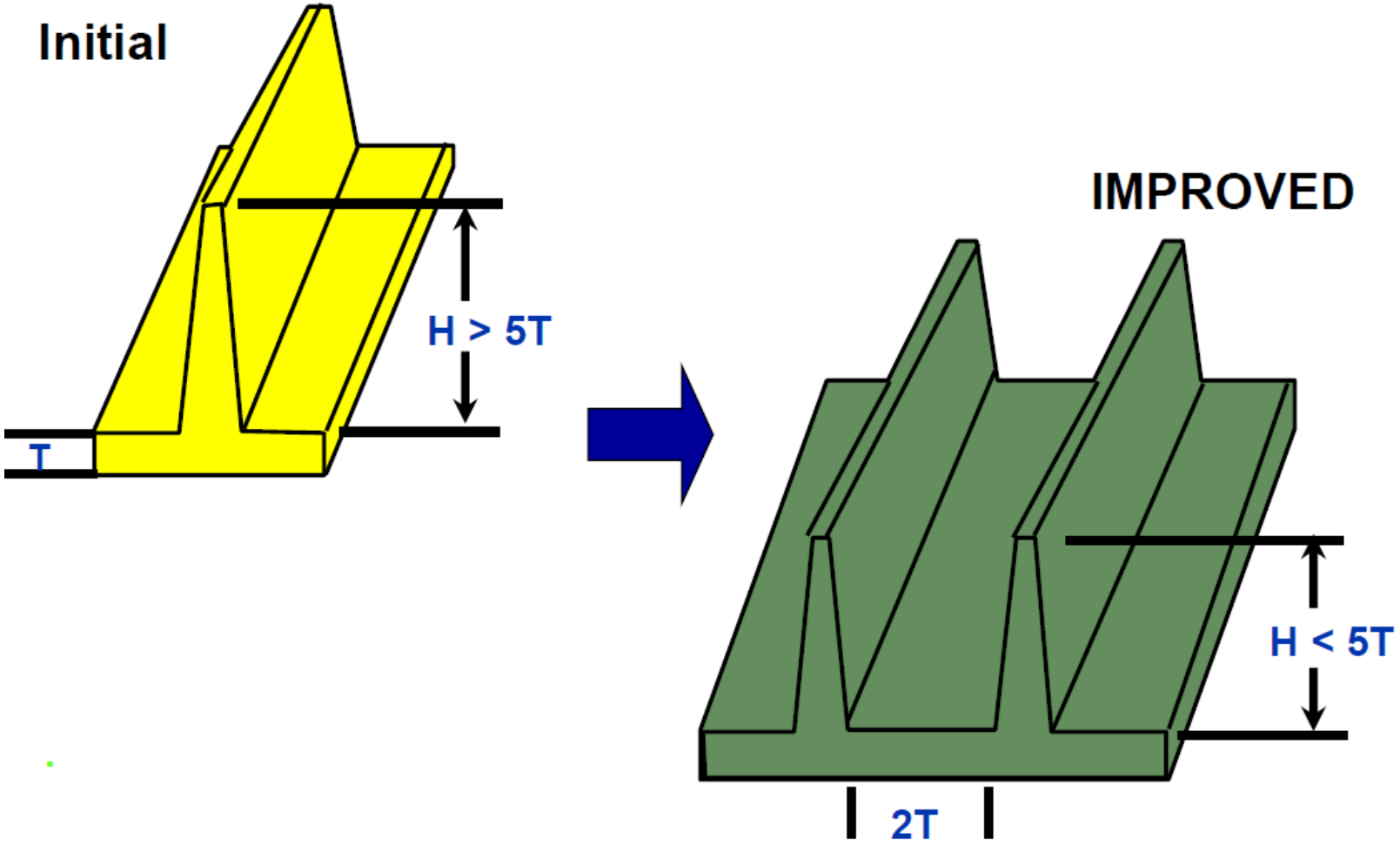
Rib Design Basics



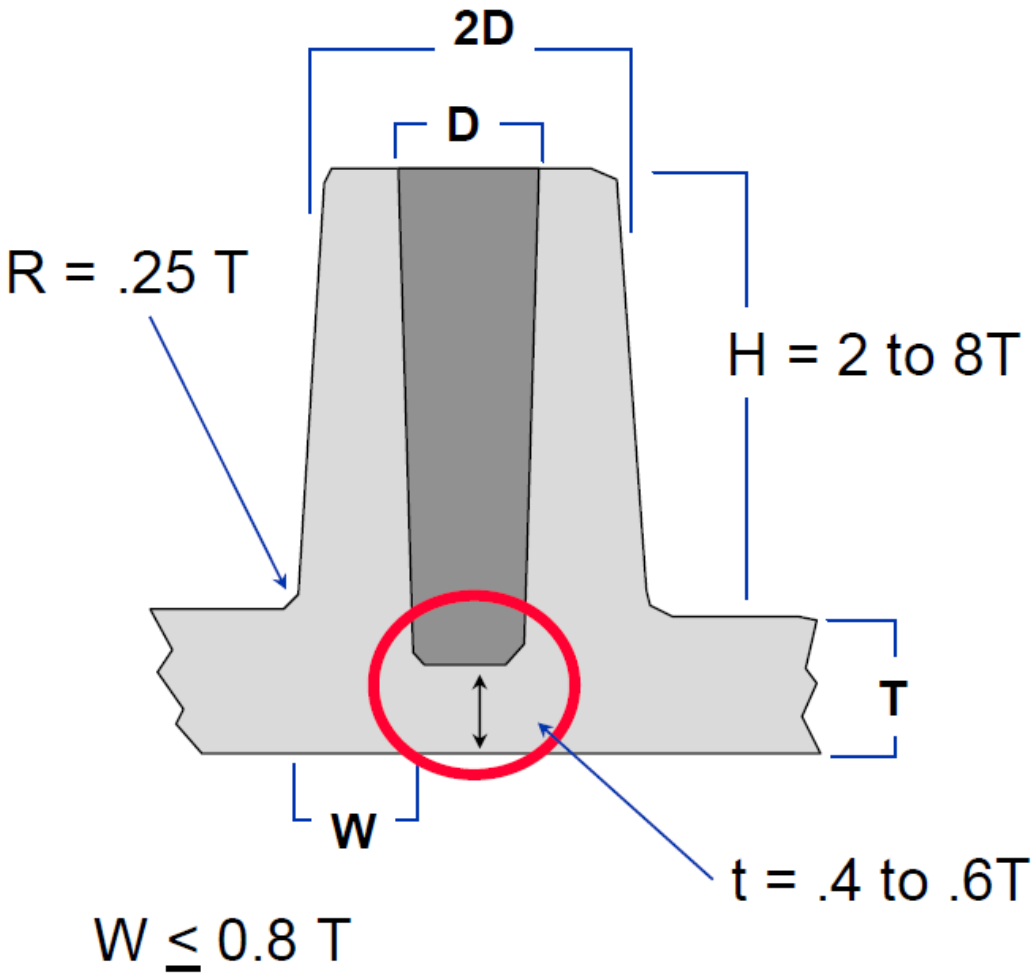
INTERSECTIONS :



Rib Configuration Design



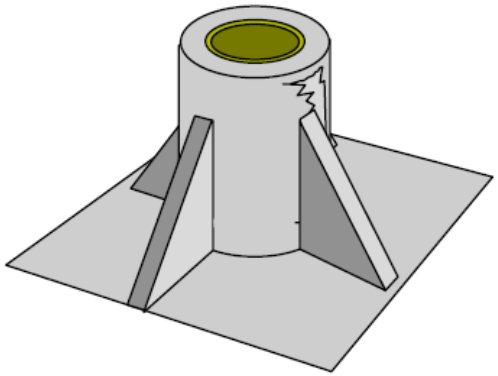
Boss Design

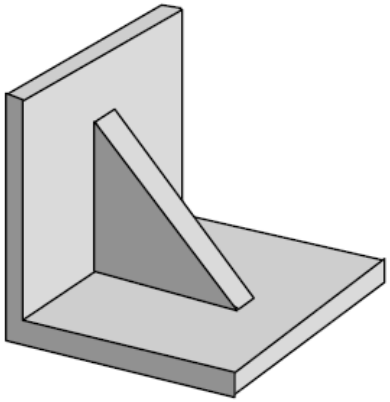


Standing Features :

- **add strength**
- **facilitate alignment**
- **during assembly**
- **attachment**

