

# Part Design for Cycle Time Reduction

*presented by:*



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# Part Design for Cycle Time Reduction

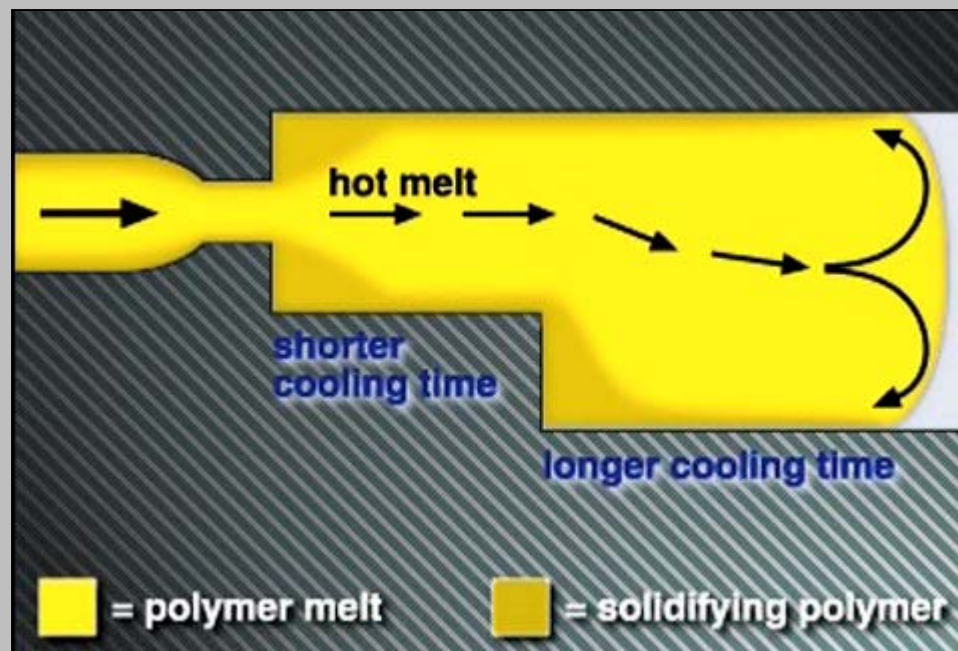
- Wall Thickness
- Part Removal
- Cooling
- Multi-Material
- Multi-Cavity



# Wall Thickness

Due to poor heat transfer...

- outer layers insulate
- plastics cool slowly



# Wall Thickness

Cooling time is exponential:

- Cooling Time  $\sim \frac{(\text{Thickness})^2}{(\text{Thermal Diffusivity})}$

$$\text{Minimum Cooling Time} = t_c = \frac{h^2}{\alpha \pi^2} \ln \left| \frac{4}{\pi} \left( \frac{T_M - T_W}{T_E - T_W} \right) \right|$$

For Example: with

$\alpha$  = thermal diffusivity  $\sim 10^{-7} \text{ m}^2/\text{s}$

$h$  = plate thickness  $\sim 3 \times 10^{-3} \text{ m}$

$T_W$  = mold wall temperature  $\sim 50^\circ\text{C}$

$T_M$  = melt temperature  $\sim 250^\circ\text{C}$

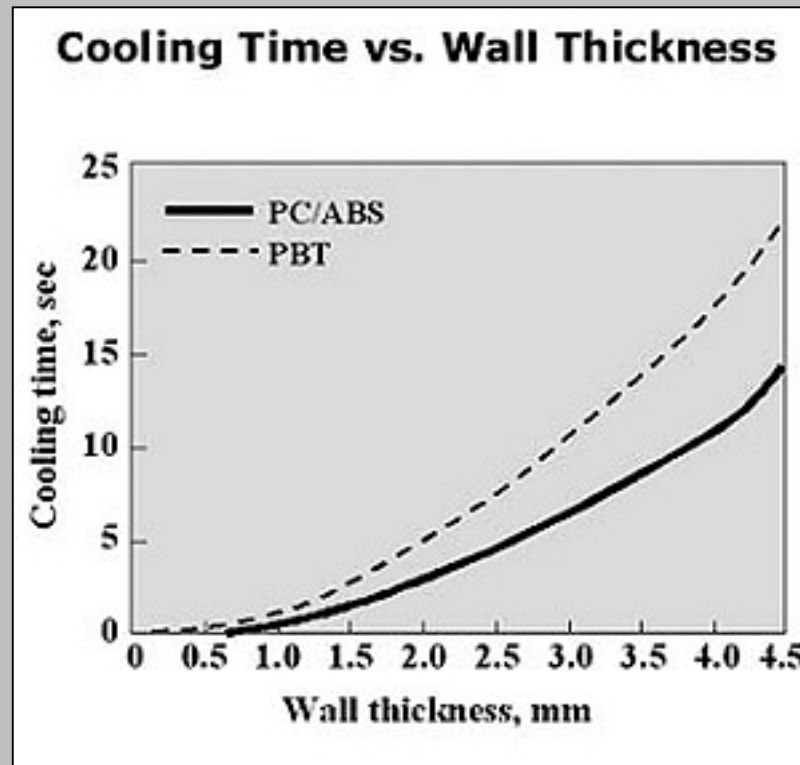
$T_E$  = ejection temperature  $\sim 100^\circ\text{C}$

