Design to the benefits of Thixomolding

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

Draft Angle:
- Facilitate Part Ejection
- Suggested: \( 0.5^\circ \cdot 3.0^\circ \)

Processing Concerns:
- Flow Length

Machinability vs. Other Metals

Corrosion:
- General
- Galvanic

Reinforcement Structures:
- Ribs
- Gussets
- Bosses

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

Equivalent Stiffness:
- Stiffness = \( E \times l \)
- Greater Moment of Inertia
Wall Thickness

- 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

Initial

Better

Best

Gradual Radiused Transitions are best
Corner Design

INITIAL

IMPROVED

Sharp Corner

R = 0.5 T

R = 1.5 T

Radius Corners / Maintain Nominal Wall
Nominal Wall

Alternatives

DESIGN FOR **UNIFORM** NOMINAL WALL:
MAXIMUM STIFFNESS WITH MINIMAL SHRINKAGE
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

- Ribs
- Bosses
- Gussets
Reinforcement Design Rules

Thixomolded Magnesium Rules

- $t \leq 1.2t_{\text{wall}}$
- $h \leq 5t_{\text{wall}}$
- $r \geq 0.6\text{mm}$
- $\Theta \geq 0.5^\circ$
- OD $\approx 2\text{ID}$

Plastic Rules

- $t \leq 0.6t_{\text{wall}}$
- $h \leq 4t_{\text{wall}}$
- $r \geq 0.375\text{mm}$
- $\Theta \geq 0.25^\circ$
- OD $\approx 2\text{ID}$

More Aggressive than Plastic
Rib Design Basics

R => .015” (The Larger the Better)

$ t < 1.25 \, T $

1/4 to 1/2 degree draft

INTERSECTIONS:

Maintain Nominal Wall at Intersections

Radius Corners
Rib Configuration Design

Initial

\[ H > 5T \]

\[ T \]

IMPROVED

\[ H < 5T \]

\[ 2T \]
Boss Design

Standing Features:
- add strength
- facilitate alignment
- during assembly
- attachment

R = .25 T

H = 2 to 8T

t = .4 to .6T

W ≤ 0.8 T
Gussets

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

Wall
Radius Corners

Insertion Angle

Strain \[ \frac{3 \ yt}{2 \ l^2} \]

Cantilever Force
\[ \frac{yBt^3 \ E_s}{4 \ l^3} \]

Insertion Force
\[ \frac{F \ \mu + \tan \ \phi}{1 - \mu \ \tan \ \phi} \]
Assembly: Fasteners

Bad Design

Good Design
Assembly: Fasteners

- **Thread Cutting Screws**: Avoid
- **Thread Forming Screws**: Low cost, high mechanical properties
- **Machine Screws into Tapped Hole**: High cost, moderate mechanical properties
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

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 (MgOAI₂O₃)

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