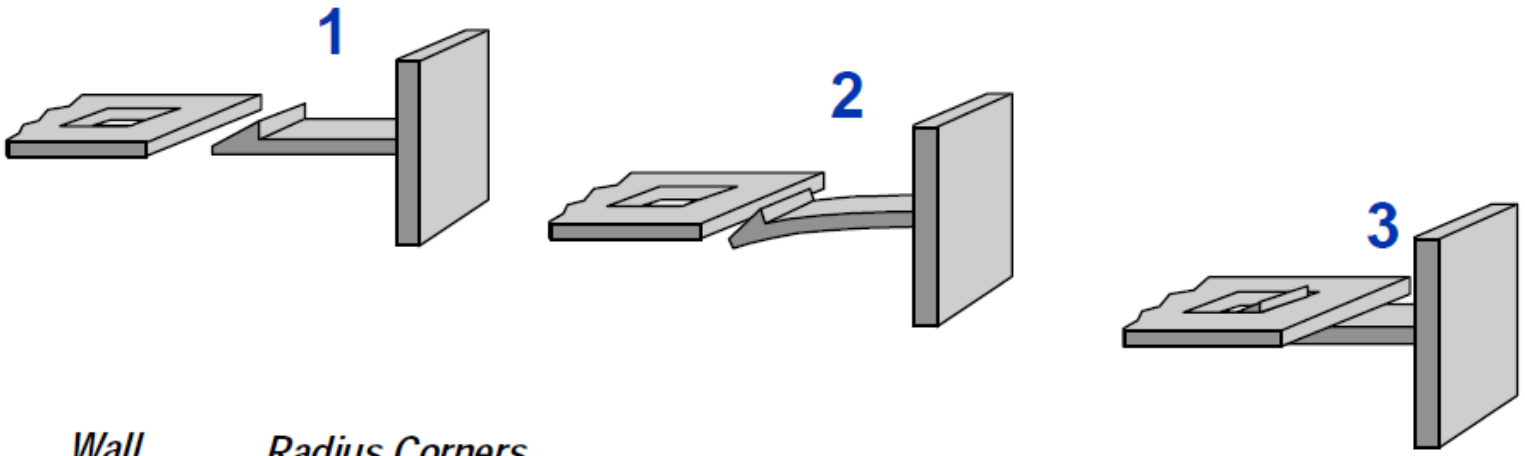
Gussets

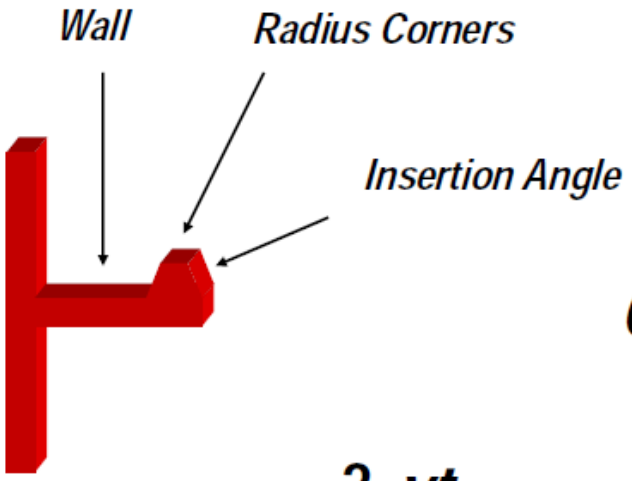




- Points of attachment
- Support Sections
- Contact with other parts / sections
- Follow thickness and height rules for Rib Design