Minimum cooling time for centerline to reach

$T_E$  is  $T_C \sim 23 \text{ sec.}$

# Wall Thickness

Cooling time is exponential:



# Wall Thickness

Every doubling in thickness  
is a four-fold increase in  
theoretical cooling time

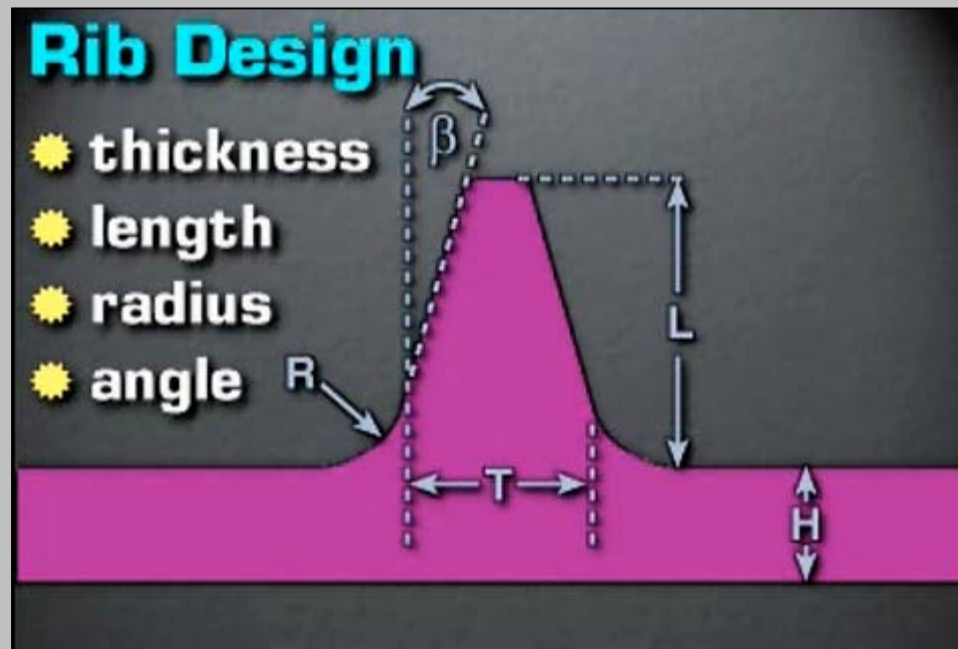
# Wall Thickness

Adversely... Less than 30%  
thickness reduction cuts  
theoretical cooling time in half

# Wall Thickness

Rib intersections...

- create inherent thick sections
- typically have poor cooling



# Wall Thickness

## Circle Diagram Method...

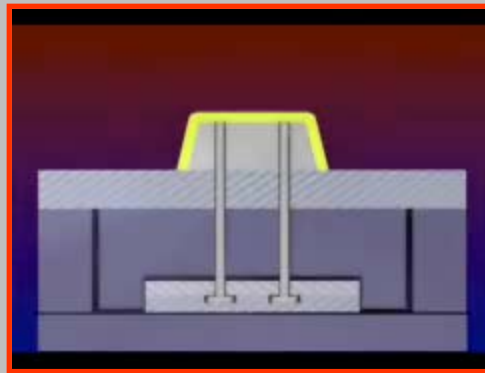
- diameter approximates thickness



# Part Removal

In production...

- part removal is most common limiting factor on cooling time



# Part Removal

Poor part and mold design...

- warpage
- distortion
- deformation
- marks



# Part Removal

No mold design can compensate  
for a poor part design

# Part Removal

## Ejection system design...

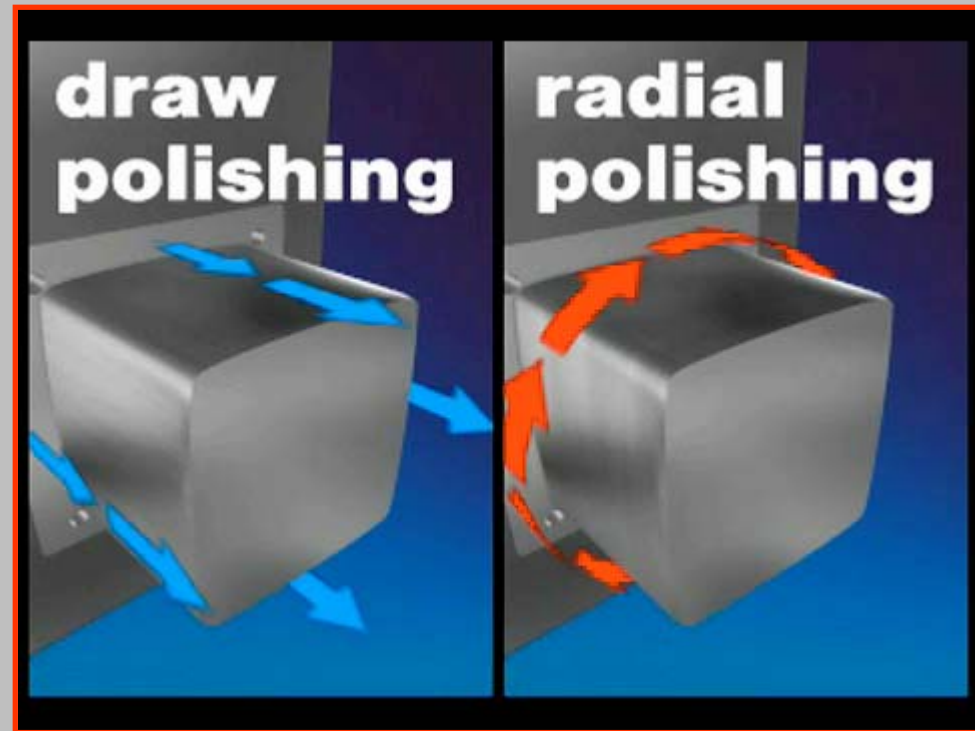
- even distribution of force
- provide push points
- easily removed undercuts
- accomodate actions



# Part Removal

Reduce stresses and vacuum forces...

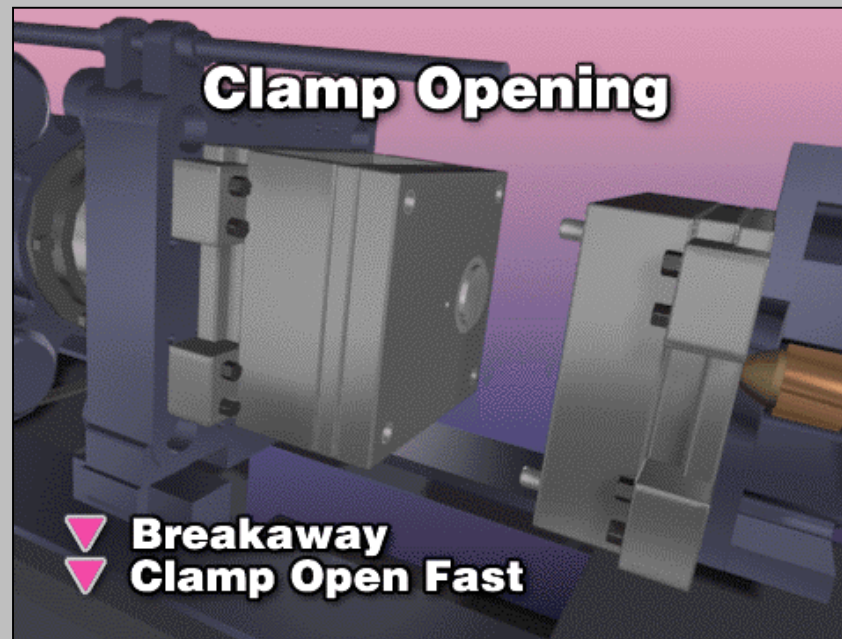
- draft angles
- draw polishing
- radii
- fillets
- ribs