Assembly: Snap Fit Designs



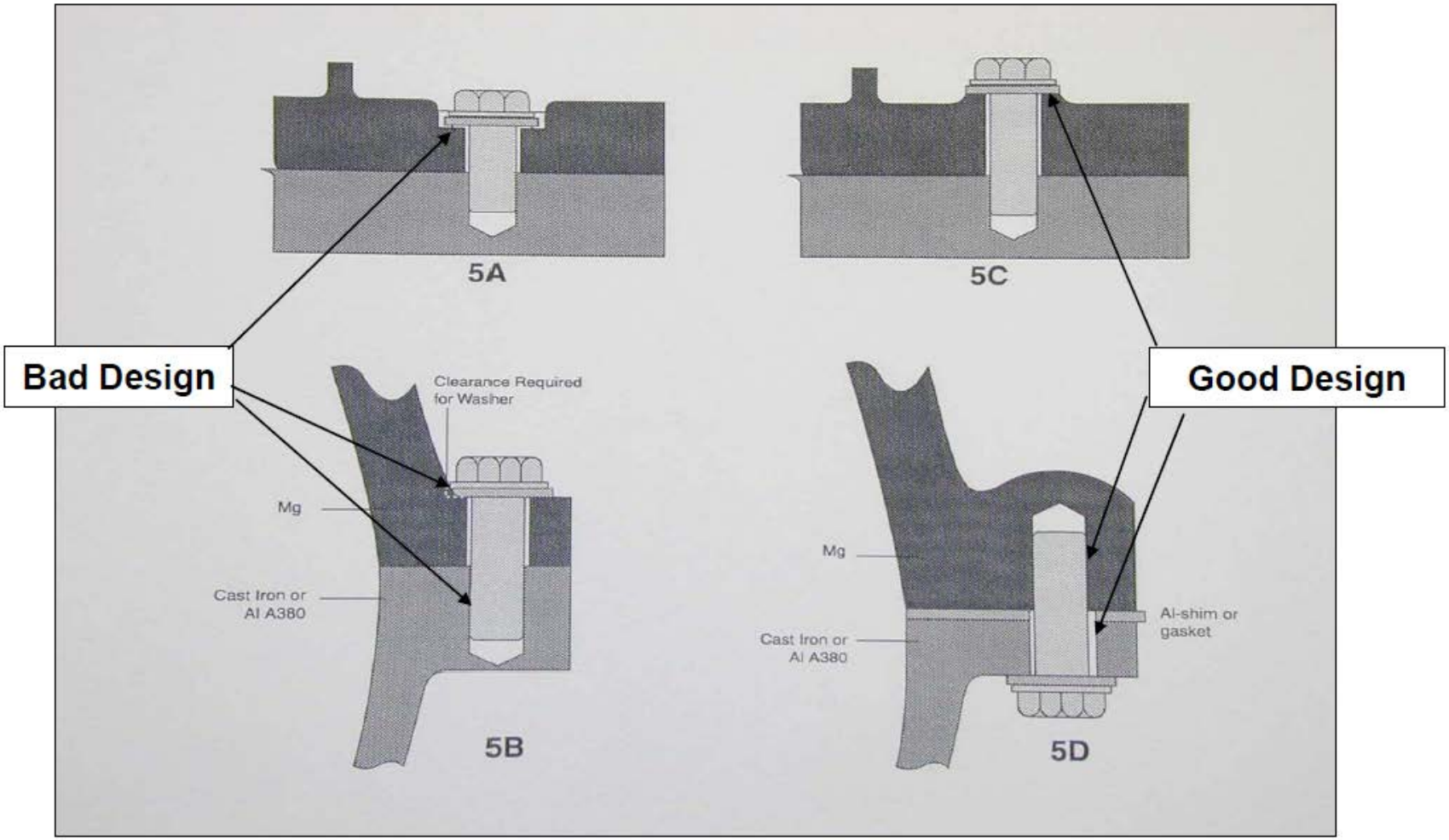


$$\text{Cantilever Force} = \frac{yBt^3 E_s}{4l^3}$$

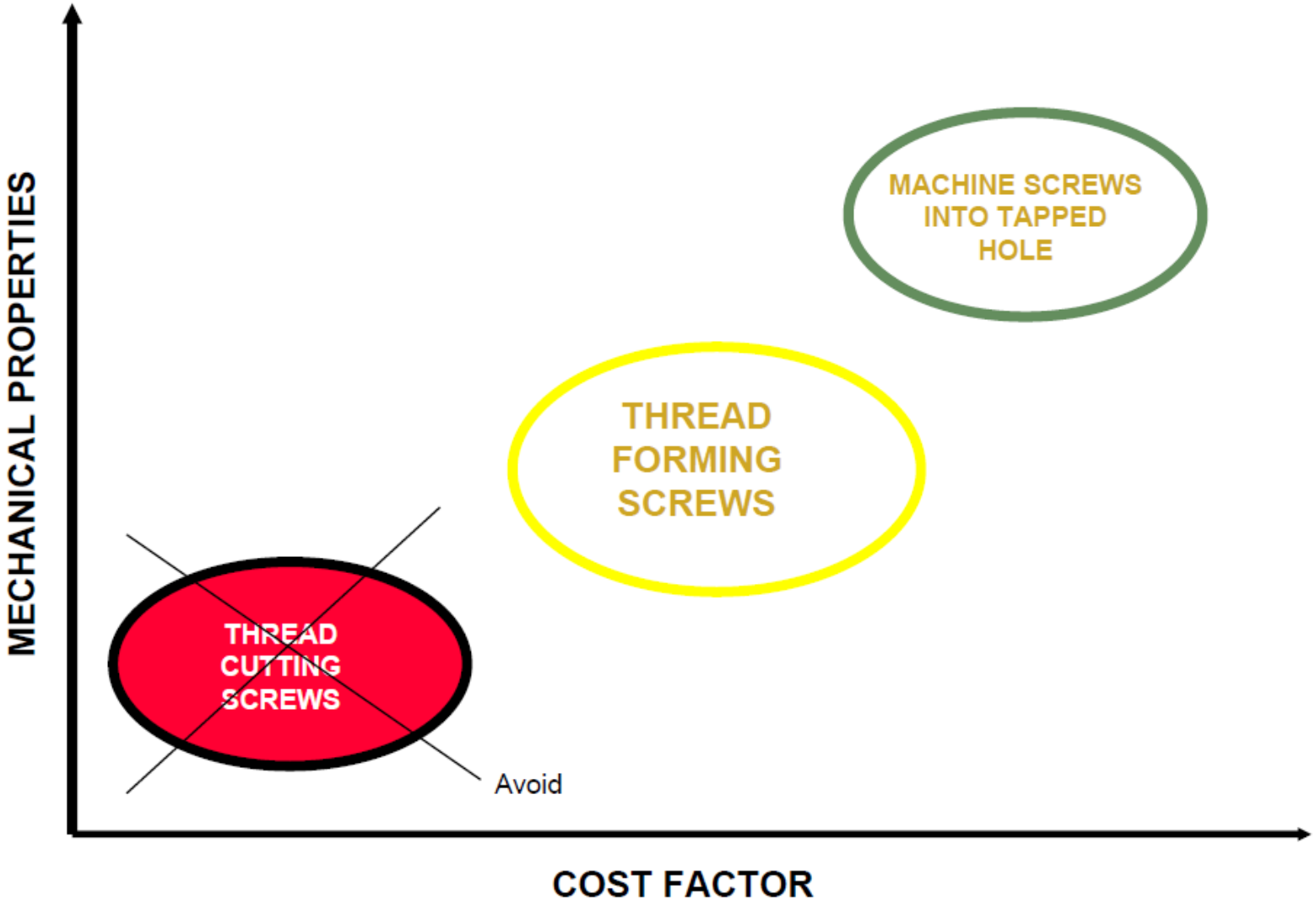
$$\text{Strain} = \frac{3yt}{2l^2}$$

$$\text{Insertion Force} = \frac{F\mu + \tan\phi}{1 - \mu\tan\phi}$$

Assembly: Fasteners



Assembly: Fasteners



Assembly: Fasteners

- Self forming screw work best
  - Do not exceed the ductility limits of Magnesium.
  - Eliminate possibility of thread damage
  - Eliminate excess debris and chips
- Use Zinc or Chromate plated screws to minimize Galvanic corrosion.