# Part Removal

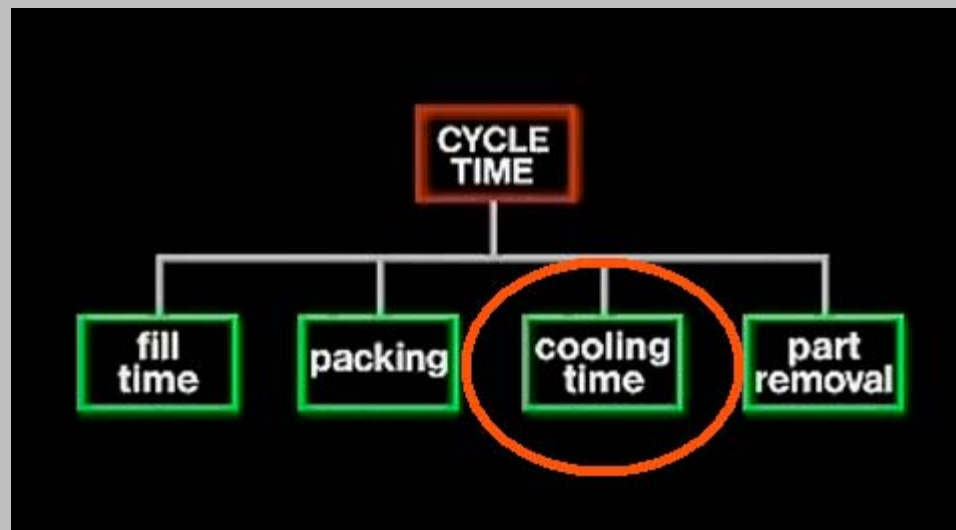
Lastly...

- ensure design accomodates mold opening



# Cooling

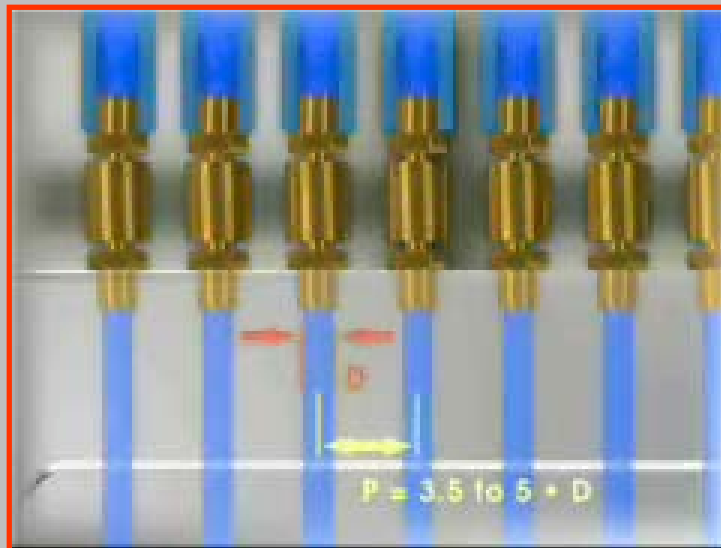
- Cooling Line Layout
- Differential Cooling
- Simplify Complex Cooling



# Cooling Line Layout

Ideal cooling lines...

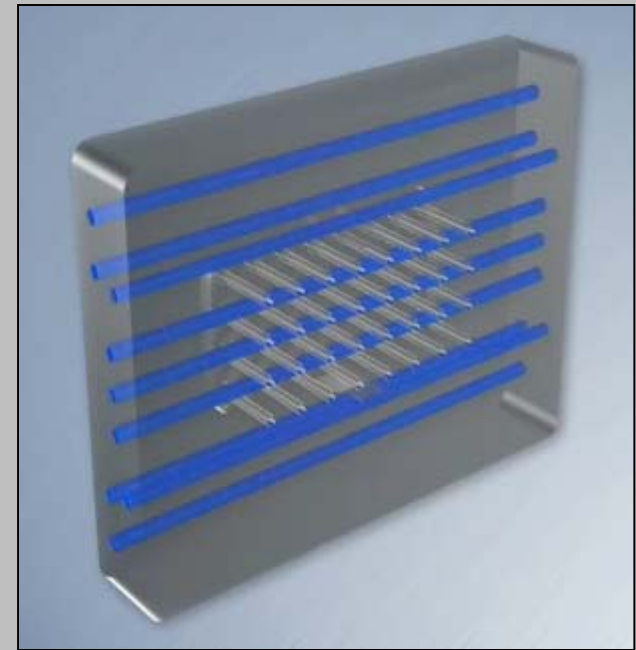
- Distance (P) = 3.5 -> 5 \* D
- Depth (H) = D \* 2



# Cooling Line Layout

The best design balances...

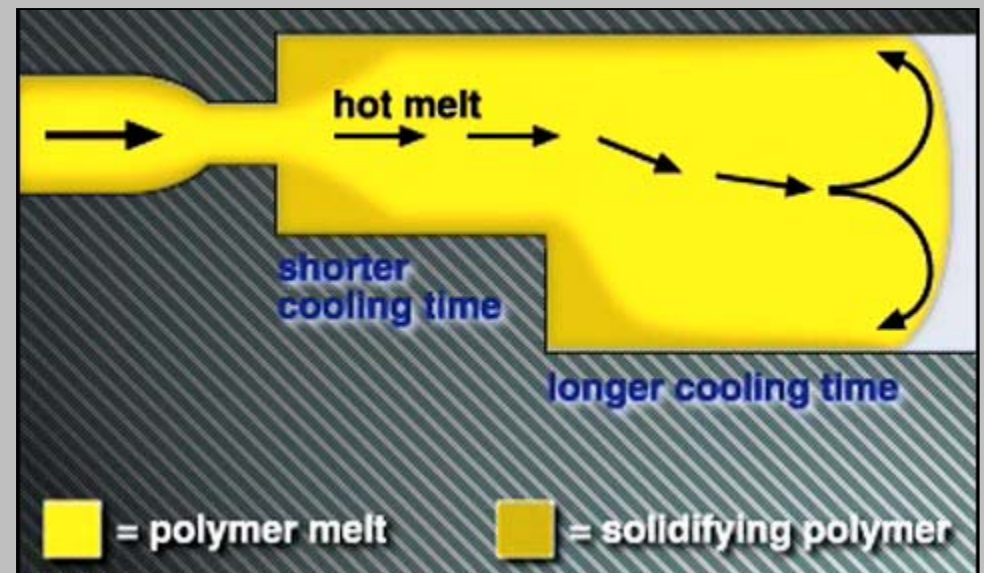
- cooling line layout
- ejection system layout



# Differential Cooling

## Variable Part Thickness Causes...

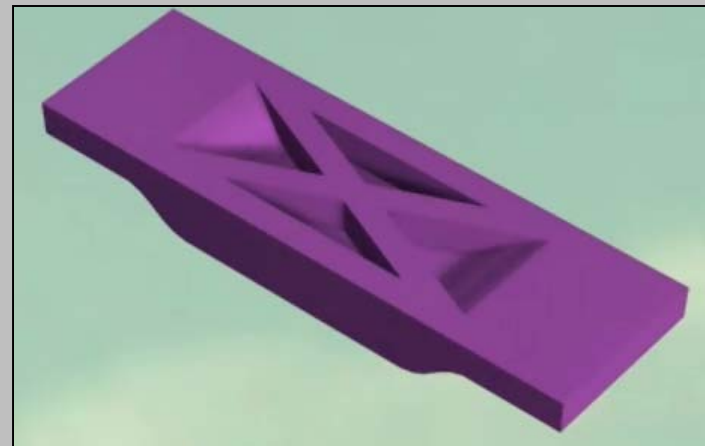
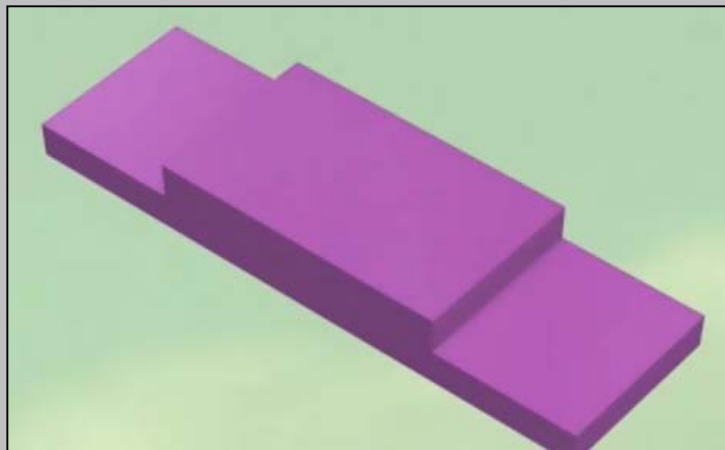
- inconsistent shrinkage
- increased warpage
- longer cooling time



# Differential Cooling

When Possible...

- smooth out thickness transitions
- avoid sharp corners
- maintain a consistent wall thickness
- use ribbing or gussets if necessary