V-Groove Stiffeners

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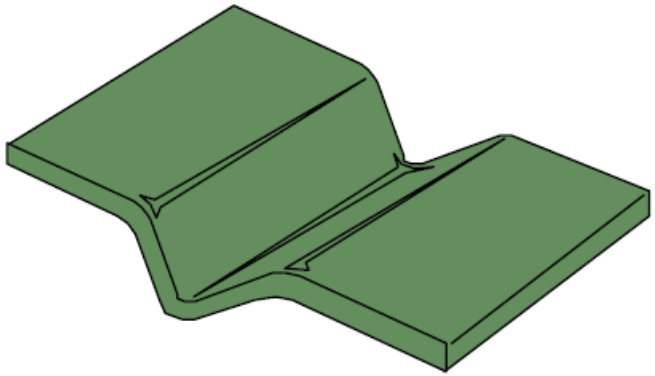
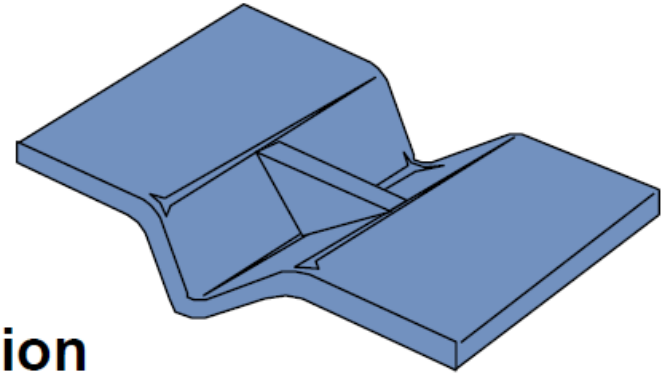
Efficient stiffeners “Corrugation Effect”



Little additional material

No additional cooling time

Reduce Expansion and Compression



Finishing Options

1. As-Molded
   - versus as-cast. Smoother, less porosity.

2. Treatments
   - Chromate
   - Phosphate

3. Hard Coats
   - Tagnite or Anomag - MgO
   - Mg Oxide ($MgOAl_2o_3$)

4. Finished (Final Finishes)
   - Power coating
   - Wet paint
   - Plating (Ni, Cu, Au, Ag, Chrome)