# Simplify Complex Cooling

## Design Considerations:

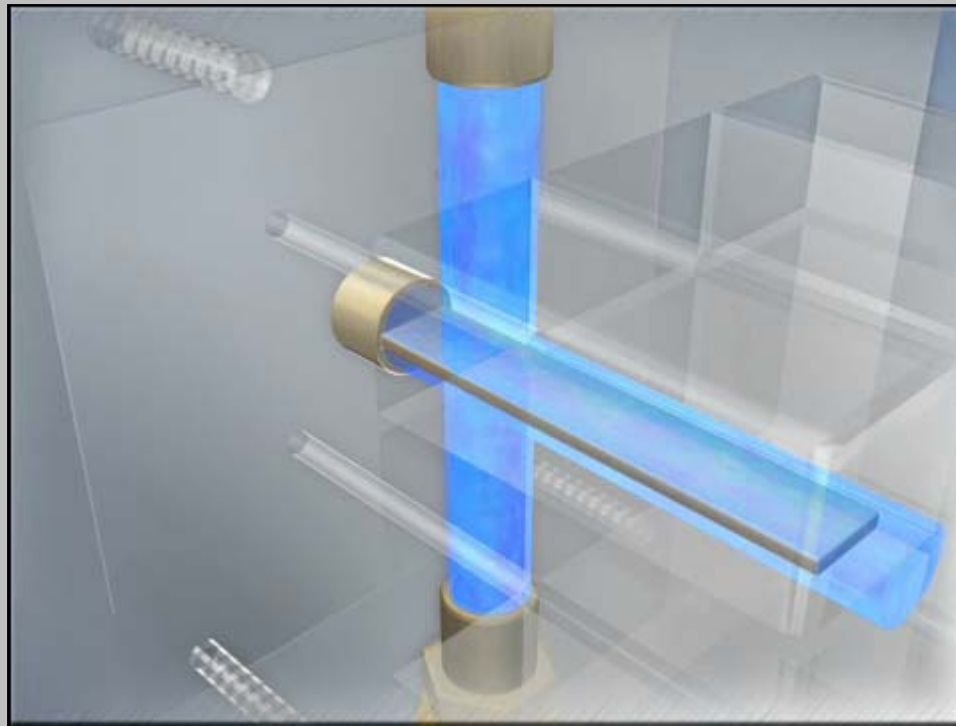
- large slides are easier to cool



# Simplify Complex Cooling

## Design Considerations:

- accomodate water baffles or bubblers



# Simplify Complex Cooling

## Design Considerations:

- thermal pins are also great solutions



# Simplify Complex Cooling

## Design Considerations:

- incorporate stripper plates when possible



# Simplify Complex Cooling

## Design Considerations:

- incorporate mold designer when possible



# Multi-Material

Many applications require different performance and appearance properties from the same part.

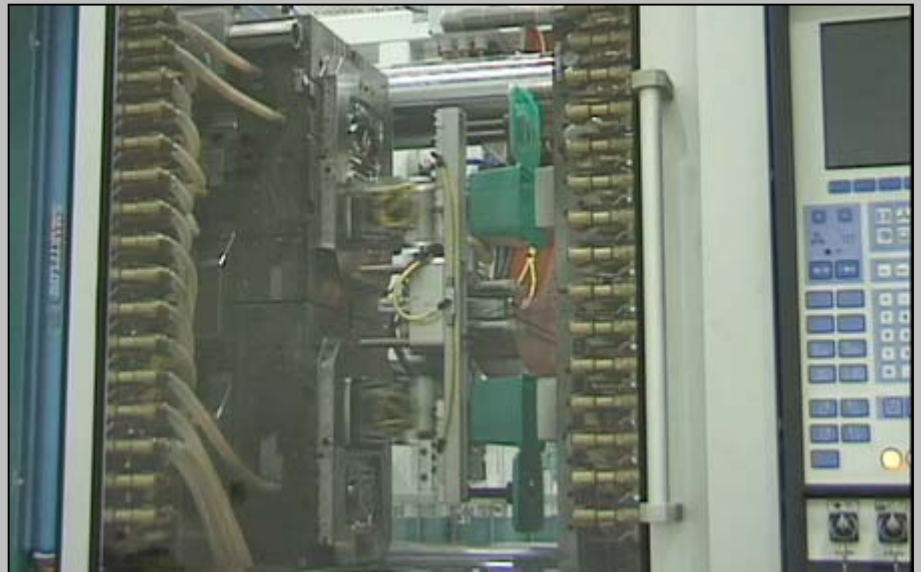
# Multi-Material

As a result, companies often use an excessive amount of an inferior material to satisfy everything.

# Multi-Material

## Cycle Time Reduction Methods...

- Inserts
- Double-Shot Molding
- In-Mold Labelling
- Assembly



# Inserts

Features can often be inserted:

- core inserts
- threaded inserts
- screws
- reinforcement



# Inserts

Inserts do not only have to be metal:

- plastic
- graphite
- ceramics



# Inserts

Can be added:

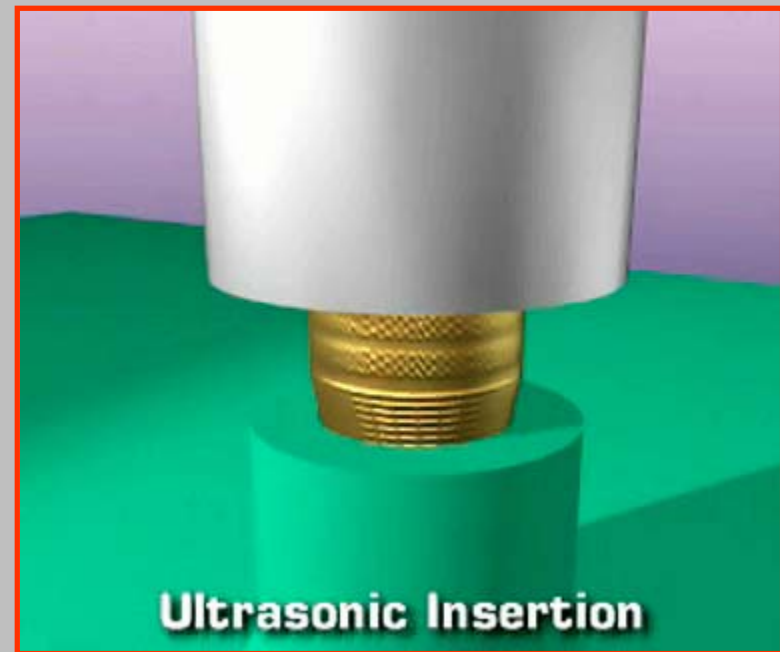
- during molding
  - overmolding
  - robotics
  - manual



# Inserts

Can be added:

- after molding
  - snap fit
  - ultrasonic welding
  - assembly



# Double-Shot

- Rotary Mold
- Retractable Core



# Rotary Mold

Two identical cores with different cavities:

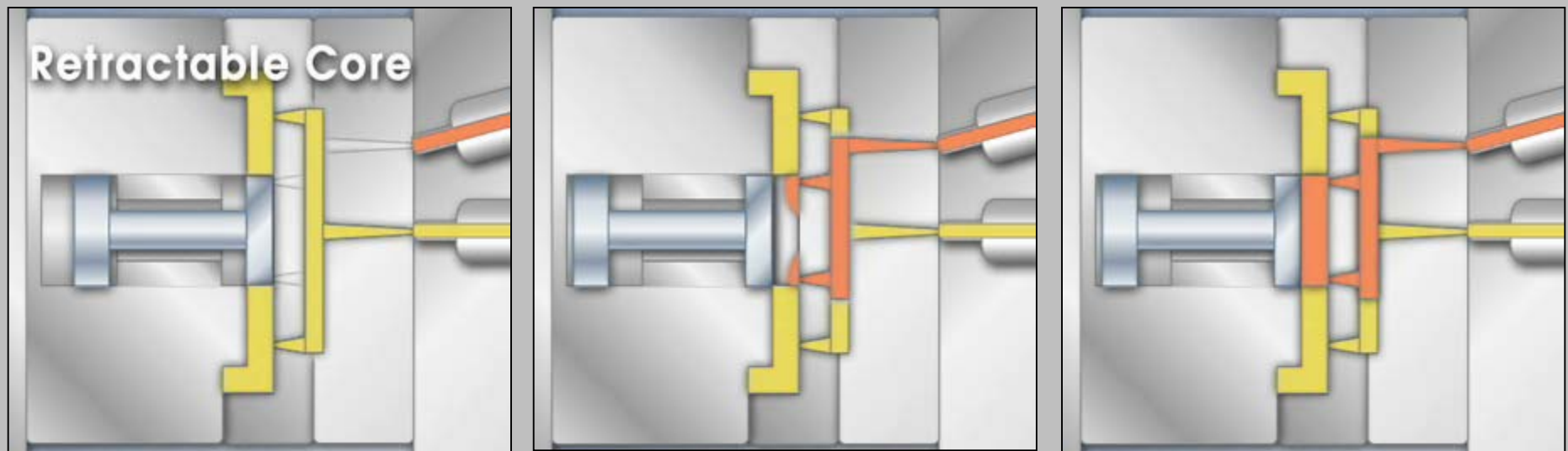
- molds cavity #1
- rotates
- over molds w/cavity #2



# Retractable Core

Core can move back and forth:

- 1st material is injected
- core retracts
- 2nd material is injected



# In-Mold Labeling

## Process:

- label or paint is applied
- mold is closed
- part is molded
- mold is opened
- part is removed



# In-Mold Labeling

## Benefits:

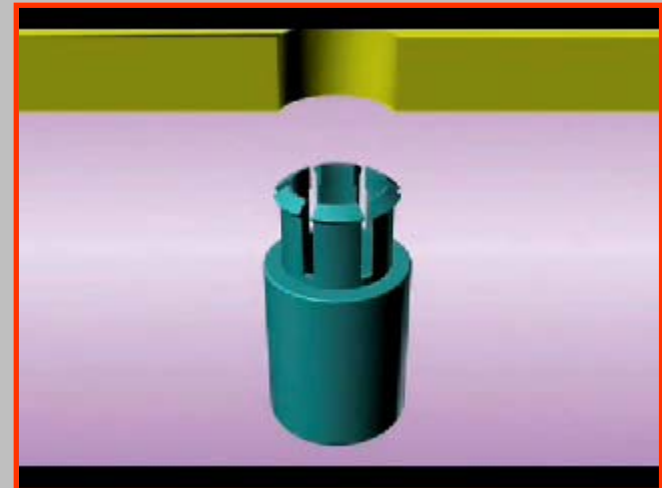
- improves appearance
- can be used with virtually any material
- reduces secondary operations



# Assembly

Use many techniques:

- after molding
  - mechanical fasteners
  - snap fits
  - welding
  - adhesives



# Assembly

When designing for disassembly, avoid:

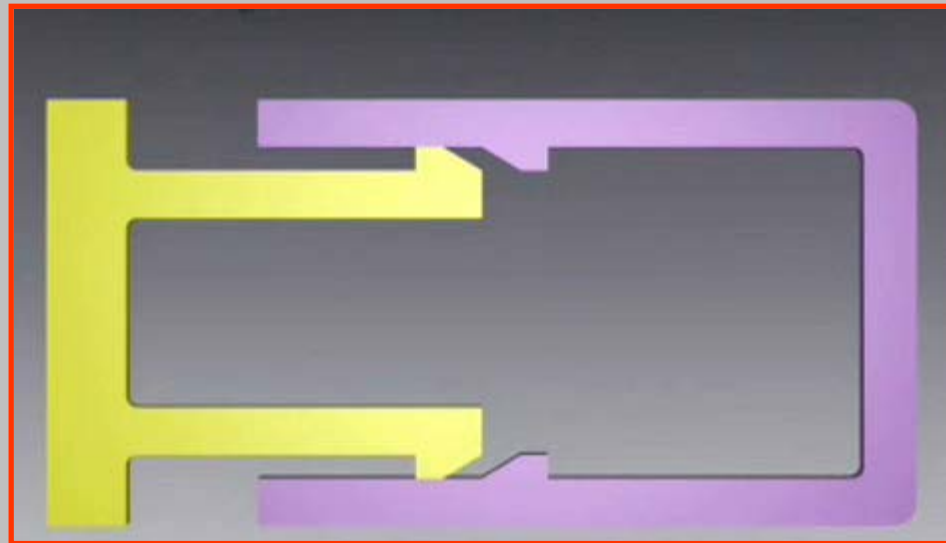
- irreversible fasteners



# Assembly

When designing for disassembly, avoid:

- non-removable snap fits



# Assembly

When designing for disassembly, avoid:

- adhesives



# Assembly

When designing for disassembly, avoid:

- plating



# Assembly

When designing for disassembly, avoid:

- ultrasonic welding



# Multi-Cavity

Design for multi-cavity use:

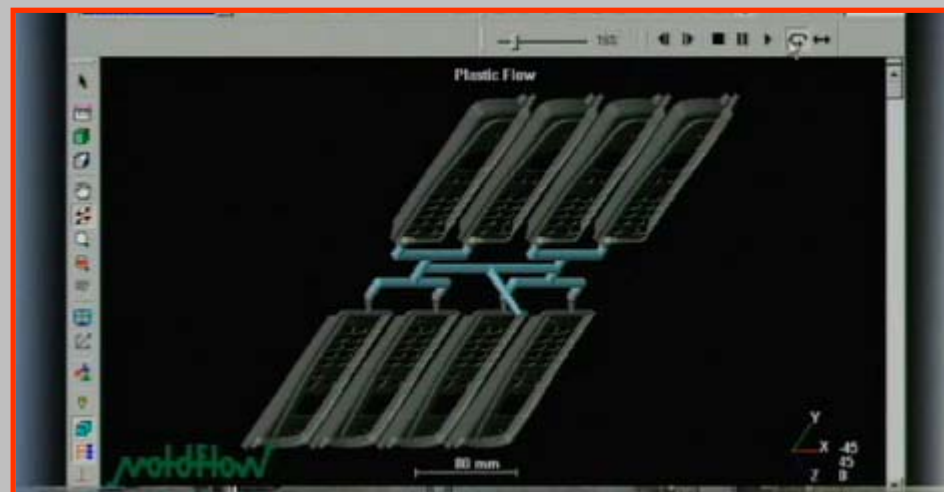
- reduces effective cycle time
- increases potential production capacity
- creates a buffer if cavity gets damaged



# Multi-Cavity

Design for multi-cavity use:

- avoid sprue gates
- avoid excessive side actions
- simplify cooling



# Special Offer – 20% discount

## Design Engineer Package

- Part Design Series
- Mold Design Series
- Understanding Plastics
- Advanced Injection Molding
- Information Provided in Follow-Up E-Mail



# Part Design for Cycle Time Reduction

Q & A Session

Please Ask Via Chat Feature

